GANDHI INSTITUTE OF TECHNOLOGY AND MANAGEMENT (GITAM)

(Deemed to be University)

VISAKHAPATNAM * HYDERABAD * BENGALURU

Accredited by NAAC with A^{+} Grade

CURRICULUM AND SYLLABUS

OF

B.Tech. Mechanical Engineering

(w.e.f. 2021-22 admitted batch)

Academic Regulations

Applicable for the Undergraduate programmes in the Faculties of
Engineering,Humanities, Management and the Sciences

https://www.gitam.edu/academic-regulations

Department of Mechanical Engineering
(Effective from academic year 2021-22 admitted batch)

Program Educational Objectives (PEO)

The program educational objectives of the Department of Mechanical Engineering Program are to produce engineers whoseattributes several years after graduation are marked by their ability to

PEO 1	Thrive as professional engineers in core mechanical engineering and other allied fields.
PEO 2	learn new knowledge and skills through professional development prospects or pursueadvanced education
PEO 3	Pursue lifelong learning opportunities to enhance and develop their technical and professional skills
PEO 4	Follow to the highest level of professional code of ethics

Program Outcomes (PO) & Program specific outcomes

Program outcomes

PO 1	Apply basic knowledge of mathematics and science to design and analyze mechanical engineering systems.
PO 2	Apply recent advances in mechanical engineering to solve industrial problems.
PO 3	Establish the procedures for experimentation using core mechanical engineering knowledgefor data collection, simulation and analysis.
PO 4	Implement computer solution methods for design and synthesis of mechanical engineeringsystems.
PO 5	Assess the influence of global changes on organization for effective decision making.
PO 6	Acquire knowledge of fast changing technologies for solving engineering problems.
PO 7	Exhibit leadership capabilities
PO 8	Perform multi-disciplinary goals as a team member.
PO 9	Communicate effectively in peer and diverse groups.
PO 10	Acquire skills to become an entrepreneur.
PO 11	Engage in life-long learning environment.
PO 12	Imbibe professional and ethical responsibility towards the society.

Programme Specific Outcomes (PSO)

After the culmination of the course students will be able to acquire:

PSO1	Competency to diagnose, interpret and unravel engineering problems in the fields of mechanical design, thermal engineering, and manufacturing technology along with alliedmulti-disciplinary streams.
PSO2	Ability to develop state-of-the-art technologies in futuristic areas of engineering throughground-breaking research.
PSO3	Aptitude for nation-building by accomplishing technological and managerial skills andbecoming Technocrats and Entrepreneurs.

Course structure of B. Tech (Mechanical Engineering) 2021-2022 admitted batch

University Core (UC)

Course code	Level	Course title	L	T	P	S	J	C
CSEN1001	1	IT Productivity Tools^	0	0	2	0	0	1*
LANG1001	1	Communication Skills in English - Beginners	0	0	4	0	0	2*
LANG1011	1	Communication Skills in English	0	0	4	0	0	2
LANG1021	1	Advanced Communication Skills in English	0	0	4	0	0	2
CLAD1001	1	Emotional Intelligence & Reasoning Skills (Softskills 1)	0	0	2	0	0	1
CLAD1011	1	Leadership Skills & Quantitative Aptitude(Softskills 2)	0	0	2	0	0	1
CLAD1021	1	Verbal Ability & Quantitative Ability(Softskills 3)	0	0	2	0	0	1
CLAD1031	1	Practicing Verbal Ability & QuantitativeAptitude (Softskills 4)	0	0	2	0	0	1
VEDC1001	1	Venture Development	0	0	0	2	0	2
DOSP10XX	1	Sports 1#	0	0	0	2	0	2*
DOSL10XX	1	Club Activity#	0	0	0	2	0	2*
POLS1001	1	Indian Constitution and History	2	0	0	0	0	2*
PHPY1001	1	Gandhi for the 21st Century	2	0	0	0	0	2*
DOSL10XX	1	Community Service#	0	0	0	0	2	2*
ENVS1001	1	Environmental Studies^	3	0	0	0	0	3*
MFST1001	1	Health and Welbeing#	0	0	2	0	0	1*
CLAD20XX	2	Softskills 5A/5B/5C	0	0	2	0	0	1
CLAD20XX	2	Softskills 6A/6B/6C	0	0	2	0	0	1
FINA3001	3	Personal Financial Planning#	0	0	2	0	0	1*

* Pass/Fail courses
# Opt any three courses among the five
^ Online/Swayam/NPTEL Courses

Softskills courses 5 and 6

Course code	Level	Course title	L	T	P	S	J	C
CLAD2001	2	Preparation for Campus Placement - 1(Softskills 5A)	0	0	2	0	0	1
CLAD2011	2	Preparation For Higher Education (GRE/GMAT) - 1 (Softskills 5B)	0	0	2	0	0	1
CLAD2021	2	Preparation for CAT/ MAT - 1 (Softskills5C)	0	0	2	0	0	1

CLAD2031	2	Preparation For Campus Placement - 2(Softskills 6A)	0	0	2	0	0	1
CLAD2041	2	Preparation For Higher Education (GRE/GMAT) - 2 (Softskills 6B)	0	0	2	0	0	1
CLAD2051	2	Preparation for CAT/ MAT - 2 (Softskills 6C)	0	0	2	0	0	1

Sports courses

Course code	Level	Course title	L	T	P	S	J	C
DOSP1001	1	Badminton	0	0	0	2	0	2
DOSP1011	1	Chess	0	0	0	2	0	2
DOSP1021	1	Carrom	0	0	0	2	0	2
DOSP1031	1	Football	0	0	0	2	0	2
DOSP1041	1	Volleyball	0	0	0	2	0	2
DOSP1051	1	Kabaddi	0	0	0	2	0	2
DOSP1061	1	Kho Kho	0	0	0	2	0	2
DOSP1071	1	Table Tennis	0	0	0	2	0	2
DOSP1081	1	Handball	0	0	0	2	0	2
DOSP1091	1	Basketball	0	0	0	2	0	2
DOSP1101	1	Tennis	0	0	0	2	0	2
DOSP1111	1	Throwball	0	0	0	2	0	2

Club activity courses

Course code	Level	Course title	L	T	P	S	J	C
DOSL1001	1	Club Activity (participant)	0	0	0	2	0	2
DOSL1011	1	Club Activity (Member of club)	0	0	0	2	0	2
DOSL1021	1	Club Activity (Leader of CLub)	0	0	0	2	0	2
DOSL1031	1	Club Activity (Competitor)	0	0	0	2	0	2

Community service courses

Course code	Level	Course title	L	T	P	S	J	C
DOSL1041	1	Community Services - Volunteer	0	0	0	0	2	2
DOSL1051	1	Community Services - Mobilizer	0	0	0	0	2	2

Faculty Core (FC)

Course code	Level	Course title	L	T	P	J	S	C
	1	Differential calculus	2	0	0	0	0	2
	1	Integral Calculus	2	0	0	0	0	2
	1	Physics	2	1	2	0	0	4
	1	Programming with Python	0	0	6	0	0	3
	1	Workshop	0	0	4	0	0	2
	1	Transform Techniques	2	0	0	0	0	2
	1	Differential Equations	2	0	0	0	0	2
	1	Chemistry	2	1	2	0	0	4
	1	Basic Electrical and Electronics Engineering	2	1	2	0	0	4
	1	Engineering Visualization and Product Realization	0	0	4	0	0	2
	1	Problem Solving and Programming in C	0	0	6	0	0	3
	2	Physics Basket 2	2	1	2	0	0	4
	2	Maths Basket 5 - Linear Algebra	2	0	0	0	0	2
	2	Design Thinking	0	0	2	0	0	1
	2	Maths Basket 6 - Complex Variables	2	0	0	0	0	2
	2	Probability and Statistics	3	0	0	0	0	3
	2	Applications of Artificial Intelligence	0	0	2	0	0	1
	3	Universal Human Values	3	0	0	0	0	3*
	3	Management Basket	3	0	0	0	0	3
	4	Capstone Project - Introduction	0	0	0	1	0	2
	4	Internship 2	0	0	0	1	0	3
	4	Capstone Project - Final	0	0	0	1	0	6
		Comprehensive Examination	1	0	0	0	0	1*
		Internship 1	0	0	0	0	1	1*
		Project Exhibition 1	0	0	0	0	1	1*
		Project Exhibition 2	0	0	0	0	1	1*

* Pass/Fail courses

Programme Core/ Major Core (PC/MaC)

Course code	Level	Course title	L	T	P	J	S	C
	2	Engineering Mechanics	2	1	0	0	0	3
	2	Thermodynamics	3	0	0	0	0	3
	2	Material Science and Engineering	2	0	2	0	0	3
	2	Computer aided machine drawing	0	0	4	0	0	2
	2	Manufacturing Processes	3	0	2	0	0	4
	2	Strength of Materials	4	0	2	0	0	5
	2	Applied Thermodynamics	3	0	2	0	0	4
	3	Mechanics of Machinery	3	0	0	0	0	3
	3	Fluid Mechanics and machinery	4	0	2	0	0	5
	3	Measurements and Metrology	3	0	2	0	0	4
	3	Design of Machine Elements	4	0	0	0	0	4
	3	Heat and Mass Transfer	3	0	2	0	0	4
	3	Introduction to CAD, CAM, and CNC machining	3	0	2	0	0	4

	4	Industrial engineering and management	3	0	2	0	0	4

Programme Elective (PE)#

Course code	Level	Course title	L	T	P	J	S	C
		Smart manufacturing basket						
		Production Tooling	3	0	0	0	0	3
		Advances in welding technology	3	0	0	0	0	3
		Unconventional Machining	3	0	0	0	0	3
		Manufacturing of Automobile Components	3	0	0	0	0	3
		Additive Manufacturing	3	0	0	0	0	3
		Computer Integrated Manufacturing	3	0	0	0	0	3
		Automation in Manufacturing	3	0	0	0	0	3
		IoT in Manufacturing	3	0	0	0	0	3
		Modern Manufacturing Methods	3	0	0	0	0	3
		Smart manufacturing systems	3	0	0	0	0	3
		Design engineering						
		Computational Methods for Mechanical Engineering.	3	0	0	0	0	3
		Control Systems Engineering	3	0	0	0	0	3
		Product Design	3	0	0	0	0	3
		Introduction to Robotics	3	0	0	0	0	3
		Advanced Strength of Materials	3	0	0	0	0	3
		Mechanics Of Composite Materials	3	0	0	0	0	3
		Mechatronics	3	0	0	0	0	3
		Finite element analysis	3	0	0	0	0	3
		Mobile Robotics	3	0	0	0	0	3
		Product life cycle management	3	0	0	0	0	3
		Mechanical Vibrations	3	0	0	0	0	3
		Tribology	3	0	0	0	0	3
		Thermal Engineering						
		Turbomachinery	3	0	0	0	0	3
		Computational Fluid Dynamics	3	0	0	0	0	3
		refrigeration and air conditioning	3	0	0	0	0	3
		Heating Ventilation and Air Conditioning	2	0	2	0	0	3
		cryogenics	3	0	0	0	0	3
		Vehicle technology	3	0	0	0	0	3
		Power Plant Engineering	3	0	0	0	0	3
		Renewable Energy Technology	3	0	0	0	0	3
		Alternative fuels and emission control	3	0	0	0	0	3
		Solar Energy	3	0	0	0	0	3
		Waste to energy	3	0	0	0	0	3
		Energy Conservation and Management	3	0	0	0	0	3
		Electric and Hybrid vehicles						
		Fundamentals of Electric and Hybrid vehicles	3	0	0	0	0	3
		Autotronics	3	0	0	0	0	3
		Fuel Cell technology and Hydrogen Storage system	3	0	0	0	0	3
		Vehicle Electrical Power systems	3	0	0	0	0	3
		Power train Integration in EHV	3	0	0	0	0	3

		AI and ML						
		Introduction to AI and ML	3	0	0	0	0	3
		Robotics and automation	3	0	0	0	0	3
		Logistics and Supply Chain Management with AI	3	0	0	0	0	3
		introduction to autonomous vehicles	3	0	0	0	0	3
		Machine Vision	3	0	0	0	0	3
		Industrial engineering						
		Statistical Quality Control	3	0	0	0	0	3
		Operations Research	3	0	0	0	0	3
		Plant Layout and Facilities Planning	3	0	0	0	0	3
		Production Planning and Control	3	0	0	0	0	3
		Inventory control	3	0	0	0	0	3
		Logistics & Supply Chain Management	3	0	0	0	0	3
		Enterprise Resource Planning	3	0	0	0	0	3
		Management Information Systems	3	0	0	0	0	3
		Engineering Optimization	3	0	0	0	0	3
		Project Planning and Management	3	0	0	0	0	3
		Decision Modelling	3	0	0	0	0	3
		Industrial Safety	3	0	0	0	0	3
		Total Quality management	3	0	0	0	0	3

Opt any five courses from Programme Elective basket

Open Elective (PE)#

Opt eligible PC/PE courses from other programmes as an open elective course and earn 24 credits

Total credit distribution

Description	Credits	% of Program (in credits)
University Core	12	8%
Faculty Core	57	36%
Major Core	52	33%
Major Electives	15	9%
Program Minor / Open Electives	24	15%
Total	160	40%
Humanities and Management	15	9%
Engineering and Technology	27	17%
Miscellaneous	24	15%
Sciences	27	17%
Programme Core	52	33%
Programme Electives	15	9%

CSEN1001: IT Productivity Tools

L	T	P	S	J	C
0	0	2	0	0	1*

This course introduces all software tools that improve the productivity of a student in enhancing his learning experience with all the activities taken up as part of his coursework.

Course Objectives

- to enable the learner, the skill in preparing technical documents of professional quality using docs, sheets and forms.
- to involve the student in designing and creating of websites and acquaint the student with the skill of processing audio, images, documents etc.
- to create awareness in analysing data using pivot tables, query manager etc.
- to create awareness in composing emails, mail merge, e-mail merge etc.
- to provide the exposure to work with collaborative tools.

List of Experiments

1. Create a typical document consisting of text, tables, pictures, multiple columns, with different page orientations.
2. Create a technical paper / technical report consisting of table of contents, table of figures, table of tables, bibilography, index, etc.
3. Compose and send customized mail / e-mail using mail-merge.
4. Create / modify a power point presentation with text, multimedia using templates with animation.
5. Create spreadsheet with basic calculations with relative reference, absolute reference and mixed reference methods.
6. Simple report preparation using filtering tool / advanced filtering commands / pivot tables in spreadsheet application.
7. Analyse the results of a examination studentwise, teacherwise, coursewise, institute-wise.
8. Collecting and consolidating data using collaborative tools like google docs, sheets, forms.
9. Create charts / pictures using online tools like: www.draw.io or smartdraw
10. Create a website of his interest.

Text Books:

1. Katherin Murray, 'Microsoft Office 365 Connect and collaborate virtually anywhere, anytime', Microsoft Press, ISBN: 978-0-7356-5694-9
2. EXCEL 2021 The Comprehensive Beginners to Advanced Users Guide to Master Microsoft Excel 2021. Learn the Essential Functions, New Features, Formulas, Tips and Tricks, and Many More
3. https://drawio-app.com/tutorials/video-tutorials/
4. Learning Web Design: A Beginner's Guide to HTML, CSS, JavaScript, and Web Graphics Fourth Edition ISBN-13: 978-1449319274

References/Online Resources

1. https://www.coursera.org/learn/introduction-to-computers-and-office-productivity-software
2. https://www.coursera.org/projects/analyze-data-pivot-tables-crosstabs-google-sheets
3. https://www.coursera.org/learn/excel-advanced#syllabus
4. https://www.coursera.org/learn/how-to-create-a-website
5. https://support.microsoft.com/en-us/office
6. https://www.diagrams.net/
7. https://edu.google.com/

Course Outcomes

- Create / alter documents / Technical Paper / Project report with text, pictures, graphs of different styles.
- Create / modify power point presentations with text, multimedia and to add animation using / creating templates.
- Perform basic calculations / retrieve data / createpivot tables / chart using a spreadsheet application.
- Create simple diagrams / charts using online tools like: www.draw.io .
- Manage documents, presentations, spreadsheets and websites in collaborative mode.

LANG1001: Communication Skills in English - Beginners

L	T	P	S	J	C
0	0	4	0	0	2*

Communication Skills in English (Beginner) is the first of the three-level courses for a developmental enhancement of learners' communication skills in English. This course focuses on giving learners exposure to factual level of comprehension (listening and reading) and application of the learning (Speaking/Writing) with an awareness for social and personality-based variations in communication. In addition to the LSRW skills, the focus of the course is on schematic thinking skills. This course is activity-based and practice-oriented in terms of procedural knowledge of vocabulary and grammatical structure. This syllabus is carefully developed to enable learners to engage in communication in English avoiding errors and be prepared for next level of learning English.

Course Objectives

- Train learners to listen actively, follow what is spoken in standard English, and answer questions to demonstrate their understanding of the main points of the speech, repeat part of what someone has said to confirm mutual understanding, though occasionally, there may be a need to ask for repetition or clarification. (Bloom's Taxonomy Level/s: 2 & 3)

- Equip learners with the skills to read and comprehend straightforward texts and simple argumentative writing to identify the topic, the desired/relevant information, the main points of the argument, and the major conclusion/s. (Bloom's Taxonomy Level/s: 2 & 4)

- Help learners apply their knowledge and language skills to make mini oral presentations, and produce short coherent written texts using appropriate cohesive devices, suitable vocabulary and grammatical structures. (Bloom's Taxonomy Level/s:3)

- Enable learners to communicate with reasonable accuracy in familiar contexts with adequate fluency and generally good control by equipping them with a repertoire of frequently used vocabulary, structures, and speech patterns. (Bloom's Taxonomy Level/s: 2 & 3)

List of Activities & Tasks for Assessment

1. Listening to others and getting to know their experiences, interests and opinions
2. Introducing oneself: Salutation, basic information, relating to the context
3. Starting a conversation: Salutation, expressing purpose, expressing gratitude
4. Sharing one's experiences, interests and opinions
5. Reading short newspaper articles for gist
6. Picking new words from an article and working on them to know the meaning and usage
7. Using the new (unknown) words in own sentences
8. Sharing news with others - initiate, sustain and conclude
9. Understanding the relevance of intonation to meaning from recorded conversations, and applying the learning in pair work (role play)
10. Writing a summary of a story/personal narrative after listening to it twice and making individual notes
11. Reading graphs, charts and maps for specific information, making note of the important information and talking briefly about it within a small peer group
12. Writing a paragraph about oneself: a brief profile including major successes, failures, and goals. Giving compliments/gratitude to others

13. Writing a paragraph (descriptive, complimentary) about others (Family, friends, role model, etc.)
14. Correcting each other's' drafts: errors in language - word choice, structure, and conventions/etiquette
15. Writing a short structured descriptive/narrative essay in 3 paragraphs, reading others' essays and sharing feedback

References

1. V. Sasikumar, P. Kiranmayi Dutt, Geetha Rajeevan. (2007). Listening and Speaking - Foundation Books Cunninhum, S. & Moor, P. (nd). New Cutting Hedge (Intermediate). Longman
2. Cambrdige Academic English: An Integrated Skills Course for EAP (Intermediate) By Craig Thaine, CUP (2012)
3. Rutherford, Andrea J. (2007). Basic Communication Skills for Technology: Second Edition. Delhi: Pearson Education.
4. McCarthy, M., O'Dell, F., Mark, G. (2005). English Vocabulary in Use. Spain: Cambridge University Press.
5. New Headway Academic Skills: Reading, Writing, and Study Skills Student's Book, Level-1 by Sarah Philpot. OUP
6. Philpot, S. & Curnick, L. (2017). Headway: Academic Skills: Reaing, Writing, and Study Skills. Introductory Level. OUP.
7. Thaine, C. (2012). Cambridge Academic English: An Integrated Skills for EAP . Intermediate. CUP.

Online References

- www.teachingenglish.org.uk
- learnenglishteens.britishcouncil.org
- https://eslflow.com/
- https://www.englishclub.com/
- https://www.oxfordlearnersdictionaries.com/
- https://dictionary.cambridge.org/
- learnenglishteens.britishcouncil.org
- https://freerice.com/categories/english-vocabulary

Course Outcomes

- Listen actively, understand and extract the essential information from short talks/conversations/discussions that are delivered in clear, standard speech. (Bloom's Taxonomy Level/s: 2 & 3)
- Read, understand, and extract specific information from straightforward factual and simple argumentative texts on general topics and subjects of interest. (Bloom's Taxonomy Level/s: 2 & 3)
- Speak clearly with some confidence on matters related to his/her interests and academic work, and make short structured oral presentations on topics of personal interest. (Bloom's Taxonomy Level/s: 3)
- Write short straightforward connected texts on a range of familiar/general topics using appropriate linking devices to achieve a clear sequence of ideas. (Bloom's Taxonomy Level/s: 3)
- Acquire sufficient language competency to express oneself in speech and writing with some confidence, using appropriate vocabulary and simple grammatical structures though lexical limitations and/or difficulty with formulation might be evident at times. (Bloom's Taxonomy Level/s: 2 & 4)

LANG1011: Communication Skills in English

L	T	P	S	J	C
0	0	4	0	0	2

Communication Skills in English (Intermediate) is the second of the three-level graded courses for a developmental enhancement of communication skills in English. Based on the learning outcomes set in the beginner level syllabus, this course focuses on giving learners more exposure to the use of language for communicative purposes and equip them with next level skills (ref. Bloom's taxonomy) and practice in terms of complexity and cognitive engagement. This course also includes inferential level of comprehension (listening and reading) that involves analysis and application of the language skills and decision-making skills while speaking/writing with an awareness for social and personality-based variations in communication. This course emphasizes guided writing through adequate tasks with pre and post context building. The focus is on stimulation and application of critical thinking in addition to schematic thinking for communication in real-life situations.

Course Objectives

- Train learners to actively listen to short audio texts with familiar content; guided activity like question-making and responding to others' questions based on the audio text would help learners engage in transactional dialogue; extended activities like extrapolating/critiquing the responses would help learners enhance their schematic thinking. (Bloom's Taxonomy Level/s: 2 & 4)
- Equip learners with strategies to read actively and critically and understand the writers' viewpoints and attitude by providing reading comprehension tasks using authentic texts such as op-ed articles from newspapers, and reports on contemporary problems. (Bloom's Taxonomy Level/s: 4 & 5)
- Help learners understand various aspects and techniques of effective presentations (group/individual) through demonstration and modelling, and enabling them to develop their presentation skills by providing training in using the tips and strategies given. Learners would be encouraged to observe and express opinion on teacher-modelling. Reflection on issues like anxiety, stage-fear, confidence, and levels of familiarity with topic and audience would be addressed. Practice would be given on tone, pitch, clarity and other speech aspects. Detailed peer feedback and instructor's feedback would cover all the significant aspects. (Bloom's Taxonomy Level/s: 2 & 4)
- Enable learners to become aware of the structure and conventions of academic writing through reading, demonstration, scaffolding activities, and discussion. Corrective individual feedback would be given to the learners on their writing. (Bloom's Taxonomy Level/s: 2 & 3)

List of Tasks and Activities

S. No.	Tasks	Activities
1	Listening to subject related short discussions/ explanations/ speech for comprehension	Pre-reading group discussion, Silent reading (Note-making), Modelling (questioning), Post-reading reflection /Presentation
2	Asking for information: asking questions related to the content, context maintaining modalities	Group role-play in a context (i.e. Identifying the situation and different roles and enacting their roles)

3	Information transfer: Verbal to visual (familiar context), demonstration by teacher, learners' task (guided with scaffolding), learners' task (free), presentation and feedback	Pair work for discussion & feedback, Presentations, question-answer
4	Information transfer: Visual to verbal (unfamiliar context); demonstration by teacher, learners' task (guided with scaffolding), learners' task (free), presentation and feedback	Pre-reading game/modelling, discussion in small groups, individual writing, and feedback
5	Introducing officials to peers and vice versa - Formal context	AV support, noticing, individual performance (3-4), pair work (in context), teacher modelling, group work for Introducing self and others in a formal context
6	Introducing friends to family and vice versa - Informal context	Teacher modelling/AV support, noticing structure & note-taking, Introducing friends and family in an informal context
7	Vocabulary in context: Find clues in a text and use them to guess the meaning of words/phrases. Apply the newly learnt vocabulary in communication (speaking and writing).	Comprehending verbal communication: Identifying the contextual clues in oral and written texts; guessing the meaning of words/phrases in context while reading texts and listening to discussions/talks
8	A five-day journal (diary) writing based on learners reading from newspaper on a single relevant/current social issue. Individual oral presentation and feedback from peers and instructor.	Note-making (group work), Discussion, Feedback
9	Follow the essentials of lectures, talks, discussions, reports and other forms of academic presentations and mak2 individual and group presentations aided with images, audio, video, tabular data, etc.	Making power point presentation aided with images, audio, video, etc. with a small group by listening to academic lectures/talks/ discussions, etc.
10	Self-reflection: Re-reading one's own drafts, identifying errors, correcting the errors, and giving rationalize the changes	Pre-task discussion/modelling, Editing the texts by careful reading and identifying the errors, peer-exchange (Pair work), feedback/consolidation
11	Collaborative work (speaking and writing) in small groups of 3 or 4 learners: discussing a general/discipline-specific topic: creating outline, assigning specific roles to members of the group; and group presentation followed by peer and instructor feedback	Pre-task modelling (peer/teacher), general discussion on structure, group work (collaboration), feedback
12	Independent reading of different text types using appropriate reference sources by adapting suitable reading styles and speed. Focus on active reading for vocabulary: low-frequency collocations and idiomatic expressions.	Brain-storming, mapping of key terms (content specific), reading and note-making (individual), oral questioning, discussion
13	Role-play (specific social and academic situations): planning (making notes), understanding nuances of speaking in context, coordinating with situational clues and fellow speakers/participants	Peer discussion for outline, A-V support, observing (teacher modelling), role play (guided), role-play (free), feedback
14	Writing instructions: Guidelines - Flowcharts - Procedures to be followed	Pre-task reading, pair work, teacher/peer-discussion, feedback
15	Speaking spontaneously on topics of interest and writing short structured essays on the same topics adopting appropriate academic conventions and grammatical accuracy.	Reading for task preparation, note-making, speaking, reflection and corrective peer and teacher feedback

Reference Books

1. P. Kiranmayi Dutt, Geetha Rajeevan. (2007). Basic Communication Skills. Foundation Books. CUP
2. Harmer, J. (1998). How to teach English. Longman
3. Sanjay Kumar & Pushp Lata. (2018). Communication Skills: A Workbook. OUP.
4. Cambridge IGCSE: English as a Second Language Teacher's Book Fourth Edition. By Peter Lucantoni. CUP (2014).
5. Cambrdige Academic English: An Integrated Skills Course for EAP (Upper Intermediate) By Martin Hewings, CUP (2012)
6. Richards, J.C. and Bohlke, D. (2012). Four Corners-3. Cambridge: CUP.
7. Headway Academic Skills: Reading, Writing, and Study Skills Student's Book, Level-2 by Sarah Philpot. OUP
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Online Resources

1. https://www.grammarly.com/blog/
2. https://www.nationalgeographic.org/education/
3. https://www.bbc.co.uk/teach/skillswise/english/zjg4scw
4. https://www.englishclub.com/
5. https://www.oxfordlearnersdictionaries.com/
6. https://dictionary.cambridge.org/
7. learnenglishteens.britishcouncil.org
8. https://freerice.com/categories/english-vocabulary
9. http://www.5minuteenglish.com/
10. https://breakingnewsenglish.com/
11. https://www.digitalbook.io/
12. https://librivox.org/

Course Outcomes

- Understand the speaker's point of view in fairly extended talks on general or discipline-specific topics, and follow simple lines of argument in discussions on familiar contemporary issues. (Bloom's Taxonomy Level/s: 3)

- "Read and demonstrate understanding of articles and reports on limited range of contemporary issues in which the writers adopt particular stances. Also provide samples of written communication containing fairly complex information and reasons for choices/opinions/stances. (Bloom's Taxonomy Level/s: 2 & 3)"

- Make short presentations on a limited range of general topics using slides, and engage in small group discussions sharing experiences/views on familiar contemporary issues and give reasons for choices/opinions/plans. (Bloom's Taxonomy Level/s: 3 & 4)

- Write clear, fairly detailed text (a short essay) on a limited range of general topics, and subjects of interest, and communicate clearly through email/letter to seek/pass on information or give reasons for choices/opinions/plans/actions. (Bloom's Taxonomy Level/s: 3)

- Reflect on others' performance, give peer feedback on fellow learners' presentations, responses to writing tasks and reading comprehension questions. (Bloom's Taxonomy Level/s: 5)

LANG1021: Advanced Communication Skills in English

L	T	P	S	J	C
0	0	4	0	0	2

Communication Skills in English (Advanced) is the third of the three-level graded courses for a developmental enhancement of communication skills in English. Based on the learning outcomes set in the upper-intermediate syllabus, this course focuses on giving learners exposure to higher level of skills/input processing (ref. Bloom's taxonomy) and practice in terms of complexity and cognitive engagement. This course includes advanced level of comprehension i.e. anaytical, evaluative and extra-polative processing (listening and reading) and involves problem-solving, logical reasoning and decision-making skills in terms of application of the learning (speaking/writing) with an awareness for social and personality based variations in communication. This course provides opportunities with activity-based practice of advanced oral and written communicative skills besides building awareness on the finer nuances of language use for various purposes. This course emhasizes free writing through meaningfully engaging tasks with a pre and post context building. There is ample scope for application of critical thinking through simulated activities for effective communication in real life situations.

Course Objectives

1. Enable learners to listen actively become aware of tone and attitude in speech, and demonstrate their comprehension of fairly complex lines of argument presented by a variety of speakers in talks/presentations/discussions. (Bloom's Taxonomy Level/s: 2 & 4)

2. Enable learners to become aware of tone and attitude in written texts, and demonstrate their comprehension of fairly complex lines of argument and points of view presented in a variety of texts by equipping them with upper intermediate to advanced level reading skills and strategies. (Bloom's Taxonomy Level/s:2 & 3)

3. Make effective presentations, engage in formal group discussions, and write structured essays/ short reports to highlight the significance of actions/decisions/experiences, and sustain views by providing relevant evidence and argument. (Bloom's Taxonomy Level/s: 3 & 4)

4. Equip learners with the skills and strategies to communicate effectively in speech and writing using the language with a degree of fluency, accuracy and spontaneity, and fairly good grammatical control adopting a level of formality appropriate to the context. Encourage learners to apply their knowledge of language and their communication skills in real life situations. (Bloom's Taxonomy Level/s:3 & 5)

List of Activities & Tasks for Assessment

S.No.	Tasks	Activities	CO
1	Evaluative and extrapolative reading of a long text/short texts on a current topic related to technology and society, identifying and questioning the author's intention, post-reading discussion in small groups, maintaining group dynamics, arriving at a consensus	Pre-reading group discussion, silent reading (Note-making), modelling (questioning), post-reading reflection and brief presentation of thoughts/ideas/opinions on the theme of the text	3
2	Debate in pairs based on listening to two recorded contemporary speeches by well-known leaders in different fields. Peer feedback and instructor feedback.	Pre-recorded audio/video for listening, student checklist for noticing key words/concepts, pre-task orientation (by teacher), pair work, feedback	1
3	Information transfer: Verbal to visual (unfamiliar context); demonstration by teacher, learners' task (guided with scaffolding), learners' task (free), presentation, question-answer(among students), modification and feedback before the final version is done	Pair work for discussion and feedback, presentations, question-answer	2
4	Information transfer: Visual to verbal (unfamiliar context); demonstration by teacher, learners' task (guided with scaffolding), learners' task (free), presentation, question-answer(among students), modification, editing, proofreading, and feedback before the final version is done	Pre-reading game/modelling, discussion in small groups, independent writing and feedback	4
5	Expressing opinion on a short argumentative text (e.g. a journal article or a newspaper editorial) and justifying one's opinion/stance; focus on the use of appropriate conventions of formal and polite speech, and managing bias	Listening to group discussions/debates, reading news-paper articles on the current issues and expressing opinions in favour or against the topic (in GDs, debates or writing argumentative essays).	3
6	Role-play (complex social and academic/professional situations): Focus on significant aspects of delivery including clarity, tone, and use of contextually appropriate vocabulary and conventions, observation, reflective discussion, and self-reflective writing	Reading newspaper/magazine articles/blog posts on current social issues, listening to talks/discussions/debates etc. and participating in role-plays using expressions appropriate to the context.	1
7	Collborative writing in groups of 3 -4 on topics that would require data collection and reading followed by recorded peer-reflection and peer-feedback, group presentation and feedback	Pre-task modelling (peer), general discussion on structure, group work (collaboration), presnetation, peer feedback, Open-class discussion	5
8	Formal Group Discussion on topics of current interest and relevance; focus on effective participation, reflection on control over argument/counter argument, and adherence to the conventions of formal GD	Noticing strategies from AV modelling, teacher scafolding though open-house discussion, Note-making (Group work), Group Discussion (free), post perfromance discussion, Feedback	2

9	Mind-mapping for advanced reading, making correlations across texts, extending author's point of view	Reading texts on abstract topics and comprehending the author's perspective by inferring the unknown words' meaning in the context and making notes using mind-map strategy and presenting it orally.	3
10	Handling question and answer sessions after presentations: justifying arguments, taking counter-arguments, agreeing and disgreeing with rationale	Listening to some lectures, talks, and presentations in the academic seminars and adapting some strategies to handle the Q&A sessions using polite and formal expressions to agree or disagree with the statements.	1
11	Modelling an interview: with a panel of four judges (peers)	Pre-task activity for orientation/strategies (controlled/guided), Model interview (AV support), Group work (role play), interview in pair (one-to-one), Interview in group (many -to-one), oral corrective feedback (peer/teacher)	2
12	Writing a short reflective report of an event - incident/meeting/celebration	Writing a report on meetings/celebrataions/events etc. by actively involving in such events and giving a short oral presentation on the same.	4
13	Speaking on abstract and complex topics beyond his/her own area of interest/field of study, using the language flexibly and effectively.	Reading texts on abstract topics and comprehending the author's perspectives. Similarly, listening to talks and discussions on an abstract topic of other discipline and making short oral presentation by sharing views and opinions.	3
14	Self-relfection on own speech in context(recorded): tone, pitch, relevance, content; extending the reflections/ideas to others	Listening to selected general discussions (audios and videos) and observing the language production. Recording own speech on some general topic and providing a critical review (self-reflection) on it by focusing on the tone, expressions and relevance of the content, etc.	1
15	Collaborative and individual task: planning, preparing (preparing an outline, structure, setting objectives and presenting the plan of action) and executing a mini-project, and submitting a brief report on the same peer and instructor feedback after the planning stage and on completion of the mini project	Pre-task modelling (peer/teacher), general discussion on structure, group work (collaboration), oral corrective, task distribution, presentation, feedback	5

Reference Books

1. Latham-Koenig, C. & Oxenden, C. (2014). American English File-5. Oxford: OUPRichards,
2. J.C. and Bohlke, D. (2012). Four Corners-4. Cambridge: CUP.
3. Cambrdige Academic English: An Integrated Skills Course for EAP (Advanced) By Martin Hewings and Craig Thaine, CUP (2012)

4. Berlin, A. (2016). 50 Conversation Classes: 50 Sets of Conversation Cards With an Accompanying Activity Sheet Containing Vocabulary, Idioms and Grammar. Poland: CreateSpace Independent Publishing Platform
5. Zemach, D. E., Islam, C. (2011). Writing Paragraphs: From Sentence toParagraph. Germany: Macmillan Education.
6. Stewart, J. P., Fulop, D. (2019). Mastering the Art of Oral Presentations: Winning Orals, Speeches, and Stand-Up Presentations. United Kingdom: Wiley.
7. Kroehnert, Gary. (2010). Basic Presentation Skills. Sidney: McGraw Hill.
8. Cunninghum, S. & Moor, P. (nd). Cutting Edge (Advanced) With Phrase Builder. Longman Publishers. CUP
9. McCarthy, M & O'Dell, F. (2017). English Idioms in Use (Advanced). Cambridge: CUP.

Online Resources

1. https://www.grammarly.com/blog/
2. https://www.nationalgeographic.org/education/
3. https://www.bbc.co.uk/teach/skillswise/english/zjg4scw
4. https://www.englishclub.com/
5. https://www.oxfordlearnersdictionaries.com/
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7. learnenglishteens.britishcouncil.org
8. https://freerice.com/categories/english-vocabulary
9. http://www.5minuteenglish.com/
10. https://breakingnewsenglish.com/
11. https://www.digitalbook.io/
12. https://librivox.org/

Course Outcomes

- Listen to extended lectures, presentations, and discussions on a wide range of contemporary issues and demonstrate understanding of relatively complex lines of argument. (Bloom's Taxonomy Level/s: 2)
- Make presentations using suitable AV aids and engage in formal group discussions on a wide range of topics of contemporary interest, demonstrating awareness of standard/widely accepted conventions. (Bloom's Taxonomy Level/s: 3)
- Read and demonstrate understanding of the writer's stance/viewpoint in articles and reports on a wide range of contemporary issues and discipline-specific subjects. (Bloom's Taxonomy Level/s: 2 & 4)
- Write analytical essays on a wide range of general topics/subjects of interest, and engage in written communication (emails/concise reports) to exchange relatively complex information, giving reasons in support of or against a particular stance/point of view. (Bloom's Taxonomy Level/s: 3 & 4)
- Complete a mini project that necessitates the use of fairly advanced communication skills to accomplish a variety of tasks and submit a report in the given format. (Bloom's Taxonomy Level/s: 4 & 5)

CLAD1001: Emotional Intelligence & Reasoning Skills (Soft Skills 1)

L	T	P	S	J	C
0	0	2	0	0	1

Course Description:

Emotional intelligence is a set of skills that are thought to contribute to the appraisal of emotions in oneself and others. It can also help contribute to the effective regulation of emotions as well as feelings (Salovey & Mayer, 1990). In terms of emotional intelligence, self-awareness and self-management have to do with our ability to relate to ourselves. Social awareness and relationship management have to do with our ability to relate to others. Similarly, the ability to solve questions on Analytical Reasoning and Data Sufficiency is a critical area tested in almost all competitive examinations and admission tests. Upon completion, students should be able (1) to deal with their own emotions as well as the emotions of others and relate better with both. Using better knowledge of EI, students will also be able to set more meaningful goals for themselves, choose suitable time management techniques that work best for them and work in teams more effectively. (2) to apply different concepts, ideas and methods to solve questions in reasoning and data sufficiency

Course Objectives:

1. Use EI to relate more effectively to themselves, their colleagues and to others. Apply self awareness and self assessment (SWOT) to better understand and manage their own emotions. Apply social awareness to empathize with others and build stronger relationships with others.
2. Set meaningful goals based on their strengths and weaknesses and apply time management techniques, such as Q4 organizing to put first things first.
3. Manage conflicts and work in teams in an emotionally intelligent manner.
4. Solve questions on non-verbal and analytical reasoning, data sufficiency and puzzles

Unit	Topics	Hours
1	Self Awareness & Self Regulation: Introduction to Emotional Intelligence, *Self Awareness:* Self Motivation, Accurate Self Assessment (SWOT Analysis), Self Regulation: *Self Control, Trustworthiness & Adaptability*	3
2	Importance, Practising Social Awareness, Building Relationships, Healthy and Unhealthy Relationships, Relationship Management Competencies- Influence, Empathy, Communication, Types of Conflicts, Causes, Conflict Management	3
3	Social Media: Creating a blog, use of messaging applications, creating a website to showcase individual talent, creation of a LinkedIn Profile	2
4	Goal Setting & Time Management: Setting SMART Goals, Time Wasters, Prioritization, Urgent Vs Important, Q2 Organization	3
5	Teamwork: Team Spirit, Difference Between Effective and IneffectiveTeams, Characteristics of High Performance Teams, Team Bonding, Persuasion, Team Culture, Building Trust, Emotional Bank Account	4
6	Verbal Reasoning: Introduction,Coding-decoding, Blood relations, Ranking, Directions, Group Reasoning	6
7	Analytical Reasoning: Cubes and Dices, Counting of Geometrical figures	3
8	Logical Deduction: Venn diagrams, Syllogisms, Data Sufficiency, Binary logic	4
9	Spatial Reasoning: Shapes, Paper Cutting/Folding, Mirror images, Water images and Rotation of figures	2
	Total Hours	30

Course Outcomes

- Students will be able to relate more effectively to themselves, their colleagues and to others
- Students will be able to set their short term and long term goals and better manage their time
- Students will be able to manage conflicts in an emotionally intelligent manner and work in teams effectively
- Students will be able to solve questions based on non-verbal and analytical reasoning, data sufficiency and puzzle

References:

1. Verbal Ability & Reading Comprehension by Arun Sharma and Meenakshi Upadhyay
2. Study material for CAT, SAT, GRE, GMAT by TIME, CareerLauncher and IMS etc.
3. Quantitative Aptitude by R S Agarwal S Chand Publications
4. Quantitative Aptitude by Pearson Publications

CLAD1011: Leadership Skills & Quantitative Aptitude
(Soft Skills 2)

L	T	P	S	J	C
0	0	2	0	0	1

Course Description:

Communication Skills is having the ability to convey information to others so that messages are understood and outcomes delivered. Some essential qualities of Communication Skills include understanding the needs of others, clearly communicating messages, adapting the communication style, and using a range of communication methods. Presentation Skills is having the ability to confidently deliver an engaging message to a group of people which achieves the objectives. Some essential qualities of Presentation Skills include a thorough preparation of content, structuring content logically, managing nerves, engaging your audience, delivering presentation objectives, positively influencing the audience, and responding to audience needs. Tackling questions based on numbers, arithmetic, data interpretation and puzzles requires the application of different rules and concepts of numerical computation, numerical estimation, and data estimation.

Course Objectives:

1. Learn and apply, through different individual and group activities, different ideas and skills to communicate in a positive and impressive manner.
2. Apply the goal setting process (based on SWOT) and Q2 organizing for effective time management.
3. Apply different concepts in numbers, numerical computation and numerical estimation to solve questions that often appear in various competitive examinations and admission tests.
4. Apply different concepts for tackling questions based on data interpretation, progression and series that are frequently given in various competitive examinations and admission tests.

Unit	Topics	Hours
1	Communication Skills: *The Communication Process*, Elements of Interpersonal Communication, *Non-Verbal Communication:* Body Language, Posture, Eye Contact, Smile, Tone of Voice, *Barriers to Communication.* Effective Listening Skills: Active Listening, Passive Listening, Asking Questions, Empathizing, Being Non Judgemental, Being Open Minded, Mass Communication: Design of Posters, Advertisements, notices, writing formal and informal invitations	5
2	Focus on Audience Needs, Focus on the Core Message, Use Body Language and Voice, Start Strongly, Organizing Ideas & Using Visual Aids: SPAM Model, Effective Opening and Closing Techniques, Guy Kawasaki's Rule (10-20-30 Rule), Overcoming Stage Fear, Story Telling	3
3	Problem Solving & Decision Making: Difference Between the Two, Steps in Rational Approach to Problem Solving: Defining the Problem, Identifying the Root Causes, Generating Alternative Solutions, Evaluating and Selecting Solutions, Implementing and Following-Up, Case Studies	3

4	Group Discussion: Understanding GD, Evaluation Criteria, Nine Essential Qualities for Success, Positive and Negative Roles, Mind Mapping, Structuring a Response, Methods of Generating Fresh Ideas	4
5	Number Theory: Number System, Divisibility rules, Remainders and LCM & HCF	3
6	Numerical Computation and Estimation - I : Chain Rule, Ratio Proportions, Partnerships & Averages, Percentages, Profit-Loss & Discounts, Mixtures, Problems on Numbers & ages	6
7	Data Interpretation: Interpretation and analysis of data in Tables, Caselets, Line-graphs, Pie-graphs, Box-plots, Scatter-plots and Data Sufficiency	3
8	Mental Ability: Series(Number, Letter and Alphanumeric), Analogy(Number, Letter and Alphanumeric) and Classifications	3
	Total Hours	30

Course Outcomes

- Students will be able to communicate 'one-on-one' and 'one-on-many' confidently using both verbal and non-verbal messages and deliver impressive talks/ presentations to a group both with and without the use of PPTs and create posters, advertisements, etc.
- Students will be able to apply the the rational model of problem solving and decision making in their problem solving and decision making efforts.
- Students will be able to solve questions based on numbers and arithmetic given in various competitive examinations
- Students will be able to solve questions based on data interpretation, progressions and series.

References:

1. Verbal Ability & Reading Comprehension by Arun Sharma and Meenakshi Upadhyay
2. Study material for CAT, SAT, GRE, GMAT by TIME, CareerLauncher and IMS etc.
3. Quantitative Aptitude by R S Agarwal S Chand Publications
4. Quantitative Aptitude by Pearson Publications

CLAD1021: Verbal Ability & Quantitative Ability (Soft Skills 3)

L	T	P	S	J	C
0	0	2	0	0	1

Course Description:

Vocabulary is an important part of verbal ability. An understanding of word formation, prefixes, suffixes and roots is necessary to remember and use a vast repository of words. Approaching words through word families and other ways of groupings is an effective way of gaining mastery over vocabulary. Understanding and getting acquainted with the different rules and exceptions in the use of grammar and structure, especially from the relevant examination point of view, is crucial to cracking questions given in many competitive tests. Similarly, improving reading comprehension skills and test taking abilities in this area takes time and effort, especially given the fact that most students do not possess strong reading habits. In so far as quantitative aptitude is concerned, students need to develop a strong foundation on the basic mathematical concepts of numerical estimation, geometry, mensuration, data sufficiency, etc. to be able to crack different round 1 tests of major recruiters and admission tests of top Indian and foreign universities.

Course Objectives:

1. List and discuss the different word formation methods, word denotation, connotation, collocation, etc. and introduce selected high frequency words, their antonyms, synonyms, etc
2. Apply different advanced reading skills to solve questions based on author's tone, main ideas and sub-ideas, inferences, parajumbles, etc. that are frequently asked in various competitive exams and admission tests.
3. Solve different types of questions based on vocabulary, such as word analogy; structure, grammar and verbal reasoning; introduce common errors and their detection and correction.
4. Solve questions on numerical estimation, mensuration, data sufficiency based on quantitative aptitude. This includes questions on time and work, time and distance, pipes and cisterns, lines and angles, triangles, quadrilaterals, polygons and circles, 2 & 3 dimensional mensuration.

1. **Vocabulary Builder:** Understanding Word Formation, Prefixes, Suffixes and Roots, Etymology, Word Denotation, Connotation and Collocation, Synonyms and Antonyms

2. **Reading Comprehension:** Advanced Reading Comprehension: Types of RC passages, Types of Text Structures, Types of RC Questions: Distinguishing Between Major Ideas and Sub Ideas, Identifying the Tone and Purpose of the Author, Reading Between the Lines and Beyond the Lines, Techniques for Answering Different Types of Questions

3. **Para Jumbles:** Coherence and Cohesion, Idea Organization Styles, Concept of Mandatory Pairs and Its Application: Transitional Words, Antecedent-Pronoun Reference, Article Reference, Cause and Effect, Chronological Order, General to Specify, Specify to General, Idea-Example, Idea-Explanation, Etc.

4. **Grammar Usage:** Rules Governing the Usage of Nouns, Pronouns, Adjectives, Adverbs, Conjunctions, Prepositions and Articles

5. **Numerical Computation and Estimation - II:** Time and Work, Pipes and Cisterns, Time and Distance, Problems on Trains, Boats and Streams, Races and Games of Skill, Simple Interest & Compound Interest

6. **Geometry:** Lines and Angles, Triangles, Quadrilaterals & Polygons, and Circles

7. **Mensuration:** 2-Dimensional Mensuration (Triangles, Quadrilaterals and Circles), 3-Dimensional Mensuration (Cubes, Cuboids, Cylinder, Cone, Sphere)

Course Outcomes:

1. List and discuss word formation methods, selected high frequency words, their antonyms, synonyms, etc.
2. Analyze reading passages and quickly find out the correct responses to questions asked, including para jumbles, by using reading skills like skimming, scanning, reading between the lines, etc.
3. Solve different types of questions based on vocabulary, structure, grammar and verbal reasoning
4. Solve questions on numerical estimation, mensuration, data sufficiency based on quantitative aptitude

References:

1. Verbal Ability & Reading Comprehension by Arun Sharma and Meenakshi Upadhyay
2. Study material for CAT, SAT, GRE, GMAT by TIME, CareerLauncher and IMS etc.
3. Quantitative Aptitude by R S Agarwal S Chand Publications
4. Quantitative Aptitude by Pearson Publications

CLAD1031: Practicing Verbal Ability & Quantitative Aptitude (Soft Skills 4)

L	T	P	S	J	C
0	0	2	0	0	1

Course Description:

A sound knowledge of the rules of English grammar, structure and style and its application in detecting errors in writing are important areas of Verbal Ability frequently tested as a part of the written test in many competitive examinations and admission tests of major recruiters and universities respectively. This module focuses on all important areas of grammar and structure commonly asked in major tests, such as GMAT, CAT, XLRI, CRT, etc. Similarly, in the area of Quantitative Aptitude, different kinds of questions are asked from Combinatorics (Permutations & Combinations, Probability], Cryptarithmetic & Modular Arithmetic (Cryptarithmetic, Application of base system (7, 24), Clocks (Base 24), Calendars (Base 7), and Mental Ability (Number series, Letter series & Alpha numeric series, Analogies (Numbers, letters), Classifications, Algebra (Exponents, Logarithms, Problems related to Equations, Special Equations, and Statistics) . This module focuses on all these areas by building on what the students already learnt in their earlier studies.

Course Objectives:

1. Apply the rules of grammar to solve questions in Error Detection, Sentence Correction and Sentence Improvement.
2. Apply the rules of structure to solve questions in Error Detection, Sentence Correction and Sentence Improvement, Fill-in-blanks and Cloze Passages.
3. Explain methods of solving problems in Combinatorics (Permutations & Combinations, Probability], Cryptarithmetic & Modular Arithmetic (Cryptarithmetic, Application of base system (7, 24), Clocks (Base 24), Calendars (Base 7)]
4. Explain how to solve questions in Mental Ability (Number series, Letter series & Alpha numeric series, Analogies, Numbers, letters, Classifications] and Algebra (Exponents, Logarithms, Problems related to Equations, Special Equations, Statistics)

1. Error Detection: Pronouns, Conjunctions, Prepositions and Articles
2. Error Detection: Tenses and their Uses
3. Sentence Correction: Subject-Verb Agreement, Antecedent-Pronoun Agreement, Conditional Clauses
4. Sentence Correction: Modifiers (Misplaced and Dangling) & Determiners, Parallelism & Word Order, and Degrees of Comparison
5. Combinatorics: Permutations & Combinations, Probability

6. Crypt arithmetic & Modular Arithmetic: Crypt arithmetic, Application of Base System (7, 24), Clocks (Base 24), Calendars (Base 7)

7. Algebra: Exponents, Logarithms, Word-problems related to equations, Special Equations, Progressions, Statistics

Course Outcomes:

1. Identify and correct errors in English grammar and sentence construction
2. Identify and correct errors in Structure, Style and Composition
3. Solve problems in Combinatorics, Cryptarithmetic, and Modular Arithmetic
4. Solve problems in Mental Ability and Algebra

References:

1. Verbal Ability & Reading Comprehension by Arun Sharma and Meenakshi Upadhyay
2. Study material for CAT, SAT, GRE, GMAT by TIME, CareerLauncher and IMS etc.
3. Quantitative Aptitude by R S Agarwal S Chand Publications
4. Quantitative Aptitude by Pearson Publications

VEDC1001: Venture Development

L	T	P	S	J	C
0	0	0	2	0	2

Course Description

In this course, you will discover your deeper self in terms of how you might contribute to society by creating exciting new products and services that can become the basis of a real business. Your efforts, creativity, passion, and dedication to solving challenging problems are the future of our society, both in your country and worldwide.

The course is divided into four sections:

1. Personal discovery of your core values and natural skills
2. Ideation and improving the impact
3. Business model design for the innovation
4. Presenting your idea in a professional manner suitable for a new venture pitch

Each section has key frameworks and templates for you to complete, improving your idea step by step until the final presentation.

First, you will discover your personal values and emerging areas of knowledge that are the foundations of any successful company. Next, you will learn how to develop insight into the problems and desires of different types of target customers and identify the design drivers for a specific innovation. Then, you will learn specific design methods for new products and services. And as important as the product or service itself, it is a strategy for monetizing the innovation – generating revenue, structuring the operating costs, and creating the operating profit needed to support the business, hire new employees, and expand forward.

This project is intended to be for teams of students. Innovation and entrepreneurship are inherently team-based. This course will give you that entrepreneurial experience.

This is the beginning of what might be the most important journey of personal and career discovery so far in your life, one with lasting impact. This is not just a course but potentially an important milestone in your life that you remember warmly in the years to come.

Course Objectives

Students will have the opportunity to:

- Discovery who you are – Values, Skills, and Contribution to Society
- Understand how creativity works and permeates the innovation process
- Learn the basic processes and frameworks for successful innovation.
- Gain experience in actually going through the innovation process.
- Conduct field research to test or validate innovation concepts with target customers.
- Understand innovation outcomes: issues around business models, financing for start-ups, intellectual property, technology licensing, corporate ventures, and product line or service extensions.

Course Materials

- Meyer and Lee (2020), Personal Discovery through Entrepreneurship, The Institute for Enterprise Growth, LLC. Boston, MA., USA
- Additional readings

- Additional videos, including case studies and customer interviewing methods.

Expectations of you in the classroom: Each student is expected to be prepared to discuss the readings/exercises assigned for each class. It's not optional! Students will be randomly asked to discuss and summarize the material. Your learning – and your success—in this course are heavilydependent upon your willingness to participate actively in class discussion. Your class participation will be assessed on the quality and consistency of your effort in each and every class.

Late assignments: Late assignments are subject to grade penalty. Lateness will only be considered for grading if prior notice was given to the instructor before the due date.

Presentation: Achieving success with an innovative idea requires you to package and present the idea in a crisp, creative, and powerful manner. The activity of presenting helps you to internalize your idea -- as you talk about it and obtain feedback – and improve upon it. There would be two major presentations during the course, plus a series of other smaller unscheduled presentations of work in progress or course material. Prepare, practice, and succeed!

Time spent outside of class: The course is hands-on and requires students to conduct field research through direct interactions with people (interviews/surveys) and online/in the library. Specifically, the course requires that students conduct studies with potential target users and stakeholders. You must be prepared to go out of your comfort zone to dig for information. You will need to search for information online and arrange to meet or talk to relevant people who may have the information you need.

Group Project Overview

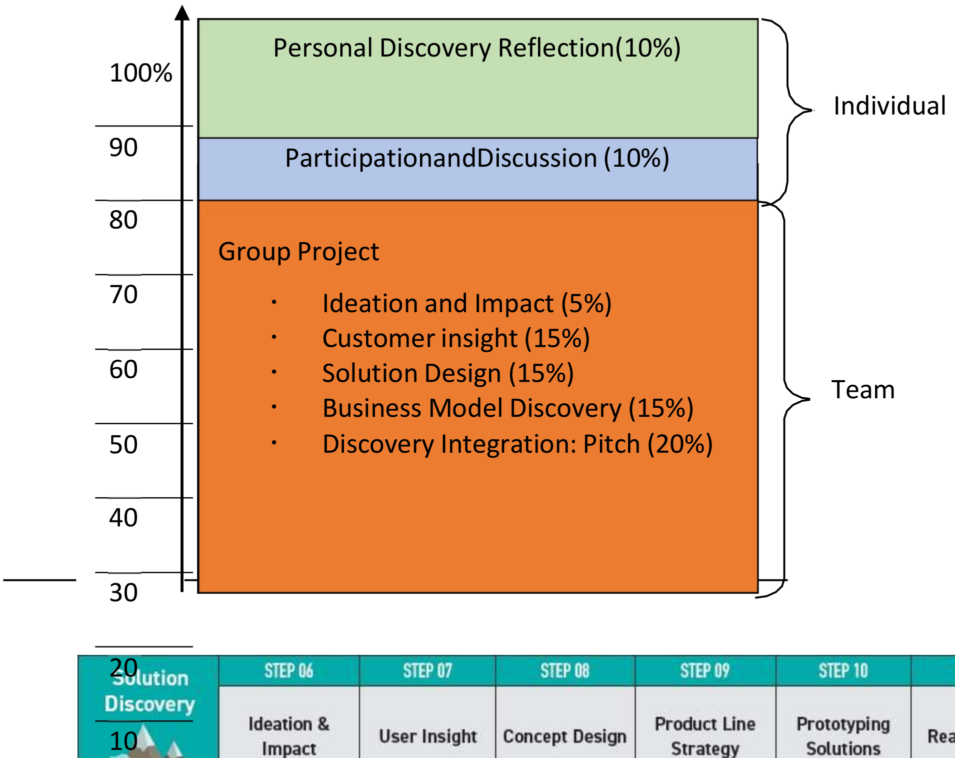
This is a semester length project and the cornerstone component of the course. The group project will give you the opportunity to apply the course concepts to a real situation. You will learn about the entrepreneurship for your own business or your work in organizations. Even if you are not going to be an entrepreneur, you need to know how to identify the opportunities, who to persuade people, and how to create economic and social values in many different contexts.

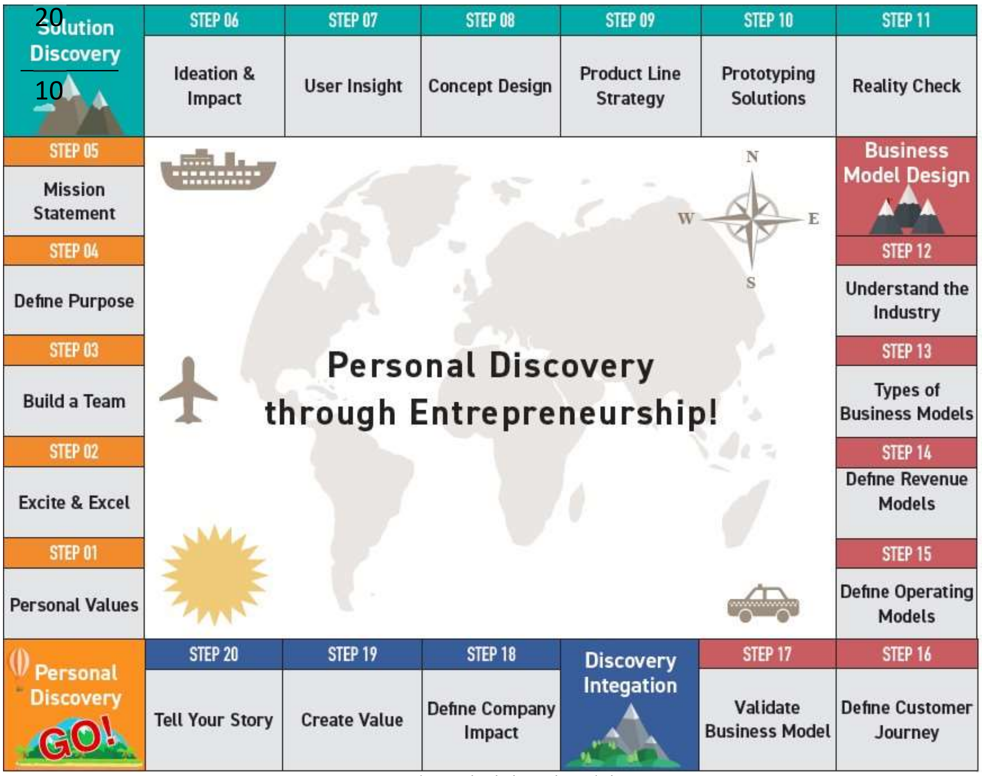
Talking to customers is one of the most important steps in investigating your business because your entrepreneurial vision must correspond to a true market opportunity. With your group, select 5-6 potential customers willing to be interviewed. They should represent a cross-section of our target market and should provide information that helps you refine your opportunity. This is not a simple survey: you are seeking in-depth understanding of the lifestyle and behaviors of your customer that can help you shape your opportunity. Please remember, you are not simply looking to confirm you have a great idea, but to shape your idea into a great opportunity. You will maximize your chances for success and your ability to execute your business cost-effectively by making early (rather than later) changes to your concept.
"Design" is fun, particularly when you merge customer insight with your own creativity. Enjoy! In this book, we provide structured methods to be an active listener and learner from customers as well as a product or service designer.

Business modeling is not as hard as it might sound. This is the design of your business – how it charges customers, what is spent producing and selling products or services, and the money that can be made for each unit sold. We keep it simple – so should you.

For the final outcome, you will be required to come up with Pitch that can used as the basis for actually starting a company based on an impactful innovation. Once again, we provide a specific format and tools for creating a compelling Pitch. We also want you to think about an exciting proposition that is more than just making money, but rather, one that helps society. This will give you innovation and venture concept greater lift with customers – and it will also make you feel better, deep inside.

Project Components and Grading





[20 Steps and activities in this course]

Deliverables

There are a number or different deliverables for the course that follow the templates presented in the book, as applied to your own venture idea. Do your best to keep up with the timeline of the class; do not fall behind! Later templates build on the learnings from prior templates. Make the most of your team! Everyone needs to pitch in. In no case, should one person be taking the lead on all templates.Rather,different team members should take the lead on specific deliverables. Coordinate well. Let your teacher know if a team member is not carrying his or her load.

Specific Deliverables

Ideation and Impact Hand-in Package: 5% of total grade
clearly written, with a one-page explanation for the team's decision

- Problem to Solve Templates, Step 4, Page 62 and 63
  (with a page of additional explanation if needed)
- Idea Impact Template, Step 6, Page 69 (with a page of explanation)

Customer Interviews and Insight Hand-in Package: 15%
(1st Round of Customer Interviews)

- Customer Interviews Template, Step 7, Pages 75-78,plus add additional template forms for each additional customer interview. The more, the better.
- Idea Reshaping Template, Step 7, Pages 84 and 85. Integration into overall conclusions. How have you improved your original idea through customer research?
- Latent Needs Template, Step 7, Page 93 – what are the frustrations of users that are not solved by current products or services?
- Full Use Case Template, Step 7, Page 99 – how do you customers' needs change over the full use case, and what innovative ideas can you propose at each step of the way?

Concept Design (and Test) Hand-in Package: 15%

- Customer Value Proposition Template: Step 8, Page 107. This becomes the landing point for what you learned in your customer interviews.
- Competitive Analysis Template: Step 8, Page 109. (Use the Web or actual stores/dealers)
- Product Vision and Subsystem Design Templates:Step 10, Pages 121 and 126 (You can add additional pages with design illustration and explanations of your bubble chart)
- Reality Check Survey Template and Results: Step 11, Page 141, 143-144
  (You can use more than 2 pages for reporting the results.)

Business Model Design Hand-in Package: 15%

- Industry Analysis Templates: Step 12, Pages 153 and 154
- Illustrate the Business Model Template: Step 13, Page 170
  (Use different colours or line patterns to show the flows of product, money, and information)
- Revenue Model Template: Step 14, Page 177
- Operating Model Template: Step 15, Page 187
- Customer Journey Template: Step 16, Page 195
- Validating the Business Model Template: Step 17, Pages 199 and 200

Discovery Integration Hand-in Package: 20%

- Business and Social Vision Impact Statement Template: Step 18, Page 210.
- Per Unit Profitability Template: Step 19, Page 229
- Your Venture Story Pitch: Step 20(PowerPoint)
- Overall Pitch Design Template:Page 264

Assemble the templates from all your work above, plus any others that you found particularly meaningful, and from these, create your Team's Innovation Pitch.The book has lists specific templates that fit for each part of the final presentation.

Do not just regurgitate the templates in your pitch; rather, take the key points from them to create your own, unique presentation. The templates help you think – but most are toocomplex to present to outside people who have not taken the course. Therefore, design thispitch as if you presenting to a new set of investors.

And don't forget to add an attractive title page with your team members names and email addresses!You can also add an Appendix at the very back with particularly interesting information, such as industry data or the results of your customer interviews and Reality Check.

Individual Innovation Assignments

You will be required to submit two Reflection Journalsas well as a maximum two pages double spaced Synthesis, Integration and Application paper by email at the Week 4 and Week 14 respectively. Please note, this exercise is not about regurgitating the course concepts.

(1) Personal Discovery Reflection Journal (10%)

At the beginning of this semester, you will have a time to think about your self (who you are, what you are good at, what areas you want to contribute on) using a couple of templates. After that sessions, you will have a quiet moment to think about yourself, yourcareer, and your happiness in your life. Please write 2-page reflectional journal what you feel and learning through the personal discovery sessions.

(2) Insight Learning Reflection Journal (10%)

At the end of this semester, you are to prepare a short reflection of impressive sessions aswell as related activities outside the classroom. Specially, (1) reflect on the key points from lectures, reading, discussion, guest speakers, and interviews, (2) apply this to your own situation, and (3) outline ways that you intend to use this knowledge in the future.

Course Schedule

Week	Session	Topics and Steps	Key CONCEPTS Introduced in Class	Class Focus Activity
1	1	**Course Overview**	1. Why is entrepreneurship important? 2. What is Personal Discovery through Entrepreneurship? 3. Four Stages; Personal Discovery, Solution Discovery, Business Model Discovery, Discovery Integration 4. Preparation (finding interesting areas)	**Lecture and Discussion**
	2	**Personal Discovery** (Step 01, Step 02)	1. Personal Values 2. Strength and Weakness	Individual: · Work with the templates provided on pages: · Core values: 22, 23 · Skills: 27, 28, 29, 30, 31 · Societal Contribution: 33, 34
2	3	**Find Teammates** (Step 03)	1. Review Problem Area Template at the beginning of the book to find classmates who want to work on the same problem area. 2. Findteammates (1) Shared values (2) Levels of commitment (3) Skills and experiences (Same or Different?)	Problem template: Page 9 · Talk to your classmates and find teammates. See who wants to work on in the same problem space, with a shared vision of solutions, and complementary skill sets. · Sit back and assess: Team templates on Pages 44, 45, and 46. · Prepare to present your team, the problem it is going to tackle, and its collective skills.
	4	**Define Purpose** (Step 04) **Create Mission** (Step 05)	1. Methods for defining and refining a venture's purpose 2. Defining a Venture's Purpose 3. Creating a Vision Statement	Team: · Purpose and Mission Templates: Pages 49 and 52 · Be prepare to present to the class. · Personal Discovery Reflection Journal Due

Week	Session	Topics and Steps	Key CONCEPTS Introduced in Class	Class Focus Activity
3	5	**Ideation & Impact** (Step 06)	Ideation Methods • An in-class ideation exercise	Team: • Problem to Solve Templates, Step 4, Page 62, and 63
	6		Increasing the Impact of an Idea. (The Eat-Your-Coffee Video – a good example of ideation)	Team: • Idea Impact Template, Step 6, Page 69
4	7	**User Insights Frameworks** (Step 07)	• Identifyand find the right target users. • Interview style and methods • The Customer Interview template.	Team: • Customer Interviews Template, Step 7, Pages 75 • Edit interview template for your project.
	8		Laddering methods for interviews	Team: • Latent Needs Template, Step 7, Page 93
5	9	**User Insights Customer Interviews** (Step 07)	• Finding latent needs • Field work check-in	Team: • Latent Needs Template, Step 7, Page 93 • Field work – customer interviewing
	10		• Think about innovation across the entire use case • Field work check-in	Team: • Full Use Case Template, Step 7, Page 99 • Field work – customer interviewing
6	11	**User Insights Interpreting Results** (Step 07)	• Interpreting customer interview results • Field work check-in	Team: • Field work – customer interviewing • Also talk to retailers/dealers if appropriate
	12		• Idea Reshaping based on Customer Interviews • Field work check-in	Teams prepare results of results from customer interviews and how the original ideas have been reshaped& improved.
7	13 14	**User Insights Interpreting Results** (Step 07)	• Customer Research Reports • Implications for product and service design	• Teams prepare PPTs for class presentation • **Customer Insight Template Hand-in Package**

Week	Session	Topics and Steps	Key CONCEPTS Introduced in Class	Class Focus Activity
8	15	**Concept Design** (Step 08)	· Defining Customer Value · Understanding Customer Value Proposition	Team: · Customer Value Proposition · Template: Step 8, Page 107 · Draft the CVP
	16		· Presentation and review of CVPs	Team: · Complete CVP
9	17	**Competitive Analysis and Positioning** (Step 08)	· Understanding of Competitive Matrix · Competitive positioning: creating your separate space	Team: · Identify major competitors, and dimensions for analysis · Template: Step 8, Page 109
	18		· Presentations of Competitive Analyses and Positionings	Team: · Perform the competitive analysis and present results, including positioning
10	19	**Product Line Strategy** (Step 09)	· Product line framework: good, better, best on underlying platforms, plus application to Services.	Team: · Identify good, better, best variations based on the underlying concept. · Product line template: Page 115
	20	**Product Visioning Subsystem Design, and Prototype Sketch** (Step 10)	· The structured bubble chart, showing implementation options and the team's choices · Prototype sketching (The Bluereo Video is a good example of iterative prototyping driven by customer discovery.)	Team: · Prototype sketch, and for Web apps, a wireframe. For physical products, an initial bill of materials. · Underlying bubble chart showing your decision process. · Product Vision and Subsystem Design Templates: Step 10, Pages 121 and 126
Week	**Session**	**Topics and Steps**	**· Key CONCEPTS Introduced in Class**	**Team or Individual Activity**
11	21	**Reality Check** (Step 11)	· The purpose of the Reality Check, testing the product concept, channel preferences, and much other.	Team: · Reality Check Survey Template and Results: Step 11, Page 141, 143-144

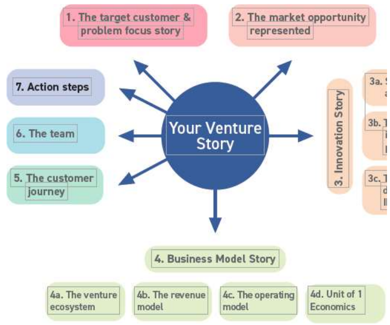
	22		· Guidance on the number or additional customers for the reality check survey · How to analyze and interpret the results	· Customize the Reality Check template for your venture. · Do a quick round of customer surveying. Aim for 12 more interviews.
12	23	**Industry Analysis** (Step 12)	· Team reports on Reality Check Results · Examine major components of an Industry Analysis · Review Templates	Team: · Prepare and present the results of your reality check, plus any pivots you wish to make. · **Concept Design (and Test) Hand-in Package** · Industry Analysis Templates: Step 12, Pages 153 and 154s
	24	**Business Model** (Step 13)	· Defining the Business Model: · Lecture on basic structure and different types. · Illustrating it as the flow of product, money, and information.	Team: · Business Model Illustration Template, Step 13, Page 170

Week	Session	Topics and Steps	· Key CONCEPTS Introduced in Class	Team or Individual Activity
13	25 26	**Business Model** (Steps 14, 15, 16, 17)	· Revenue and Expenses · The key decision points in the Revenue Model · The key decision points in the Operating Model · Designing the Customer Journey · Validating the Business Model (The Polka Dog Bakery Video: an example of creating a new retail experience, plus new products.)	Team · Step 14, Page 177 · Step 15, Page 187 · Step 16, Page 195 · Step 17, Pages 199 and 200 · Validate the Revenue and Operating Model by trying to have phone calls with a few Sellers and Manufacturers to validating pricing, channels, and costs.
14	27	**Impact Visioning** (Step 18)	· Develop clear statements for business and societal impact. · Look at good existing examples of companies that do both.	Team: · Start integrating your research and templates towards the final presentation, provided in Step 20, Page 264 · **Business Model Design Hand-in Package**
	28	**Creating Value** (Step 19)	· Develop a project of the profitability in make low volumes for a product, a service, and a Web app. · Discuss applications of the framework to your venture.	Team: · Develop and present Unit of 1 Economics Template, Step 19, Page 229 · Keep working on the Final presentation

<table>
<tr><th>Week</th><th>Session</th><th>Topics and Steps</th><th>Key CONCEPTS Introduced in Class</th><th>Team or Individual Activity</th></tr>
<tr><td rowspan="2">15</td><td>29</td><td rowspan="2">Tell Your Story</td><td rowspan="2">• Presentation Format and Style

• Format:
(1) Title Slide with names and contact information
(2) The Target Customer and the Problem to be Solved
(3) The Market Opportunity
(4) The Innovation Story
(5) The Business Model Story
(6) The Customer Journey
(7) The Team
(8) The Proposed Action Steps.
(9) Appendices (if needed or desired)

• If you have built a prototype during the class, please bring it and show it to us!

(The Fortify Video is a good example of how a good technical idea can translate into a business model, and next, into a well-funded venture.)</td><td rowspan="2">Team:
• The PPT Presentation


• Practice, practice, practice!
• Not too many words on one slide
• Use pictures
• Use template to develop your thinking, but try to create slides that are not just the templates.</td></tr>
<tr><td>30</td></tr>
<tr><td colspan="3">Final Course Deliverables</td><td>Due on the Monday after the weekend of the final class meeting.</td><td>Team: Your Venture PPTs

Individual: Insight Learning Reflection Journal</td></tr>
</table>

Course Outcomes

5. Identify one’s values, passions, skills and their will to contribute to society
6. Formulate an idea and validate it with customers
7. Demonstrate prototyping and analyze the competition for the product
8. Create business models for revenue generation and sustainability of their business
9. Come up with a pitch that can used as the basis for actually starting a company based on an impactful innovation and societal impact

DOSP1001: Badminton

L	T	P	S	J	C
0	0	0	2	0	2*

This course provides instruction and the opportunity for participation in sports and physical fitness activities. Skills, strategies, rules, and personal wellness goals are included as appropriate. This course will provide students with an understanding of the fundamental concepts of the physiological functions and training principles associated with the chosen sport.

Course Objectives:

1. Understand training principles used in the sport
2. Demonstrate knowledge of the game in a recreational /competitive play setting
3. Organize an event around the sport
4. Demonstrate concepts of warm up, game conditioning, training plans

Course Outcomes:

1. Learn to play Badminton
2. Understanding of the fundamental concepts such as rules of play, game variations
3. Understanding of the governing structure and administration of the sport
4. Understand the event management of the sport
5. Apply sport concepts into an active physical lifestyle

List of Activities:

1. Watch a sport documentary / training video / game history
2. On field coaching and demonstration session
3. Guided practice and play
4. Event management & game officiating
5. Friendly competitions and structured matches

Instructional Plan:

1. Introduction to Badminton - History and development
2. Rules of the Game, Play Area & dimensions
3. Fundamental Skills - Badminton: Grips - Racket, shuttle
4. Sports Specific fitness and warmup drills
5. Stances and footwork
6. Badminton Gameplay: Service, Forehand, Backhand
7. Preparatory Drills and Fun Games
8. Game Variations: Singles/ Doubles/ Mixed

Reference:

1. Handbook of the Badminton World Federation (BWF)

DOSP1011: Chess

L	T	P	S	J	C
0	0	0	2	0	2*

This course provides instruction and the opportunity for participation in sports and physical fitness activities. Skills, strategies, rules, and personal wellness goals are included as appropriate. This course will provide students with an understanding of the fundamental concepts of the physiological functions and training principles associated with the chosen sport.

Course Objectives:

1. Understand training principles used in the sport
2. Demonstrate knowledge of the game in a recreational /competitive play setting
3. Organize an event around the sport
4. Demonstrate concepts of warm up, game conditioning, training plans

Course Outcomes:

1. Learn to play Chess
2. Understanding of the fundamental concepts such as rules of play, game variations
3. Understanding of the governing structure and administration of the sport
4. Understand the event management of the sport
5. Apply sport concepts into an active physical lifestyle

List of Activities:

1. Watch a sport documentary / training video / game history
2. On field coaching and demonstration session
3. Guided practice and play
4. Event management & game officiating
5. Friendly competitions and structured matches

Instructional Plan:

1. Introduction to Chess - History and development
2. Rules of the Game, Play Area & dimensions
3. Fundamental Skills - Chess: Pieces & functions, basic play
4. Chess board moves & terminology
5. Chess Gameplay: Openings, castling, strategies & tactics
6. Preparatory Drills and Fun Games
7. Game Variations & Officiating

Reference:

1. International Chess Federation (FIDE) Handbook

DOSP1031: Football

L	T	P	S	J	C
0	0	0	2	0	2*

This course provides instruction and the opportunity for participation in sports and physical fitness activities. Skills, strategies, rules, and personal wellness goals are included as appropriate. This course will provide students with an understanding of the fundamental concepts of the physiological functions and training principles associated with the chosen sport.

Course Objectives:

1. Understand training principles used in the sport
2. Demonstrate knowledge of the game in a recreational /competitive play setting
3. Organize an event around the sport
4. Demonstrate concepts of warm up, game conditioning, training plans

Course Outcomes:

1. Learn to play Football
2. Understanding of the fundamental concepts such as rules of play, game variations
3. Understanding of the governing structure and administration of the sport
4. Understand the event management of the sport
5. Apply sport concepts into an active physical lifestyle

List of Activities:

1. Watch a sport documentary / training video / game history
2. On field coaching and demonstration session
3. Guided practice and play
4. Event management & game officiating
5. Friendly competitions and structured matches

Instructional Plan:

1. Introduction to Football - History and development
2. Rules of the Game, Play Area & dimensions
3. Fundamental Skills - Kicking, heading, ball control, Keeping
4. Movement, throwins, tackling, defense, scoring, defense
5. Gameplay- Formations, passing, FKs, CKs, PK, tactics
6. Preparatory Drills and Fun Games
7. Game Variations: Small sided games, 7v7, 11v11

Reference:

1. FIFA Laws of the Game

DOSP1041: Volleyball

L	T	P	S	J	C
0	0	0	2	0	2*

This course provides instruction and the opportunity for participation in sports and physical fitness activities. Skills, strategies, rules, and personal wellness goals are included as appropriate. This course will provide students with an understanding of the fundamental concepts of the physiological functions and training principles associated with the chosen sport.

Course Objectives:

1. Understand training principles used in the sport
2. Demonstrate knowledge of the game in a recreational /competitive play setting
3. Organize an event around the sport
4. Demonstrate concepts of warm up, game conditioning, training plans

Course Outcomes:

1. Learn to play Volleyball
2. Understanding of the fundamental concepts such as rules of play, game variations
3. Understanding of the governing structure and administration of the sport
4. Understand the event management of the sport
5. Apply sport concepts into an active physical lifestyle

List of Activities:

1. Watch a sport documentary / training video / game history
2. On field coaching and demonstration session
3. Guided practice and play
4. Event management & game officiating
5. Friendly competitions and structured matches

Instructional Plan:

1. Introduction to Volley - History and development
2. Rules of the Game, Play Area & dimensions
3. Fundamental Skills - Striking, Ball control, Lifting
4. Sports Specific fitness and warmup drills
5. Stances and footwork
6. Preparatory Drills and Fun Games
7. Gameplay: Jumps, strikes, layoffs, attack, defense

Reference:

1. FIVB - Official Volleyball Rules

DOSP1051: Kabaddi

L	T	P	S	J	C
0	0	0	2	0	2*

This course provides instruction and the opportunity for participation in sports and physical fitness activities. Skills, strategies, rules, and personal wellness goals are included as appropriate. This course will provide students with an understanding of the fundamental concepts of the physiological functions and training principles associated with the chosen sport.

Course Objectives:

1. Understand training principles used in the sport
2. Demonstrate knowledge of the game in a recreational /competitive play setting
3. Organize an event around the sport
4. Demonstrate concepts of warm up, game conditioning, training plans

Course Outcomes:

1. Learn to play Kabaddi
2. Understanding of the fundamental concepts such as rules of play, game variations
3. Understanding of the governing structure and administration of the sport
4. Understand the event management of the sport
5. Apply sport concepts into an active physical lifestyle

List of Activities:

1. Watch a sport documentary / training video / game history
2. On field coaching and demonstration session
3. Guided practice and play
4. Event management & game officiating
5. Friendly competitions and structured matches

Instructional Plan:

1. Introduction to Kabaddi - History and development
2. Rules of the Game, Play Area & dimensions
3. Fundamental Skills - Raiding, catching
4. Sports Specific fitness and warmup drills
5. Stances and footwork
6. Preparatory Drills and Fun Games
7. Gameplay: Chain system movement

Reference:

1. Amateur Kabaddi Federation of India (AKFI) - Official Rules
2. Rules of Kabadddi - International Kabaddi Federation

DOSP1091: Basketball

L	T	P	S	J	C
0	0	0	2	0	2*

This course provides instruction and the opportunity for participation in sports and physical fitness activities. Skills, strategies, rules, and personal wellness goals are included as appropriate. This course will provide students with an understanding of the fundamental concepts of the physiological functions and training principles associated with the chosen sport.

Course Objectives:

1. Understand training principles used in the sport
2. Demonstrate knowledge of the game in a recreational /competitive play setting
3. Organize an event around the sport
4. Demonstrate concepts of warm up, game conditioning, training plans

Course Outcomes:

1. Learn to play Basketball
2. Understanding of the fundamental concepts such as rules of play, game variations
3. Understanding of the governing structure and administration of the sport
4. Understand the event management of the sport
5. Apply sport concepts into an active physical lifestyle

List of Activities:

1. Watch a sport documentary / training video / game history
2. On field coaching and demonstration session
3. Guided practice and play
4. Event management & game officiating
5. Friendly competitions and structured matches

Instructional Plan:

1. Introduction to Basketball - History and development
2. Rules of the Game, Play Area & dimensions
3. Fundamental Skills - Passing, Receiving, Dribbling
4. Sports Specific fitness and warmup drills
5. Stances and footwork: Jumps, dribbles, catching, throws
6. Preparatory Drills and Fun Games
7. Gameplay: Shots, throws, movements, attack, defense

Reference:

1. FIBA Basketball Official Rules

DOSP1111: Throwball

L	T	P	S	J	C
0	0	0	2	0	2*

This course provides instruction and the opportunity for participation in sports and physical fitness activities. Skills, strategies, rules, and personal wellness goals are included as appropriate. This course will provide students with an understanding of the fundamental concepts of the physiological functions and training principles associated with the chosen sport.

Course Objectives:

1. Understand training principles used in the sport
2. Demonstrate knowledge of the game in a recreational /competitive play setting
3. Organize an event around the sport
4. Demonstrate concepts of warm up, game conditioning, training plans

Course Outcomes:

1. Learn to play Throwball
2. Understanding of the fundamental concepts such as rules of play, game variations
3. Understanding of the governing structure and administration of the sport
4. Understand the event management of the sport
5. Apply sport concepts into an active physical lifestyle

List of Activities:

1. Watch a sport documentary / training video / game history
2. On field coaching and demonstration session
3. Guided practice and play
4. Event management & game officiating
5. Friendly competitions and structured matches

Instructional Plan:

1. Introduction to Throwball - History and development
2. Rules of the Game, Play Area & dimensions
3. Fundamental Skills - Throwing, Receiving
4. Sports Specific fitness and warmup drills
5. Stances and footwork
6. Preparatory Drills and Fun Games
7. Gameplay: Shots, throws, movements, control

Reference:

1. World Throwball Federation - Rules of the Game

DOSL1001: Club Activity – Participant

L	T	P	S	J	C
0	**0**	**0**	**2**	**0**	**2***

This course recognizes student participation in multiple activities organized by various student organizations that pursue specific co-curricular and extra-curricular interests. These activities allow students to engage in and identify and pursue their personal interests and hobbies.

Course Objectives

- Create opportunities for students to participate in a variety of non-academic experiences
- Interact with and learn from peers in a setting without an external performance pressure
- Allow exploration of interesting activities and reflection about these experiences
- Learn to manage time effectively

List of Student Club Activities

1. Music (vocals, instruments, technical, recording, mixing, production, management)
2. Dance (Indian classical, western, jazz, latin, contemporary, folk, production, event management)
3. Theatre (classical, experimental, one-act, street, production, direction, casting, etc.)
4. Arts (fine arts, painting, calligraphy, sketching, caricaturing, etc)
5. Craft (origami, model making, sculpture, pottery, etc)
6. Cooking (home-style, baking, confectionery, Indian, intercontinental, etc.)
7. Graffiti (street, mural, collage, multi media, etc)
8. Workshops, quizzes, debates, elocution, etc
9. Filmmaking (adventure, drama, film appreciation, documentary, etc)
10. Photography (conventional, immersive (360), landscape, portrait, technical, editing, etc.)
11. College Fests
12. Designing (graphic design, landscape, interior, etc)
13. Competitive coding
14. Recreational sports activities
15. Other club activities organized by student clubs

List of Activities

1. Participation in various club based activities
2. Weekly reflection paper
3. Portfolio (on social media using an instagram account)
4. Two learning papers (one per semester)

Text Books

1. Small move: big Change (Caroline Arnold)
2. How to Win at College: Surprising Secrets for Success from the Country's Top Students (Cal Newport)

References

1. Making the most of college: Students speak their minds (author - Richard Light)
2. Failing Forward: Turning Mistakes into Stepping Stones for Success (John C Maxwell)
3. The Last Lecture (Randy Pausch)
4. Lean in (Sheryl Sandberg)
5. Youtube- Introduction to various club activities

Course Outcomes

Upon successful completion of the course, student will be able to

- Identify personal interest areas
- Learn from diverse perspectives and experiences
- Gain exposure to various activities and opportunities for extra-curicular activities
- Learn to manage time effectively
- gain confidence

DOSL1011: Club Activity – Member of the Club

L	T	P	S	J	C
0	0	0	2	0	2*

This course encourages and acknowledges student members' work in organizing events and activities organized by various student organizations that pursue specific co-curricular and extra-curricular interests. These activities allow students to actively learn from the process of conceptualizing and organizing such activities as part of a team.

Course Objectives
- Create opportunities for students to learn from organizing club activities
- Learn teamwork, leadership, planning and management of events and activities
- Learn to appreciate multiple perspectives, cultures, and individual capabilities
- Learn to manage time effectively

List of Student Club Activities
1. Music (vocals, instruments, technical, recording, mixing, production, management)
2. Dance (Indian classical, western, jazz, latin, contemporary, folk, production, event management)
3. Theatre (classical, experimental, one-act, street, production, direction, casting, etc.)
4. Arts (fine arts, painting, calligraphy, sketching, caricaturing, etc)
5. Craft (origami, model making, sculpture, pottery, etc)
6. Cooking (home-style, baking, confectionery, Indian, intercontinental, etc.)
7. Graffiti (street, mural, collage, multi media, etc)
8. Workshops, quizzes, debates, elocution, etc
9. Filmmaking (adventure, drama, film appreciation, documentary, etc)
10. Photography (conventional, immersive (360), landscape, portrait, technical, editing, etc.)
11. College Fests
12. Designing (graphic design, landscape, interior, etc)
13. Competitive coding
14. Recreational sports activities
15. Other club activities organized by student clubs

List of Activities
1. Be a member of a club and organize activities in that particular interest area
2. Learn from diverse perspectives and experiences
3. Learn to design and execute extra-curicular activities
4. Develop management skills through hands on experience
5. Explore different managerial roles and develop competencies

Text Books
1. Small move: big Change (Caroline Arnold)
2. How to Win at College: Surprising Secrets for Success from the Country's Top Students (Cal Newport)

References

1. Making the most of college: Students speak their minds (author - Richard Light)
2. Failing Forward: Turning Mistakes into Stepping Stones for Success (John C Maxwell)
3. The Last Lecture (Randy Pausch)
4. Lean in (Sheryl Sandberg)
5. Youtube- Introduction to various club activities

Course Outcomes

Upon successful completion of the course, student will be able to

- Be a member of a club and organize activities in that particular interest area
- Learn from diverse perspectives and experiences
- Learn to design and execute extra-curicular activities
- Develop management skills through hands on experience
- Explore different managerial roles and develop competencies

DOSL1021: Club Activity – Leader of the Club

L	T	P	S	J	C
0	0	0	2	0	2*

This course encourages and recognizes student members' work in leading the student organizations through various leadership roles. As leaders they work not just to organize events and activities in specific co-curricular and extra-curricular interests, but also lead the teams that form the core members of the clubs. These activities allow students to learn and practice leadership and management skills through real world experience.

Course Objectives

- Create opportunities for students to learn from organizing club activities
- Learn teamwork, leadership, planning and management of events and activities
- Learn to appreciate multiple perspectives, cultures, and individual capabilities
- Learn to manage time effectively

List of Student Club Activities

1. Music (vocals, instruments, technical, recording, mixing, production, management)
2. Dance (Indian classical, western, jazz, latin, contemporary, folk, production, event management)
3. Theatre (classical, experimental, one-act, street, production, direction, casting, etc.)
4. Arts (fine arts, painting, calligraphy, sketching, caricaturing, etc)
5. Craft (origami, model making, sculpture, pottery, etc)
6. Cooking (home-style, baking, confectionery, Indian, intercontinental, etc.)
7. Graffiti (street, mural, collage, multimedia, etc)
8. Workshops, quizzes, debates, elocution, etc
9. Filmmaking (adventure, drama, film appreciation, documentary, etc)
10. Photography (conventional, immersive (360), landscape, portrait, technical, editing, etc.)
11. College Fests
12. Designing (graphic design, landscape, interior, etc)
13. Competitive coding
14. Recreational sports activities
15. Other club activities organized by student clubs

List of Activities

1. Be the leader of the club and implement the charter, vision and mission of the club
2. Learn from diverse perspectives and experiences
3. Learn to lead the team, design and execute extra-curicular activities
4. Develop management skills through hands on experience
5. Explore different managerial roles and develop competencies

Text Books

1. Small move: big Change (Caroline Arnold)
2. How to Win at College: Surprising Secrets for Success from the Country's Top Students (Cal Newport)

References

1. Making the most of college: Students speak their minds (author - Richard Light)
2. Failing Forward: Turning Mistakes into Stepping Stones for Success (John C Maxwell)
3. The Last Lecture (Randy Pausch)
4. Lean in (Sheryl Sandberg)
5. Youtube- Introduction to various club activities

Course Outcomes

Upon successful completion of the course, student will be able to

- Be the leader of the club and implement the charter, vision and mission of the club
- Learn from diverse perspectives and experiences
- Learn to lead the team, design and execute extra-curricular activities
- Develop management skills through hands on experience
- Explore different managerial roles and develop competencies

DOSL1031: Club Activity – Competitor

L	T	P	S	J	C
0	0	0	2	0	2*

This course encourages and recognizes student members' work in leading the student organizations through various leadership roles. As leaders they work not just to organize events and activities in specific co-curricular and extra-curricular interests, but also lead the teams that form the core members of the clubs. These activities allow students to learn and practice leadership and management skills through real world experience.

Course Objectives

- Create opportunities for students to learn from organizing club activities
- Learn teamwork, leadership, planning and management of events and activities
- Learn to appreciate multiple perspectives, cultures, and individual capabilities
- Learn to manage time effectively

List of Student Club Activities

1. Music (vocals, instruments, technical, recording, mixing, production, management)
2. Dance (Indian classical, western, jazz, latin, contemporary, folk, production, event management)
3. Theatre (classical, experimental, one-act, street, production, direction, casting, etc.)
4. Arts (fine arts, painting, calligraphy, sketching, caricaturing, etc)
5. Craft (origami, model making, sculpture, pottery, etc)
6. Cooking (home-style, baking, confectionery, Indian, intercontinental, etc.)
7. Graffiti (street, mural, collage, multimedia, etc)
8. Workshops, quizzes, debates, elocution, etc
9. Filmmaking (adventure, drama, film appreciation, documentary, etc)
10. Photography (conventional, immersive (360), landscape, portrait, technical, editing, etc.)
11. College Fests
12. Designing (graphic design, landscape, interior, etc)
13. Competitive coding
14. Recreational sports activities
15. Other club activities organized by student clubs

List of Activities

1. Be the leader of the club and implement the charter, vision and mission of the club
2. Learn from diverse perspectives and experiences
3. Learn to lead the team, design and execute extra-curicular activities
4. Develop management skills through hands on experience
5. Explore different managerial roles and develop competencies

Text Books

1. Small move: big Change (Caroline Arnold)
2. How to Win at College: Surprising Secrets for Success from the Country's Top Students (Cal Newport)

References

1. Making the most of college: Students speak their minds (author - Richard Light)
2. Failing Forward: Turning Mistakes into Stepping Stones for Success (John C Maxwell)
3. The Last Lecture (Randy Pausch)
4. Lean in (Sheryl Sandberg)
5. Youtube- Introduction to various club activities

Course Outcomes

Upon successful completion of the course, student will be able to

- Be the leader of the club and implement the charter, vision and mission of the club
- Learn from diverse perspectives and experiences
- Learn to lead the team, design and execute extra-curricular activities
- Develop management skills through hands on experience
- Explore different managerial roles and develop competencies

POLS1001: Indian Constitution and History

L	T	P	S	J	C
2	0	0	0	0	2*

Course Description:
This course analyzes the basic structure and operative dimensions of the Indian Constitution. It explores various aspects of the Indian political and legal system from a historical perspective highlighting the various events that led to the making of the Indian Constitution. The course also deals with various challenges faced by the constitution and its coping mechanisms. Broadly, the students would understand and explain the working of different institutions and political debates ensuing from the operation of the Indian constitution in action.

Course Objectives:
1. To introduce constitutional history of India.
2. To explain the process of making Indian constitution
3. To analyze Fundamental of Rights, Duties and other principles in constitution
4. To create familiarity with political developments which shaped the constitution.

Course Outcomes:

On the successful completion of the course students would be able to:
1. Demonstrate an understanding of the Constitution of India and how constitutional governance is carried out in India
2. Interpret knowledge of the Fundamental Rights and Duties of the Citizens as well as the Obligation of the state towards its citizens
3. Correlate familiarity with key political developments that have shaped the Constitution and amended it from time to time.
4. Equip themselves to take up other courses in law after having done a foundation course on Indian Constitution

Unit I: India as a Nation **6 hrs**
Khilani, S. (2004). *Introduction, The Idea of India*, Chapter 1. New Delhi: Penguin Books, pp. 1-15.
Rowat, D. (1950). 'India: The Making of a Nation', *International Journal, 5*(2), 95-108. doi:10.2307/40194264
Brass, P. (2018). 'Continuities and Discontinuities between pre- and post-Independence India', Chapter 1. *The Politics of Idea since independence*, New Delhi: Cambridge University Press. pp. 1-30.

<u>Module Learning Outcomes</u>

1. Understand ideas of India
2. Explain the story behind making constitution and its future.
3. Articulate the differences between pre and post-colonial governments.

Unit 2: Understanding the Constitution 6 hrs

Mehta, U.S. (2011). 'Constitutionalism' in *The Oxford Companion to Politics in India*, (ed) by Nirja Gopal Jayal, and Pratap Bhanu Mehta, New Delhi: Oxford University Press. pp. 15-27.
Austin, G. (2016), 'The Constituent Assembly: Microcosm in Action' in *The Indian Constitution: Cornerstone of a Nation*, New Delhi: Oxford University Press, pp. 1-25.
Beteille, Andre (2008): "Constitutional Morality," *Economic and Political Weekly,* Vol 43, Issue No 40
Prahladan, Vivek (2012): "Emergence of the Indian Constitution," *Economic and Political Weekly*, Vol 47, Issue No 07.

Module Learning Outcomes
Understand the concept of constitutionalism. Demonstrate strength or weakness of constitutional morality in India
Evaluate constituent assembly debates in framing Indian Constitution.

Unit 3: The Preamble, Fundamental Rights and Directive Principles of State Policy 6 hrs

Bhakshi, P.M. (2011). 'Preamble' in *The Constitution of India*, New Delhi: Universal Law. Pp. 1-5.
Laxmikanth, M. (2017). 'Chapter IV: Preamble of the Constitution' in *Indian Polity*, Chennai: McGraw Hills.
Kumar, Virendra (2007): "Basic Structure of The Indian Constitution: Doctrine of Constitutionally Controlled Governance [From Kesavananda Bharati to I.R. Coelho]" *Journal of the Indian Law Institute*, Vol 49, No 3, pp 365-398.
Austin, G (2016), ' ' in *The Indian Constitution: Cornerstone of a Nation*, New Delhi: Oxford University Press, pp.63-105.
Reddy, S (1980). Fundamental Ness of Fundamental Rights and Directive Principles in the Indian Constitution. *Journal of the Indian Law Institute*, 22(3), pp. 399-407.
Bhatia, Gautam (2017): "The Supreme Court's Right to Privacy Judgement," *Economic and Political Weekly*, Vol 52, Issue No 44

Module Learning Outcomes

1. Explain the relationship between 'Preamble' and 'The constitution'.
2. Interpret the key concepts of preamble
3. Analyzes the dynamic nature of Indian constitution
4. Understanding Fundamental Rights
5. Evaluate Directive Principles of State Policy
6. Interpret case studies on Fundamental Rights.

Unit 4: Citizenship 6 hrs

Jayal, N.G. (2019). 'Reconfiguring citizenship in contemporary India' in *South Asia Journal of South Asian Studies*, pp.33-58.
Roy, Anupama. (2010). 'Chapter I: Enframing the citizen in contemporary times' in *Mapping Citizenship in India*, New Delhi: Oxford University Press.
Das, Veena (2010): "State, Citizenship and the Urban Poor," *Citizenship Studies,* Vol 15, pp 319-333.
Valerian Rodrigues

Module Learning Outcomes

1. Explain different dimensions of citizenship in Indian context
2. Evaluate the basis of citizenship
3. Compare 'claim' and 'status'of citizenship

Unit 5: Separation and Distribution of Powers 6 hrs

Pal, Ruma. (2016). 'Separation of Powers' in *The Oxford Handbook of the Indian Constitution*, (ed) by Sujit Choudhry, Madhav Khosla, and Pratap Bhanu Mehta, Delhi: Oxford University Press.
Bakshi, P. (1956). 'Comparative Law: Separation of Powers in India'. *American Bar Association Journal, 42*(6), 553-595.
Rao, P. (2005). 'Separation of Powers in a Democracy: The Indian Experience'. *Peace Research, 37*(1), 113-122.
Kumar, Ashwani (2019): "Constitutional Rights, Judicial Review and Parliamentary Democracy," *Economic and Political Weekly*, Vol 51, Issue 15
Tillin, Louise. (2015). 'Introduction' in *Indian Federalism*. New Delhi: Oxford University Press. pp. 1-30.
Chakrabarty, Bidyut and Rajendra Kumar Pandey. (2008). *Federalism' in Indian Government and Politics*, New Delhi: Sage Publications. pp. 35-53.
Arora, B. and Kailash, K. K. (2018). 'Beyond Quasi Federalism: Change and Continuity in Indian Federalism', in *Studies in Indian Politics*, pp. 1-7.
Agrawal, Pankhuri (2020): "COVID-19 and dwindling Indian Federalism," *Economic and Political Weekly,* Vol 55, Issue No 26

Module Learning Outcomes

1. Explain the importance of separation of powers in a democracy
2. Understand the relation between three organs of the government
3. Evaluate the system of 'checks and balances'
4. Understand the difference between unitary and federal political systems
5. Critically analyze the Indian model of Federalism
6. Evaluate the distribution of responsibilities between union and state governments.

Recommended Readings:

De, Rohit. (2018). *A People's Constitution – The Everyday Life of Law in the Indian Republic*, USA: Princeton University Press.
Granville Austin, *The Indian Constitution: Cornerstone of a Nation*, Oxford University Press, Oxford, 1966.
Lahoti, R.C. (2004). *Preamble: The Spirit and Backbone of the Constitution of India*. Delhi: Eastern Book Company.
Rajeev Bhargava (ed), *Ethics and Politics of the Indian Constitution*, Oxford University Press, New Delhi, 2008.
Subhash C. Kashyap, *Our Constitution*, National Book Trust, New Delhi, 2011.
Tillin, Louise. (2015). *Indian Federalism*. New Delhi: Oxford University Press.
Zoya Hassan, E. Sridharan and R. Sudarshan (eds), *India's Living Constitution: Ideas, Practices, Controversies*, Permanent Black, New Delhi, 2002.

PHPY1001: Gandhi for the 21st Century

L	T	P	S	J	C
2	0	0	0	0	2*

Course Description
This course provides the students with basic knowledge on Gandhi's early life, transformations in South Africa and his entry into India's national movement. While going through the social-political, economic and educational philosophies of Gandhi, the course analyses how his ideologies are relevant even in the 21st century.

Course Objectives

The objectives of the course are;
1. To provide the students with the basic knowledge on Gandhi's life and his philosophies
2. To understand the early influences and transformations in Gandhi
3. To analyse the role of Gandhi in India's national movement
4. To apply Gandhian Ethics while analysing the contemporary social/political issues
5. To appreciate the conflict resolution techniques put forward by Gandhi and its significance in the current scenario.

Module I : MK Gandhi: Childhood and Education
M K Gandhi, Formative Years (1869-1893): Early childhood - study in England - Indian influences, early Western influences.

Module II: From Mohan to Mahatma-South African Experiences
Gandhi in South Africa (1893-1914): South African Experiences - civil right movements in South Africa - invention of Satyagraha - Phoenix settlement- Tolstoy Farm - experiments in Sarvodaya, education, and sustainable livelihood.

Module III: Gandhi and Indian National Movement
Gandhi and Indian National Movement (1915-1947): Introduction of Satyagraha in Indian soil -non-cooperation movement - call for women's participation - social boycott - Quit-India movement - fighting against un-touchability - Partition of India- independence.

Module IV: Gandhi and Sustainable Development
Gandhian Constructive Programs-Eleven Vows-Sarvodaya-Seven Social Sins-Gandhian Economics and Sustainable Development

Module V: Gandhi and Contemporary Issues
Conflict Resolution Techniques of Gandhi-Ecological Challenges and Gandhian solutions-Gandhian Ethics-An Analysis

Learning Outcomes
1. To understand the life of Gandhi
2. To understand the role of Gandhi in Indian national movement
3. To analyse the origin and significance of Satyagraha
4. To understand the eleven vows of Gandhi which he followed through-out his life.

5. To examine the significance of constructive programs today

Course Outcomes

After the successful completion of the course the students will be able to;
1. Understand the life of Gandhi
2. Appreciate the role of Gandhian non-violence and Satyagraha in India's freedom struggle.
3. Critically examine the philosophy of Gandhi on Education, Sarvodaya, and Satyagraha
4. Analyse the contemporary significance of Gandhian constructive programmes and eleven vows
5. Examine the possible solutions for some of the contemporary challenges like environmental issues, moral degradation and ethical dilemmas.

References

1. Gandhi, M K. (1941). *Constructive Programme*. Ahmadabad: Navjivan Publishing House
2. Gandhi, M. K. (1948). *The Story of My Experiments with Truth*. Ahmadabad: Navjivan Publishing House
3. Gandhi, M K. (1968). *Satyagraha in South Africa*. Ahmadabad: Navjivan Publishing House.
4. Khoshoo, T N (1995). *Mahatma Gandhi: An Apostle of Applied Human Ecology*. New Delhi:TERI
5. Kripalani, J.B. (1970). *Gandhi: His Life and Thought*. New Delhi: Publications Division.
6. Narayan, Rajdeva (2011). *Ecological Perceptions in Gandhism and Marxism*. Muzaffarpur: NISLS
7. Pandey, J. (1998). *Gandhi and 21st Century*. New Delhi: Concept.
8. Weber, Thomas (2007).Gandhi as Disciple and Mentor. New Delhi: CUP

DOSL1041: Community Services - Volunteer

L	T	P	S	J	C
0	0	0	0	2	2*

This course recognizes student participation in Community service activities organized by various student organizations and other Government and non-government organizations that exist for providing service to communities. These activities allow students to develop empathy, citizenship behavior and community values.

Course Objectives

- To help students develop empathy and citizenship behavior
- Enable students to develop an altruistic attitude and community development sensibility
- Allow exploration of community service activities and reflect about these experiences
- Learn to work in small and large teams for achieving community objectives

List of Community Service Activities

1. Community Health Services
2. Swachh Bharat Abhiyan and other Cleanliness drives
3. Tree Plantation and similar environmental conservation initiatives
4. Rain water harvesting awareness and implementation
5. Fundraising and visits to Orphanages, Old-age homes, etc.
6. Health and disease awareness programs
7. Working with NGOs
8. Disaster mitigation and management training and relief work
9. Rural Upliftment projects
10. Campus awareness and action projects (cleanliness, anti-ragging, blood donation, etc)
11. Community investigations and surveys for development research
12. Educational support for underprivileged (remedial classes, coaching, training, etc)
13. Service camps
14. Advocacy and information literacy initiatives
15. Other activities serving local communities

List of Activities

1. Participation in various community service activities
2. Weekly reflection paper
3. Portfolio (on social media using an instagram account)
4. Two learning papers (one per semester)

Text Books

1. Soul of a citizen: living with conviction in Challenging times (author: Paul Rogat Loeb)
2. Community Services intervention: Vera Lloyd

References

1. A path appears: Transforming lives, creating opportunities (Nicholas Kristof and Sheryl WuDunn)
2. The story of My Experiments with Truth (author: M. K. Gandhi)

Course Outcomes

- Experience of volunteering in a variety of Community service activities
- Gaining empathy for lesser privileged sections of society by experience
- Understanding the process of generating community awareness
- Understanding Disaster management and relief through training and experience
- Developing environmental and sustainability awareness

DOSL1051: Community Services - Mobilizer

L	T	P	S	J	C
0	0	0	0	2	2*

This course recognizes student leadership in mobilizing community service activities as members of various student organizations or other Government and non-government organizations that exist for providing service to communities. These activities allow students to develop leadership, management skills, empathy, citizenship behavior and community values.

Course Objectives
- To help students understand leadership in a community environment
- Enable students to develop an altruistic attitude and community development sensibility
- Allow deep understanding of community service through practical experience
- Learn to lead small and large teams for achieving community objectives

List of Community Service Activities
1. Community Health Services
2. Swachh Bharat Abhiyan and other Cleanliness drives
3. Tree Plantation and similar environmental conservation initiatives
4. Rain water harvesting awareness and implementation
5. Fundraising and visits to Orphanages, Old-age homes, etc.
6. Health and disease awareness programs
7. Working with NGOs
8. Disaster mitigation and management training and relief work
9. Rural Upliftment projects
10. Campus awareness and action projects (cleanliness, anti-ragging, blood donation, etc)
11. Community investigations and surveys for development research
12. Educational support for underprivileged (remedial classes, coaching, training, etc)
13. Service camps
14. Advocacy and information literacy initiatives
15. Other activities serving local communities

List of Activities
1. Organizing and leading teams in various community service activities
2. Fortnightly reflection paper
3. Portfolio (on social media using an instagram account)
4. Two learning papers (one per semester)

Text Books
1. Soul of a citizen: living with conviction in Challenging times (author: Paul Rogat Loeb)
2. Community Services intervention: Vera Lloyd

References

1. A path appears: Transforming lives, creating opportunities (Nicholas Kristof and SherylWuDunn)
2. The story of My Experiments with Truth (author: M. K. Gandhi)
3. List of student run and and other Government and non-government community serviceorganizations organizations

Course Outcomes

- Experience of mobilizing and executing Community service activities
- Providing opportunities for community service volunteering for other fellow students
- Understanding the process of mobilizing cash, kind and volunteer support
- Building leadership and management skills
- Building empathy and citizenship behavior

ENVS1001: Environmental Studies

L	T	P	S	J	C
3	0	0	0	0	3*

The course enables the students to adapt eco-centric thinking and actions rather than human-centric thinking on natural resources, their utilization and conservation. The course also focuses on the importance of ecosystems, biodiversity and their degradation led to pollution. This course helps in finding solutions through application of control measures to combat pollution and legal measures to achieve sustainable development.

Course Objectives

1. To impart knowledge on natural resources and its associated problems.
2. To familiarize learners about ecosystem, biodiversity, and their conservation.
3. To introduce learners about environment pollution.
4. To acquaint learners on different social issues such as conservation of water, green building concept.
5. To make learners understand about the present population scenario, its impacts and role of informational technology on environment and human health.
6. To make learners understand about the importance of field visit.

Course Outcomes

After the completion of the course student will be able to

1. List different natural resources and their uses
2. Summarize the structure and function of terrestrial and aquatic ecosystems.
3. Identify causes, effects, and control measures of pollution (air, water & soil).
4. Function of green building concept.
5. Adapt value education

UNIT – I **Multidisciplinary nature of environmental studies & Natural Resources:** No of Hours: 10

Multidisciplinary nature of environmental studies Definition, scope and importance. Need for public awareness. Natural resources and associated problems. Uses and over exploitation of Forest resources, Water resources, Mineral resources, Food resources, Energy resources. Role of an individual in conservation of natural resources.

Activity:

1. Planting tree saplings
2. Identification of water leakage in house and institute-Rectify or report
3. Observing any one day of a week as Car/bike/vehicle free day.

UNIT – II **Ecosystem and biodiversity** No of Hours: 10

Ecosystem: Structure components of ecosystem: Biotic and Abiotic components. Functional components of an ecosystem: Food chains, Food webs, Ecological pyramids, Energy flow in the ecosystem (10% law), Ecological succession.

Biodiversity: Definition, Biogeographical classification of India, Values of biodiversity: consumptive use, productive use, social, ethical, aesthetic. Hot-spots of biodiversity. Threats to biodiversity: habitat loss, poaching, man wildlife conflicts. Conservation of biodiversity: In – situ and Ex-situ

Activity”

1. Visit to Zoological Park-Noting different ecosystem
2. Biodiversity register- Flora and fauna in the campus

UNIT – III **Environmental Pollution** No of Hours: 10

Definition Causes, effects, and control measures of: -Air pollution. Water pollution. Soil pollution. Marine pollution. Noise pollution. Nuclear hazards. Solid waste Management: Causes, effects, and control measures. Role of an individual in prevention of pollution. Pollution case studies.

Activity

1. Visit to treatment plant and documentation.
2. Documentation of segregation of solid waste-Dry and Wet

Learning Outcomes:

After completion of this unit, the student will be able to

UNIT – IV **Social Issues and the Environment** No of Hours: 10

From Unsustainable to Sustainable development Urban problems related to energy. Water conservation, rainwater harvesting, watershed management. Environmental ethics: Issues and possible solutions. Green building concept.

Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies.

Activity:

1. Observing zero hour at individual level-documentation.
2. Eco friendly idols.
3. Rainwater harvesting-creating storage pits in nearby area.

UNIT – V **Human Population and the Environment and Environment Protection Act and Field work** No of Hours: 10

Population growth, variation among nations. Environment and human health. HIV/AIDS, Human rights. Value Education. Women and Child Welfare. Role of Information Technology in Environment and human health. Environment Legislation. Air (Prevention and Control of Pollution) Act. Water (Prevention and Control of Pollution) Act. Wildlife Protection Act. Environmental Protection Act, Issues involved in enforcement of environmental legislation.

Activity:

1. Visit to a local polluted site-industry/agriculture
2. Identifying diseases due to inappropriate environmental conditions

Text Book(s)

1. Erach Bharucha. Textbook of environmental studies for undergraduates courses-Universities Press, India Private Limited. 2019.
2. Kaushik A and Kaushik C.P. Perspectives in Environmental Studies. New Age International Publishers Edition-VI. 2018.
3. Dave D Katewa S.S. Textbook of Environmental Studies, 2nd Edition. Cengage Learning India. 2012.

Additional Reading

1. Benny Joseph. Textbook of Environmental Studies 3rd edition, McGraw Hill Publishing company limited. 2017.

Reference Book(s):

1. McKinney M.L., Schoch R.M., Yonavjak L. Mincy G. Environmental Science: Systems and Solutions. Jones and Bartlett Publishers. 6th Edition. 2017.
2. Botkin D.B. Environmental Science: Earth as a Living Planet. John Wiley and Sons. 5th edition. 2005.

Journal(s):

1. https://www.tandfonline.com/loi/genv20
2. https://library.lclark.edu/envs/corejournals

Website(s):

https://www.ugc.ac.in/oldpdf/modelcurriculum/env.pdf

From Climate Science to Action | Coursera

	Programme Objectives (POs)												PSO’s		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2												2		
CO2		2				1							2		
CO3			1						1					1	
CO4				2							2				1
CO5	1													1	
CO6					2							1			1

1-Low, 2-Medium and 3-High Correlation

MFST1001: Health & Wellbeing

L	T	P	S	J	C
0	0	2	0	0	1*

The course provides the students a better understanding of the role of a proper diet in maintenance of human health. This course emphasizes the composition of the food, and will help to understand how to exercise, the role of sports and physical fitness in development of a good health. The course also focuses on the importance of emotional well-being and mindfulness. This course helps in teaching the role of yoga in maintenance of physical balance.

Course Objectives

- To provide an understanding of the relationship between food and nutrition
- To emphasize the role of exercise, sports and physical fitness in obtaining a good health
- To explain about the mindfulness and emotional well being
- To teach the role of yoga and meditation in maintaining the body balance

UNIT-I

Understand the relationship between Food and Nutrition and how food composition affects nutritional characteristics. Knowledge about regulatory principles in determining diets and recommended daily allowances. Understand how to create personalised diet/nutrition plans.

UNIT-II

Understand how exercise, activity and sports helps in developing good health. Experiential exposure to the role of proper, specific nutritional interventions along with structured activities on developing proper physical health. Practical exercises and assignments in sports and exercise regimes.

UNIT-III

Introduction to emotional wellbeing and mindfulness. Teaching of mindfulness practices to reduce stress, increase relaxation and improve mental wellbeing.

UNIT-IV

Introduction to Yoga theory and how Yoga helps in maintaining balance in the body. Practice of Yoga and meditation to improve overall emotional and physical balance. Practical yoga exercises and meditation techniques

Course outcomes:

By the end of the course, student will

- Learn the role of nutrition and diet in maintaining a good health
- Will understand how the exercise, sports and physical activities will improve health
- Will learn mindfulness practices for reducing stress
- Will know the importance of yoga and meditation

CLAD2001: Preparation for Campus Placement-1

(Soft Skills 5A)

L	T	P	S	J	C
0	0	2	0	0	1

Course Description:

The course addresses all relevant areas related to campus placements and readies them to ace their upcoming/ ongoing recruitment drives. Specifically, it focuses on students' career preparedness, interview skills, test preparedness, etc.

Course Objectives:

Prepare the students for their upcoming/ ongoing campus recruitment drives.

1. Career Preparedness: Resume & Cover Letter Writing, Interview Skills: Elevator Pitch, Making the First Impression, Being Other-Oriented, Being Positive and Curious, communicating with Confidence and Poise, Frequently Asked Questions & How to Answer Them, Pitfalls to Avoid, Etc. Etiquette: Hygiene, Courtesy, Culture differences, Workplace, use of cell phone, Profanity, Slang, Protocol.

2. Verbal Ability: Practising Reading Comprehension, Error Detection, Sentence Completion, MCQs, FIBs, Para jumbles, Cloze Test, Critical Reasoning.

3. Quantitative Aptitude: Number Systems, Algebra, Geometry, Data Handling, Data Sufficiency, Word Problems

4. Reasoning: Logical and Verbal Reasoning

Course Outcomes:

1. Write a power resume and covering letter
2. Answer interview questions with confidence and poise
3. Exhibit appropriate social mannerisms in interviews
4. Solve placement test questions on verbal ability, quantitative aptitude and reasoning

References:

1. Verbal Ability & Reading Comprehension by Arun Sharma and Meenakshi Upadhyay
2. Study material for CAT, SAT, GRE, GMAT by TIME, CareerLauncher and IMS etc.
3. Quantitative Aptitude by R S Agarwal S Chand Publications
4. Quantitative Aptitude by Pearson Publications

CLAD2011: Preparation for Higher Education (GRE/ GMAT)-1 (Soft Skills 5B)

L	T	P	S	J	C
0	0	2	0	0	1

Course Description:

1. The course offers a special track for students who aspire to go abroad in pursuit of their higher education for which a GRE/ GMAT score is a prerequisite. It covers all four topical areas of these tests and includes fully solved mock tests as well.

Course Objectives:

1. Prepare the students to solve questions from all four broad areas of GRE/ GMAT
2. Orient the students for GRE/ GMAT through mock tests

1. Verbal Reasoning: Reading Comprehension, Sentence Equivalence, Text Completion, Sentence Correction, Critical Reasoning

2. Quantitative Reasoning: Arithmetic, Algebra, Geometry, Data Analysis

3. Analytical Writing Assessment: Issue/ Argument

4. Integrated Reasoning

Course Outcomes:

1. Solve questions from all four broad areas of GRE/ GMAT
2. Practice answering several mock tests

References:

1. Verbal Ability & Reading Comprehension by Arun Sharma and Meenakshi Upadhyay
2. Study material for CAT, SAT, GRE, GMAT by TIME, CareerLauncher and IMS etc.
3. Quantitative Aptitude by R S Agarwal S Chand Publications
4. Quantitative Aptitude by Pearson Publications

CLAD2021: Preparation for CAT/ MAT - 1
(Soft Skills 5C)

L	T	P	S	J	C
0	0	2	0	0	1

Course Description:

The course offers a special track for UG students who aspire to go for higher education in business management in India for which cracking CAT/ MAT/ other related test is mandatory. It covers all four topical areas of these tests and includes fully solved mock tests as well.

Course Objectives:

1. Prepare the students to solve questions from all four relevant areas of CAT/ XAT/ MAT, etc.
2. Orient the students for CAT/ XAT, etc. through mock tests

1. Quantitative Ability: Arithmetic, Algebra, Geometry, Mensuration, Calculus, Trigonometry

2. Data Interpretation: Data Interpretation and Data Sufficiency

3. Logical Reasoning: Data Management, Deductions, Verbal Reasoning and Non-Verbal Reasoning
4. Verbal Ability: Critical Reasoning, Sentence Correction, Para Completion, Para Jumbles, Reading Comprehension

Course Outcomes:

1. Solve questions from all four relevant areas of CAT/ MAT as listed above
2. Practice test-cracking techniques through relevant mock tests

References:

1. Verbal Ability & Reading Comprehension by Arun Sharma and Meenakshi Upadhyay

2. Study material for CAT, SAT, GRE, GMAT by TIME, CareerLauncher and IMS etc.
3. Quantitative Aptitude by R S Agarwal S Chand Publications
4. Quantitative Aptitude by Pearson Publications

CLAD2031: Preparation for Campus Placement-2

(Soft Skills 6A)

L	T	P	S	J	C
0	0	2	0	0	1

Course Description:

This course builds on the previous course and focuses on all four major areas of campus placements, including career preparedness, mock interviews, verbal ability, quantitative aptitude and logical reasoning.

Course Objectives:

1. To comprehensively prepare all eligible and aspiring students for landing their dream jobs.
2. To sharpen the test-taking skills in all four major areas of all campus drives

1. Career Preparedness II: Mock Interviews, Feedback and Placement Readiness

2. Verbal Ability II: Practising Reading Comprehension, Error Detection, Sentence Completion, MCQs, FIBs, Para jumbles, Cloze Test, Critical Reasoning

3. Quantitative Aptitude II: Number Systems, Algebra, Geometry, Data Handling, Data Sufficiency, Word Problems

4. Reasoning II: Logical and Verbal Reasoning

Course Outcomes:

1. Demonstrate career preparedness and confidence in tackling campus interviews
2. Solve placement test questions of a higher difficulty level in verbal ability, quantitative aptitude and logical reasoning.
3. Practice test-taking skills by solving relevant questions accurately and within time.

References:

1. Verbal Ability & Reading Comprehension by Arun Sharma and Meenakshi Upadhyay

2. Study material for CAT, SAT, GRE, GMAT by TIME, CareerLauncher and IMS etc.
3. Quantitative Aptitude by R S Agarwal S Chand Publications
4. Quantitative Aptitude by Pearson Publications

CLAD2041: Preparation for Higher Education (GRE/ GMAT)-2
(Soft Skills 6B)

L	T	P	S	J	C
0	0	2	0	0	1

Course Description:

1. The course offers a special track for students who aspire to go abroad in pursuit of their higher education for which a GRE/ GMAT score is a prerequisite. It covers all four topical areas of these tests at a higher difficulty-level and includes fully solved mock tests as well.

Course Objectives:

1. Prepare the students to solve higher level questions from all four broad areas of GRE/ GMAT
2. Orient the students for GRE/ GMAT through mock tests

1. Verbal Reasoning II: Reading Comprehension, Sentence Equivalence, Text Completion, Sentence Correction, Critical Reasoning

2. Quantitative Reasoning II: Arithmetic, Algebra, Geometry, Data Analysis

3. Analytical Writing Assessment II: Issue/ Argument

4. Integrated Reasoning II

Course Outcomes:

1. Solve higher level questions from all four broad areas of GRE/ GMAT
2. Practice answering several mock tests

References:

1. Verbal Ability & Reading Comprehension by Arun Sharma and Meenakshi Upadhyay
2. Study material for CAT, SAT, GRE, GMAT by TIME, CareerLauncher and IMS etc.
3. Quantitative Aptitude by R S Agarwal S Chand Publications
4. Quantitative Aptitude by Pearson Publications

CLAD2051: Preparation for CAT/ MAT - 2
(Soft Skills 6C)

L	T	P	S	J	C
0	0	2	0	0	1

Course Description:

The course offers a special track for UG students who aspire to go for higher education in business management in India for which cracking CAT/ MAT/ other related test is mandatory. It covers all four topical areas of these tests at a higher level of difficulty and includes fully solved mock tests as well.

Course Objectives:

1. Prepare the students to solve all types of questions from all four relevant areas of CAT/ XAT/ MAT, etc.

1. Quantitative Ability II: Arithmetic, Algebra, Geometry, Mensuration, Calculus, Trigonometry
2. Data Interpretation II: Data Interpretation and Data Sufficiency
3. Logical Reasoning II: Data Management, Deductions, Verbal Reasoning and Non-Verbal Reasoning
4. Verbal Ability II: Critical Reasoning, Sentence Correction, Para Completion, Para Jumbles, Reading Comprehension

Course Outcomes:

1. Solve higher difficulty level questions from all four relevant areas of CAT/ MAT as listed above
2. Practice test-cracking techniques through relevant mock tests

References:

1. Verbal Ability & Reading Comprehension by Arun Sharma and Meenakshi Upadhyay
2. Study material for CAT, SAT, GRE, GMAT by TIME, CareerLauncher and IMS etc.
3. Quantitative Aptitude by R S Agarwal S Chand Publications
4. Quantitative Aptitude by Pearson Publications

FINA3001: Personal Financial Planning

L	T	P	S	J	C
0	0	2	0	0	1*

Course Overview

Personal Financial Planning is one of the most significant factors in our lives. It is essential that funds are available as and when required at various stages of life. Unavailability of funds at critical stages of our life leads to financial distress and leads to many medical and non-medical problems. There are certain planned and unplanned events in our life. On the one hand, education of our children, their marriage, our retirement etc. are some of the planned events of our life, but at the same time, some medical urgency, accident or death of an earning member might be some unplanned events. Many of these events are beyond our control, but the availability of funds can be planned to avoid any financial distress. In other words, we cannot stop the rain but can plan for an umbrella.
This course looks at the many challenges an individual faces in a complex financial environment and the rising uncertainties of one's life. It focuses on achieving long-term financial comfort of individual and family through goal setting, developing financial and life strategies, acquiring personal financial planning knowledge and managing risk throughout one's life.

Course Objectives:

1. To build students' ability to plan for long-term financial comfort of individual and family through goal setting, developing financial and life strategies.
2. To provide students with knowledge on terms, techniques to evaluate investment avenues.
3. To build the skill set of the student to enable them to file their tax returns.

Course Outcome:
1. Describe the financial planning process and application of time value of money
2. Application of life and non-life insurance products in financial planning
3. Understand the investment avenues and analysis of investment returns
4. Understand the retirement planning and its application
5. Describe and analysis the Tax Planning

Unit 1: Basics of Financial Planning
Financial Planning Meaning, Need, Objectives, Financial Planning Process, Time Value of Money and its application using excel (NP)

Unit 2: Risk and Insurance Management
Need for insurance, Requirement of insurance interest, Role of insurance in personal finance, Steps in insurance planning, Life and Non-life insurance products, Life insurance needs analysis (NP)

Unit 3: Investment Products and Measuring Investment Returns
Investment Products: Small Saving Instruments, Fixed Income Instruments, Alternate

Investments, Direct Equity

Measuring Investment Returns: Understanding Return and its concept, Compounding concept, Real vs Nominal Rate of Return, Tax Adjusted Return, Risk-Adjusted Return (NP)

Unit 4: Retirement Planning

Introduction to the retirement planning process, estimating retirement corpus, Determining the retirement corpus, Retirement Products (NP)

Unit: 5 Tax Planning

Income Tax: Income tax principles: Heads of Incomes, Exemptions and Deductions, Types of Assesses, Rates of Taxation, Obligations for Filing and Reporting, Tax aspects of Investment Products, Wealth Tax

Text Books

1. National Institute of Securities Management (NISM) Module 1 & XA
2. Madhu Sinha, Financial Planning, 2 Edition, McGraw Hill India
3. Simplified Financial Management by Vinay Bhagwat, The Times Group

Reference Books

1. Personal Financial Planning (Wealth Management) by S Murali and K R Subbakrishna, Himalaya Publishing House.
2. Mishra K.C., Doss S, (2009). Basics of Personal Financial Planning 1e. National Insurance Academy, New Delhi: Cengage Learning.
3. Risk Analysis, Insurance and Retirement Planning by Indian Institute of Banking and Finance.

PHYS1001: PHYSICS

L	T	P	C
3	0	2	4

This course is designed with fundamentals of electromagnetism and properties of materials for advanced courses in their respective engineering branches. It introduces electromagnetic theory with relevant mathematical tools, optical fibres and their propagation characteristics, properties of dielectric and magnetic materials. It also introduces principles of semiconductors and some widely used semiconductor devices for various applications.

Course Objectives

- To introduce mathematical principles to estimate forces, fields and waves.
- To familiarize students with electromagnetics in modern communication systems.
- To impart knowledge concerning the electrical behaviour of dielectric materials.
- To demonstrate the properties of magnets.
- To introduce semiconductor physics and devices.

UNIT I: Basics of Electromagnetics 9 L

Electrostatic field: Coulomb's law and Gauss 'law, derivation of Coulombs law from Gauss' law, applications of Gauss' law (line charge, thin sheet of charge and solid charged sphere), Gauss' law of electrostatics in dielectric medium, divergence and curl of electric fields, electric potential, relation between potential and force, Poisson's and Laplace equations.
Magnetostatic field: Biot–Savarts' law, divergence and curl of magnetic fields, Faraday's and Ampere's laws in integral and differential form, displacement current, continuity equation, Maxwell's equations.

Learning Outcomes:

- apply Coulomb's and Gauss' laws to electric field configurations from charge distributions (L3)
- apply the Biot-Savarts' law to derive magnetostatic field distributions (L3)
- use vector calculus to describe electromagnetic phenomena(L2)
- relate the law of conservation of charge to continuity equation(L3)
- illustrate the Maxwell's equations, Maxwell's displacement current and correction of Ampere's law(L2)

Pedagogy tools: Blended learning, Case let, video lectures, self-reading

UNIT II: Fiber Optics 7 L

Introduction, advantages of optical fibers, principle and structure, acceptance angle, numerical aperture, modes of propagation, classification of fibers, fiber optic communication, importance of V-number, fiber optic sensors (Temperature, displacement and force), applications.

Learning Outcomes:

After completion of this unit, the student will be able to

- apply the principle of propagation of light in optical fibers(L3)
- explain the working and classification of optical fibers(L2)
- analyse propagation of light through optical fibers based on the concept of modes (L4)
- summarize applications of optical fibers in medical, communication and other fields(L2)

Pedagogy tools: Blended learning, Case let, video lectures, self-reading

UNIT III: Dielectric, Magnetic and superconducting Materials 10 L

Dielectric materials: Introduction, electric polarization, dielectric polarizability, susceptibility and dielectric constant, types of polarizations (qualitative treatment only). Magnetic materials: Introduction, magnetic dipole moment, magnetization, magnetic susceptibility and permeability, origin of permanent magnetic moment, classification of magnetic materials, Weiss theory of ferromagnetism (qualitative), domain theory, hysteresis, soft and hard magnetic materials.

Superconductivity: definition –Meissner effect –type I & II superconductors –BCS theory (qualitative) –high temperature superconductors –Josephson effects applications.

Learning Outcomes:

After completion of this unit, the student will be able to

- explain the concept of dielectric constant and polarization in dielectric materials (L2)
- interpret dielectric loss, Lorentz field and Claussius-Mosotti relation (L2)
- classify the magnetic materials(L2)
- explain the phenomenon of hysteresis for a ferromagnetic material and summarize the properties of hard and soft magnetic materials (L2)
- understand the concept of superconductivity (L2)

Pedagogy tools: Blended learning, Case let, video lectures, self-reading

UNIT IV: Semiconductor Physics 8 L

Introduction, origin of energy band, intrinsic and extrinsic semiconductors, mechanism of conduction in intrinsic semiconductors, generation and recombination, carrier concentration in intrinsic semiconductors, variation of intrinsic carrier concentration with temperature, n-type and p-type semiconductors, carrier concentration in n-type and p- type semiconductors, Drift and diffusion currents in semiconductors.

Learning Outcomes:

After completion of this unit, the student will be able to

- outline the properties of semiconductors(L2)
- interpret expressions for carrier concentration in intrinsic and extrinsic semiconductors(L2)
- assess the variation of carrier concentration in semiconductors with temperature (L5)

Pedagogy tools: Blended learning, Case let, video lectures, self-reading

UNIT V: Semiconductor Devices 8 L

Zener Diode, Tunnel diode, Hall effect and its applications, magnetoresistance, p-n junction layer formation and V-I characteristics, direct and indirect band gap semiconductors, construction and working of photodiode, LED, solar cell.

Learning Outcomes:

After completion of this unit, the student will be able to

- explain the drift and diffusion currents and formation of junction layer (L2)
- state Einstein’s relations(L1)
- explain Hall effect and its applications(L3)
- illustrateandinterprettheV-Icharacteristicsofap-njunctiondiode(L2)
- describe applications of p-n junction diodes in photodiodes, LEDs and solar cells (L3).

Pedagogy tools: Blended learning, Case let, video lectures, self-reading

Text Book(s)

1. David J.Griffiths, “Introduction to Electrodynamics”, 4/e, Pearson Education, 2014.
2. Charles Kittel, “Introduction to Solid State Physics”, Wiley Publications, 2011.
3. M. N. Avadhanulu, P.G. Kshirsagar, “A Text book of Engineering Physics”, 11/e, S. Chand Publications, 2019.

Reference book(s)

1. Principles of Physics, 10ed, ISV, Jearl Walker, David Halliday, Robert Resnick, Wiley India.
2. Gerd Keiser, “Optical Fiber Communications”, 4/e, Tata Mc Graw Hill, 2008.
3. S.O.Pillai, “Solid StatePhysics”, 8/e, New Age International, 2018.
4. S.M. Sze, “Semiconductor Devices-Physics and Technology” , Wiley, 2008.

Journal(s):

1. https://aapt.scitation.org/doi/abs/10.1119/1.3317450
2. https://aapt.scitation.org/doi/full/10.1119/1.5144798
3. https://aapt.scitation.org/doi/abs/10.1119/1.1511591

PHYSICS LABORATORY

List of Experiments

1. To determine the magnetic field along the axis of a circular coil carrying current.
2. To determine the numerical aperture of a given optical fiber and hence to find its acceptance angle
3. To determine magnetic susceptibility by Quincke’s tube method
4. To determine the Hall coefficient using Hall effect experiment
5. To determine the resistivity of semiconductor by Four probe method
6. To determine the energy gap of a semiconductor.
7. To study the characteristics of PN Junction diode.
8. To study magnetic hysteresis loop (B-H curve).
9. To determine the dielectric constant of a substance by resonance method.
10. To determine hysteresis loss by CRO.
11. To study the characteristics of Photodiode
12. To study the characteristics of Solar Cell
13. To study the characteristics of Zener diode
14. To study the resonance of LCR circuit

Text Book:

1. S. Balasubramanian, M.N. Srinivasan “A Text book of Practical Physics”- S Chand Publishers,2017

PHYS1031: MECHANICS AND PROPERTIES OF MATTER

L	T	P	C
3	**1**	**0**	**4**

This course is designed for students of Aerospace, Civil and Mechanical Engineering. It introduces fundamentals of elasticity and thermal properties – the essentials for understanding the behaviour of materials. Mechanics of solids is taught to acquaint them with the behaviour of rigid objects. An introduction to sensors will be useful for all the branches as an application of modern technology.

Course Objectives

- To acquaint the basic concepts of sound waves and principles in acoustic design.
- To introduce the concepts of elasticity, strain hardening and failure in materials and impart the relation between stress and strain.
- To impart the phenomenon of heat transfer so as to understand a wide variety of practical engineering problems.
- To demonstrate the use of Newton's laws of motion for understanding the mechanics of a particle.
- To explain the working principle and construction of different types of sensors.

UNIT-I Mechanics: 10 Hours

Basic laws of vectors and scalars; Rotational frames; Conservative and non-conservative forces; F = - grad V; Central forces; Elliptical, parabolic and hyperbolic orbits; Noninertial frames of reference; Centripetal acceleration; Harmonic oscillator; Damped harmonic motion; Forced oscillations and resonance. Degrees of freedom.

Learning Outcomes:

After completion of this unit, the student will be able to

- Explain forces and moments in mechanical systems using scalar and vector techniques L2
- interpret the equation of motion of a rigid rotating body (torque on a rigid body) L3
- apply the Newton's second law for inertial and non inertial frame of reference L3
- summarize harmonic motion in undamped, damped and forced oscillations L2

Pedagogy tools: Blended learning, Case let, video lectures, self-reading

UNIT-II Elasticity 8 Hours

Concepts of elasticity and plasticity, stress and strain, Hooke's law, different moduli of elasticity, Poisson's ratio, strain energy, stress-strain diagram, elastic behavior of a material, factors affecting elasticity, relation between different moduli of elasticity, determination of elastic moduli.

Learning Outcomes:

After completion of this unit, the student will be able to

- explain the basic concepts of elasticity, plasticity, strain hardening and failure in materials L2
- determine graphically a material's mechanical properties in terms of its one dimensional stress-strain curve L2
- derive the generalized Hooke's law by recognizing the basic stress-strain response of isotropic materials L3
- Define several elastic constants and determine the relationship between them L1
- evaluate strain energy under different loadings L3

Pedagogy tools: Blended learning,Case let, video lectures, self-reading

UNIT - III Thermal Properties 10 Hours

Transfer of heat energy; Thermal expansion of solids and liquids; Expansion joints -bimetallic strips; Thermal conduction, convection and radiation and their fundamental laws; Heat conductions in solids; Thermal conductivity - Forbe's and Lee's disc method: theory and experiment; Applications (qualitative only): heat exchangers, refrigerators, ovens and solar water heaters.

Learning Outcomes:

After completion of this unit, the student will be able to

- explain the process of thermal expansion in solids and liquids L3
- distinguish fundamental laws related to conduction, convection and radiation of heat L1
- determine the thermal conductivity of a material by Forbes and Lee's disc method L4
- summarize the working of heat exchangers, refrigerators, ovens and solar water heaters L2

UNIT - IV Acoustics 8 Hours

Characteristics of sound waves; Weber-Fechner Law; Absorption coefficient, determination of absorption coefficient; Reverberation time; Sabine's formula, derivation of Sabine's formula using growth and decay method; Intensity of sound; Acoustics of buildings, Acoustic requirements of a good auditorium.

Learning Outcomes:

After completion of this unit, the student will be able to

- explain the basic concepts in acoustics and describe Weber-Fechner Law L2
- determine absorption coefficient and reverberation time L3
- derive Sabine's formula using growth and decay method L4
- solve problems involving the intensity of a sound wave L4
- summarize the principles of acoustics in designing an acoustically good auditorium L3

Pedagogy tools: Blended learning, Case let, video lectures, self-reading

UNIT– V: Sensors 9 Hours

Sensors (qualitative description only); Different types of sensors and applications; Strain and pressure sensors- Piezoelectric, magnetostrictive sensors; Fibre optic methods of pressure sensing; Temperature sensor - bimetallic strip, pyroelectric detectors; Hall-effect sensor; Smoke and fire detectors.

Learning Outcomes:

After completion of this unit, the student will be able to

- describe the principle of strain and pressure sensors L1
- explain the principle and working of magnetostrictive and piezoelectric sensors L3
- illustrate the fibre optic methods of pressure sensing L3
- infer the functioning of temperature sensors like bimetallic strip and pyroelectric detectors L2
- outline the principle and working of Hall-effect sensor, smoke and fire detectors L2

Text Book(s)

1. D.Kleppner and Robert Kolenkow"An Introduction to Mechanics- II" Cambridge University Press,2015.
2. M.N. Avadhanulu & T.V.S. Arun Murthy, S Chand A Textbook of Engineering Physics, Volume-I 2018.
3. Ian R Sinclair, Sensor and Transducers 3/e,Elsevier (Newnes), 2001.

Reference Book(s)

1. M K Varma, "Introduction to Mechanics"-Universities Press, 2015
2. Prithwiraj Purkait, Budhaditya Biswas and Chiranjib Koley, Chapter 11 Sensors and Transducers, Electrical and Electronics Measurements and Instrumentation, 1/e., McGraw Hill Education (India) Private Limited, 2013.

Course Outcomes:

After completion of this course, the student will be able to

- describe the fundamental principles of acoustics with emphasis on physical mechanisms, law and relationships L1
- apply the concepts of strain, internal force, stress and equilibrium to deformation of solids L3
- explain the fundamental theory for the analysis of heat transfer processess in solids and liquids and to apply basic principles of heat transfer in design of refrigerators and heaters L4
- estimate forces and moments in mechanical systems using scalar and vector techniques L4
- outline the basic principle and operation of different types of sensors L2

PHYS1011: PRINCIPLES OF QUANTUM MECHANICS

L	T	P	C
3	**1**	**0**	**4**

This course is designed with principles of Quantum mechanics for advanced courses in their respective engineering branches. It introduces Quantum mechanics with relevant mathematical tools and provides a basis for further study of quantum mechanics. It also introduces basics of Qubits for Quantum computing applications.

Course Objectives

- To introduce the basic principles of quantum mechanics.
- To introduce wave equation and significance of wave function.
- To teach solving the Schrödinger's equation for spinless particles moving in one-dimensional potential.
- To develop an understanding of concepts of angular momentum.
- To introduce Dirac bra-ket formalism and the concept of QUBITs.

UNIT – I: Introduction to Quantum Physics (10 Hours)

Introduction, Classical Mechanics vs Quantum Mechanics, Planck's quantum theory (qualitative), Photo-electric effect. De Broglie wavelength and matter waves; Davisson-Germer experiment. Wave description of particles by wave packets. Group and Phase velocities and relation between them, Wave-particle duality, Heisenberg uncertainty principle: ground state energy of hydrogen atom.

Learning Outcomes:

After completion of this unit, the student will be able to

- Get a grasp on the elementary aspects of energy and momentum of a photon and de Broglie wavelength of a particle.
- Know about the uncertainty principle for position and momentum and for energy and time.
- To study the basic principles of quantum mechanics

Pedagogy tools: Blended learning, Case let, video lectures, self-reading

UNIT – II: Properties of Matter Waves (8 Hours)

Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of a wave function, probabilities and normalization.

Learning Outcomes:

After completion of this unit, the student will be able to

- understand the significance of Schrodinger's time independent wave equation.
- explain the operator formulation of quantum mechanics.
- learn the concept of wave function

Pedagogy tools: Blended learning, Case let, video lectures, self-reading

UNIT – III: Quantum Tunneling (8 Hours)

One dimensional infinitely rigid box-energy eigenvalues and eigenfunctions, normalization; Quantum dot as example; Quantum mechanical tunnelling in one dimensional rectangular potential barrier, 1D linear harmonic oscillator (no derivation required, only eigen function, eigen values and zero-point energy).

Learning Outcomes:

After completion of this unit, the student will be able to

- Derive wave functions with reflection and transmission coefficients
- The concept of quantum mechanical tunneling
- solve time-independent Schrödinger equation for simple potentials

Pedagogy tools: Blended learning,Case let, video lectures, self-reading

UNIT - IV Quantum Properties of Electrons (9 Hours)

Electron angular momentum, angular momentum operator, Space quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Zeeman Effect, Stark Effect, Gyromagnetic Ratio and Bohr Magneton (qualitative)

Learning Outcomes:

After completion of this unit, the student will be able to

- understand spin magnetic moment and total angular momentum
- relate the eigenvalue problems for energy, momentum and angular momentum explain the idea of spin
- explain the interaction between spin of electron and magnetic field
- understand the interaction between electron and electric field

Pedagogy tools: Blended learning,Case let, video lectures, self-reading

UNIT – V: Qubits for Quantum Computing (10 Hours)

Introduction to Dirac Bra-Ket notation, Introduction to Pauli spin matrices, Quantum Superposition, Interference, Quantum Measurement, Decoherence, Entanglement, Bloch sphere, Qubits, and multiple qubits, Qubits Vs classical bits, representation of a qubit probability.

Learning Outcomes:

After completion of this unit, the student will be able to

- apply Bra-Ket notation in obtaining eigen values
- understand quantum entanglement
- describe the fundamentals of the quantum computing

Pedagogy tools: Blended learning,Case let, video lectures, self-reading

Textbook(s):

1. Quantum Mechanics, G. Aruldhas, 2ndEdn. 2002, PHI Learning of India.
2. Quantum Mechanics, Satya Prakash, 2016, Pragati Prakashan.
3. Quantum Computing for Everyone, Chris Bernhardt, 2019, The MIT Press,

Reference Book(s):

1. Introduction to Quantum Mechanics, D.J. Griffith, 2ndEd. 2005, Pearson Education.
2. Quantum Computing: An Applied Approach, Jack D. Hidary, 2019,

Springer Journal(s):

1. https://aapt.scitation.org/doi/full/10.1119/1.4897588
2. https://aapt.scitation.org/doi/full/10.1119/1.3639154

Websites:

1. https://www.intechopen.com/online-first/73811
2. https://www.quantum-inspire.com/kbase/what-is-a-qubit/

PHYS1021: PHYSICS OF SEMICONDUCTING DEVICES

L	T	P	C
3	1	0	4

This course is designed with fundamentals of electromagnetism and properties of materials for advanced courses in their respective engineering branches. It introduces electromagnetic theory with relevant mathematical tools, optical fibers and their propagation characteristics, properties of dielectric and magnetic materials. It also introduces principles of semiconductors and some widely used semiconductor devices for various applications.

Course Objectives

- To introduce nature light and its properties.
- To familiarize students with different semiconductors and its energy band gaps.
- To introduce semiconductor physics and devices.
- To impart knowledge about the semiconducting optical devices.
- To demonstrate the properties of different semiconducting optical devices.

UNIT I Elements of light (8 hours)

Nature of light, Light sources, Black body, Colour temperature, Units of light, Radio metric and photometric units, Light propagation in media and waveguides, Electro-optic effects. Overview of luminescence: Photoluminescence, Cathodoluminescence, Electroluminescence, Injection-luminescence.

Learning Outcomes:

After completion of this unit, the student will be able to

- Understanding the dual nature of light L2
- Understanding different law for energy spectrum emitted by black body. L3
- To explain the concepts of electro-optics effects L1
- To summarize the overview of different luminescence L2

UNIT II: Semiconductor Materials (10 hours)

Free electron theory of metals, Density of states in 1D, 2D, and 3D, Bloch's theorem for particles in a periodic potential, Energy band diagrams, Kronig-Penny model (to introduce origin of band gap), Energy bands in solids, E-k diagram, Direct and indirect bandgaps, Types of electronic materials: metals, semiconductors, and insulators, Occupation probability, Fermi level, Effective mass.

Learning Outcomes:

After completion of this unit, the student will be able to

- Outline the properties of semiconductors L2
- Know the bands structure of metals and semiconductors L3
- Understand the electronic structure of interfaces between different types of materials L2
- To determine the different band gaps of direct and indirect band gap materials L5
- To explain the occupation probability and Fermi level variation in different electronic materials L1

UNIT III: Light-semiconductor interaction **(10 hours)**

Optical transitions in bulk semiconductors: absorption, spontaneous emission, and stimulated emission; Einstein coefficients, Population inversion, application in semiconductor Lasers; Transition rates (Fermi's golden rule), Optical loss and gain; Photovoltaic effect.

Learning Outcomes:

After completion of this unit, the student will be able to

- To summarize the optical transition in bulk semiconductors L2
- To explain the concepts of absorption, spontaneous emission and stimulated emission L1
- To outline the population inversion in semiconductor lasers L2
- To evaluate the transition rates and optical loss and gain in materials L5

UNIT IV: Solar cells and Photovoltaic devices: **(9 hours)**

Charge carrier generation and recombination, p-n junction model and depletion capacitance, Current voltage characteristics in dark and Light, Device Physics of Solar Cells, Principle of solar energy conversion, Conversion efficiency, Type of solar cells in use: Dye Sensitized Solar Cells, Thin film solar cells.

Learning Outcomes:

After completion of this unit, the student will be able to

- Outline the properties of semiconductors L2
- Know about the interaction of light with materials and its optical properties L3
- Illustrate and interpret the voltage and current characteristics of p-n junction diodes model L1
- Explain the conduction mechanism in semiconducting and optical devices. L5
- To describe the applications of p-n junction diodes in types of solar cells L3

UNIT V: Semiconductor devices **(8 hours)**

Radiative recombination devices: Light-emitting diodes (LED), Organic Light Emitting Diodes (OLED) and its types, Photoelectric devices: Photodiodes. Photoconducting devices: Photodetectors and photoconductors, Photoresistors, Photo transistors, Stimulated emission devices: Injection laser diodes, Quantum cascade lasers.

Learning Outcomes:

After completion of this unit, the student will be able to

- describe applications of light emitting diodes and its radiative recombination process L2
- explain the concepts of photoconductive devices and its applications in different devices L3
- to define the concepts of Photodetectors and photoconductors, Photoresistors, Photo transistors, L1
- to access the variation of stimulated emission in injection and quantum lasers L5

Text Books:

1. Schubert, E., Light-Emitting Diodes, 2/e, Cambridge: Cambridge University Press, 2006.

2. Physics of Solar Cells: From Basic Principles to Advanced Concepts, 3rd Edition Peter Würfel, UliWürfel (2016) Wiley.
3. Solid State Physics, Neil W. Ashcroft, N. David Mermin (2003) Cengage Learning India

Reference Books:

1. Quantum Cascade Lasers by Vasilios N. Stavrou: https://www.intechopen.com/books/5389.
2. Optoelectronic materials and device concepts; Manijeh Razeghi, SPIE, 1991
3. Introduction to Organic Electronic and Optoelectronic Materials and Devices; Sun and Dalton, CRC Press, 2008.
4. Semiconductor Physics and Devices, 3ed, An Indian Adaptation, S. M. Sze, M. K. Lee, Wiley India.
5. Semiconductor optoelectronics; Jasprit Singh, McGraw-Hill, 1995.

Course Outcomes

After completion of this unit, the student will be able to

- Outline the properties of semiconductors L2
- explain the occupation probability and Fermi level variation in different electronic materials L1
- Know about the interaction of light with materials and its optical properties L3
- Explain the conduction mechanism in semiconducting and optical devices. L5

PHYS1041: MECHANICS AND MODERN PHYSICS

L	T	P	C
3	1	0	4

This course designed for students of Biotechnology to impart principles of Newtonian mechanics will help the students in understanding the oscillatory behavior of materials. It also introduces fundamentals of quantum mechanics – the essentials for understanding the behavior of properties of materials. Fundamentals of optics and electromagnetism in understanding the use in spectroscopy. An introduction to sensors will be useful for all the branches as an application of modern technology.

Course Objectives

- To impart knowledge on damped and forced oscillations.
- To familiarize students with the concepts of quantum mechanics
- To impart knowledge concerning the wave properties of electromagnetic waves
- To familiarize the students about the Maxwell's equations and its propagation
- To outline the principles and working of few common sensing devices

UNIT - I Fundamentals of Dynamics and Oscillations 10 Hours

Fundamentals of Dynamics: Reference frames. Inertial frames; Galilean transformations; Galilean invariance. Review of Newton's Laws of Motion.

Oscillations: SHM, Simple Harmonic Oscillations. Differential equation of SHM and its solution. Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor

Learning Outcomes:

After completion of this unit, the student will be able to

- Differentiate between inertial and non-inertial frames of reference
- Solve the differential equation of simple harmonic oscillator
- Distinguish between forced and damped oscillators
- Estimate the resonance and its properties
- Describe the Newton's laws of motion

Pedagogy tools: Blended learning, Case let, video lectures, self-reading

UNIT - II Modern Physics (Quantum Physics) 8 Hours

Introduction, matter waves and its properties, Davisson-Germer experiment, GP Thomson experiment, Heisenberg's uncertainty principle, Schrodinger's time independent wave equation, physical significance of wave function, particle in a one-dimensional infinite well, rectangular potential barrier (transmission coefficient), band theory of solids (qualitative), distinction between metals, insulators and semiconductors, introduction to Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstien statistics.

Learning Outcomes:

After completion of this unit, the student will be able to

- Get a grasp on the elementary aspects of energy and momentum of a photon and de Broglie wavelength of a particle.
- Know about the uncertainty principle for position and momentum and for energy and time.

- Understand the significance of Schrodinger’s time independent wave equation and apply it to a restricted particle.
- Derive wave functions with reflection and transmission coefficients.
- Differentiate between the Maxwell-Bolzmann, Fermi-Dirac and Bose-Einstien statistics

Pedagogy tools: Blended learning,Case let, video lectures, self-reading

UNIT – III: Optics 10 Hours

Interference: Introduction, interference in thin films due to reflected light: interference in parallel-sided film and wedge-shaped film, Newton’s rings. Diffraction: Introduction; Fraunhofer diffraction at single slit (qualitative only), diffraction due to N-slits (diffraction grating) (qualitative only), determination of wavelength of light with a plane transmission grating.

Polarisation: Introduction; Double refraction –double refraction in calcite crystal, negative and positive crystals, Nicol’s prism, Retarders (quarter and half¬wave plates).

Learning Outcomes:

After completion of this unit, the student will be able to

- Develop the ability to determine the conditions for constructive and destructive interference
- Figure out the position and intensity variation of the dark fringes in single-slit diffraction (Fraunhoffer Diffraction).
- Acquire a basic understanding of diffraction gratings with dispersive nature.
- Comprehend the concepts and meaning of Polarization.
- Know about polarization of light, polarizer and methods of producing polarized light.

Pedagogy tools: Blended learning,Case let, video lectures, self-reading

UNIT – IV: Maxwell`s equations and Electromagnetic wave propagation 8 Hours

Maxwell’s equations (both differential and integral forms) and its physical significance, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves, polarization of EM waves.

Learning Outcomes:

After completion of this unit, the student will be able to

- Relate the Maxwell’s equation in differential and integral forms
- Interpret the behavior of plane electromagnetic waves in vacuum
- Summarize the significance of Maxwell’s equations
- Evaluate the energy density of electromagnetic wave
- Describe the wave propagation in vacuum and medium

Pedagogy tools: Blended learning,Case let, video lectures, self-reading

UNIT - V Sensors 9 Hours

Sensors (qualitative description only); Different types of sensors and applications; Strain and pressure sensors -Piezoelectric, magnetostrictive sensors, ultrasonic sensors; Fibre optic methods of pressure sensing; Temperature sensor -bimetallic strip, pyroelectric detectors; Hall-effect sensor; Smoke and fire detectors

Learning Outcomes:

After completion of this unit, the student will be able to

- Illustrate the principle of strain and pressure sensors

- explain the principle and working of magnetostrictive and piezoelectric sensors
- Evaluate the fibre optic methods of pressure sensing
- Infer the functioning of temperature sensors like bimetallic strip and pyroelectric detectors
- State the principle and working of Hall-effect sensor, smoke and fire detectors

Pedagogy tools: Blended learning,Case let, video lectures, self-reading

Textbook(s):

1. Mechanics, D.S. Mathur, S.Chand and Company Limited, 2000.
2. A Text Book of Optics, 25/e, Brij Lal, M N Avadhanulu & N Subrahmanyam, 2012, S. Chand Publishing.
3. Ian R Sinclair, Sensor and Transducers 3rd eds, 2001, Elsevier (Newnes)
4. David J. Griffiths, "Introduction to Electrodynamics"-4/e, Pearson Education,2014
5. M.N. Avadhanulu, P.G. Kshirsagar, A Textbook of Engineering Physics, S.Chand, 2014.

Reference Book(s):

1. Optics, Ajoy Ghatak, 2008, Tata McGraw Hill
2. Prithwiraj Purkait, Budhaditya Biswas and Chiranjib Koley, Chapter 11 Sensors and Transducers, Electrical and Electronics Measurements and Instrumentation, 1st eds., 2013 McGraw Hill Education (India) Private Limited.
3. Elements of Properties of Matter, D. S. Mathur, S. Chand Publishing

Journal(s):

1. https://aapt.scitation.org/doi/abs/10.1119/1.3317450
2. https://aapt.scitation.org/doi/full/10.1119/1.3639154

CHEM1001: CHEMISTRY

L	T	P	C
3	0	2	4

This course enables the students to gain knowledge on various aspects of Water and its treatment, electrochemical energy systems, Construction of batteries, renewable energy sources, Semiconductors, Steel, Cement and Polymers, Corrosion and its control, nano-materials, Analytical instruments and applications. The knowledge gained in this course can be applied to the latest developments in technology.

Course objectives

- To impart knowledge on various aspects of water and its treatment.
- To study about electrochemical energy systems, renewable energy sources, solar cells and their applications.
- To gain knowledge on materials such as steel, cement and polymers
- To create awareness on corrosion and its control.
- To introduce different types of nano-materials.
- To expose the students to latest instrumental techniques such as scanning electronic microscope (SEM) & transmission electron microscope (TEM).

Unit-1: Water and its treatment **9L**

Water and its treatment: Introduction – hardness of water – Causes of hardness - Types of hardness: temporary and permanent – expression and units of hardness. Estimation of hardness of water by complexometric method. Potable water and its specifications. Steps involved in treatment of water – Disinfection of water by chlorination and ozonization- industrial water treatment- Boiler feed water and its treatment -internal conditioning– Calgon and Phosphate conditioning. External treatment of water – Ion exchange process. Desalination of water – Reverse osmosis.

Learning outcomes:

After the completion of the Unit I, the student will be able to

- list the differences between temporary and permanent hardness of water. (L-1)
- explain the principles of reverse osmosis. (L-2)
- compare the quality of drinking water with BIS and WHO standards. (L-2)
- illustrate problems associated with hard water. (L-2)
- demonstrate the Industrial water treatment processes. (L-2)

Unit-2: Electrochemical Energy Systems **9L**

Battery Technology: Basic concepts, battery characteristics, classification of batteries, Important applications of batteries, Classical batteries-dry/Leclanche cell, Modern batteries-zinc air, Lead-acid storage battery, lithium cells- Lithium ion cell, Li MnO_2 cell. Fuel cells- Introduction - classification of fuel cells – hydrogen and oxygen fuel cell, propane and oxygen fuel cell- Merits of fuel cell. **Renewable energy sources – Types of renewable energy sources. Semiconductors:** Definition, types of semiconductors: doping- n type and p – type semiconductors and applications.**-** **Solar cells:** Introduction, harnessing solar energy, Photovoltaic cell, solar water heaters.

Learning outcomes:

After the completion of the Unit II, the student will be able to

- define electrode potential. (L-1)

- explain Nernst's equation. (L-2)
- illustrate difference between primary and secondary cells. (L-2)
- summarize the applications of solar energy. (L-2)
- construct different cells. (L-3)

Unit-3: Engineering materials and Polymer Chemistry 8L

Steel – Types of Steel, chemical composition – applications of alloy steels
Cement: Portland cement, constituents, Manufacture of Portland Cement, chemistry of setting and hardening of cement (hydration, hydrolysis, equations).
Polymer Chemistry: Concept of polymerization – Types of Polymerization, Chain growth polymerization – mechanisms of free radical and cationic polymerizations, Thermoplastic resins and Thermosetting resins: examples- Polyethylene, Styrene, Nylon 6,6 and Bakelite. and applications, Conducting polymers:– Examples – and applications.

Learning outcomes:

After the completion of the Unit IV, the student will be able to

- classify the types of steel. (L-2)
- illustrate the chemical reactions involved in the manufacturing of cement. (L-2)
- identify preparation and properties of polymers. (L-3)
- distinguish between thermoplastic and thermo setting resins. (L-4)

Unit-4: Corrosion and its control 8L

Corrosion and Its Prevention: Electrochemical theory of corrosion, Corrosion due to dissimilar metal cells (galvanic cells), Corrosion due to differential aeration cells, Uniform corrosion, pitting corrosion and stress corrosion cracking, Effect of pH, temperature and dissolved oxygen on corrosion rate. Corrosion prevention and control by cathodic protection- protective coatings-paints.

Learning outcomes:

After the completion of the Unit III, the student will be able to

- explain theories of corrosion. (L-2)
- classify different corrosion methods. (L-2)
- summarize the various factors affecting corrosion. (L-2)
- identify different organic coatings. (L-3)
- apply the principles of corrosion control. (L-3)

Unit-5: Nanomaterials and Analytical Instrumental Techniques 8L

Nanomaterials: Introduction to nanomaterial: nanoparticles, nanocluster, carbon nanotube (CNT) and nanowires. Chemical synthesis of nanomaterials: sol-gel method. Characterization: Principle and applications of scanning electron microscope (SEM) and transmission electron microscope (TEM)

Analytical Instrumental Techniques

Review of electromagnetic spectrum, Quantization of energy. Absorption of radiation: Beer-Lambert's law. Principle and applications of pH metry, potentiometry, conductometry, IR and UV-spectroscopy with examples.

Learning outcomes:

After the completion of the Unit V, the student will be able to

- classify nanomaterials. (L-2)

- explain the synthesis and characterization methods of nano materials. (L-2)
- describe the principles of different analytical techniques. (L-3)
- compare the principles of SEM and TEM. (L-4)

Course outcomes

After the completion of the course, the student will be able to

- list the important purification methods of water. (L-1)
- illustrate the principles and applications of batteries, solar energy. (L-2)
- explain the importance of materials such as steel, cement and polymers
- identify different protective coatings. (L-3)
- analyze the importance of nano materials and the principles of SEM and TEM. (L-4)

Text Books:

1. P.C. Jain and M. Jain, Engineering Chemistry, 15/e, Dhanapat Rai & Sons, Delhi (2014).
2. B.K. Sharma, Engineering Chemistry, Krishna Prakashan, Meerut.
3. O G Palanna, Engineering Chemistry, Tata McGraw Hill Education Private Limited, (2009).

Reference Books:

1. Sashi chawla, A Textbook of Engineering Chemistry, Dhanapath Rai and sons, (2003)
2. B.S Murthy and P. Shankar, A Text Book of NanoScience and NanoTechnology, University Press (2013).
3. S.S. Dara, A Textbook of Engineering Chemistry, S.Chand & Co, (2010)
4. N.Krishna Murthy and Anuradha, A text book of Engineering Chemistry, Murthy Publications (2014).
5. K. Sesha Maheshwaramma and Mridula Chugh, Engineering Chemistry, Pearson India Edn services, (2016).

CHEMISTRY LABORATORY

The course enables the students to gain knowledge on various, instrumental methods of analysis, measurements of physical parameters, volumetric analysis, preparation of polymers, analysis of water, and chromatographic separation techniques.

Course objectives

- To familiarize the students with the basic concepts of Chemistry lab.
- To train the students on how to handle the instruments.
- To demonstrate the digital and instrumental methods of analysis.
- To expose the students in practical aspects of the theoretical concepts.

List of experiments

1. Determination of Mohr's salt by potentiometric method
2. Determination of strength of an acid by pH metric method
3. Determination of conductance by conductometric method
4. Determination of viscosity of a liquid
5. Determination of surface tension of a liquid
6. Determination of sulphuric acid in lead-acid storage cell
7. Determination of chromium (VI) in potassium dichromate

8. Determination of copper in a copper ore
9. Determination of Zinc by EDTA method.
10. Estimation of active chlorine content in Bleaching powder
11. Preparation of Phenol-Formaldehyde resin
12. Preparation of Urea-Formaldehyde resin
13. Thin layer chromatography
14. Preparation of TiO2/ZnO nano particles
15. SEM analysis of nano materials

Course Outcomes:

After the completion of the laboratory course, the student will be able to

- explain the functioning of the instruments such as pH, Conductometric and Potentiometric methods. (L-2)
- identify different ores (Cr & Cu) and their usage in different fields (industry, software devices, electronic goods). (L-3)
- experiment with the physical parameter of organic compounds. (L-3)
- compare the viscosities of oils. (L-4)
- list the preparation of polymers and nano materials. (L-4)

Text Books

1. Mendham J, Denney RC, Barnes JD, Thosmas M and Sivasankar B Vogel's Quantitative Chemical Analysis 6/e, Pearson publishers (2000).

2. N.K Bhasin and Sudha Rani Laboratory Manual on Engineering Chemistry 3/e, Dhanpat Rai Publishing Company (2007).

MATH1001 - SINGLE VARIABLE CALCULUS

L	T	P	C
2	0	0	2

This course is designed to impart knowledge on differentiation and integration of function, emphasizing their inter-relationship and applications to engineering.

Course Objectives:

- To familiarize the students in the concepts the derivatives and its underlying concepts like limits and continuity.
- To explain the concept of derivative and calculation of extreme values of extreme values of various functions.
- To impart knowledge on integration for the computation of areas, arc lengths.
- To demonstrate various techniques of integrations.

Unit I: Limits and continuity of single and several variables (6 hours)

Limit of a Function and Limit Laws, The Precise Definition of a Limit, One-Sided Limits, Continuity (Without proofs). Functions of Several Variables, Limits and Continuity in Higher Dimensions (Without proofs)

Learning Outcomes:

At the end of this unit, the student will be able to

- define and calculate limits and one-sided limits of single variables
- define and calculate limits of several variables.
- define continuity and determine whether a function is continuous of single and several variables.

Unit II: Derivatives and applications (7 hours)

The Derivative as a Function, Differentiation Rules, The Chain Rule, Extreme Values of Functions on Closed Intervals, Monotonic Functions (Without proofs)

Learning Outcomes:

At the end of this unit, the student will be able to

- know the definition of derivative and how to use the most common rules of derivatives
- apply various rules to obtain the derivatives of different functions.
- find the extreme values of various functions.

Unit III: Integrals and applications (7 hours)

The Definite Integral, The Fundamental Theorem of Calculus, Indefinite Integrals and the Substitution Method, Definite Integral Substitutions and the Area between Curves, Arc Length (Without proofs)

Learning Outcomes:

At the end of this unit, the student will be able to

- know about anti-derivative and the Fundamental Theorem of Calculus and its applications
- apply concept of integration to evaluate geometric area and solve other applied problems
- apply substitution to compute definite integrals.

Unit IV: Techniques of integration **(6 hours)**

Using basic Integration Formulas, Integration by Parts, Trigonometric Integrals, Trigonometric Substitutions, Integration of Rational Functions by Partial Fractions (Without proofs)

Learning Outcomes:

At the end of this unit, the student will be able to

- evaluate integrals using integration by parts.
- evaluate indefinite and definite integrals using by the method of substitution.
- evaluate integrals of trigonometric and rational functions.

Textbook:

1. Joel Hass, Christopher Heil, Maurice D. Weir, Thomas' Calculus, Fourteenth edition, Pearson Addison Wesley (2018).

References:

1. Erwin Kreyszig, Advanced Engineering Mathematics,10/e, John Wiley & Sons, 2018.
2. B. S. Grewal, Higher Engineering Mathematics, 44/e, Khanna publishers, 2017.
3. James Stewart, "Calculus: Early Transcendentals", Cengage Learning, 7th Edition, New Delhi, 2015.
4. Hyghes-Hallett, Gleason, McCallum et al. Single Variable Calculus (6th Edn) John Wiley and Sons New York, 2013.

Course Outcomes:

At the end of the course, the student will be able to

- determine limit, one sided limit, continuity of single and several variable functions.
- solve problems in a range of mathematical applications using the derivative or the integral.
- apply the fundamental theorem of calculus.
- evaluate integrals using various techniques.

MATH1011- SEVERAL VARIABLE CALCULUS

L	T	P	C
2	0	0	2

This course is designed to impart knowledge on calculus of functions of more variables which are useful in modelling and analyzing physical phenomena involving continuous change of variables or parameters and have applications across all branches of engineering.

Course Objectives:

- To teach basic concepts of partial derivatives.
- To explain the evaluation of double integrals and its applications.
- To demonstrate the evaluation and applications of triple integrals.
- To acquaint the knowledge of line and surface integrals and applications.

Unit I: Partial derivatives and applications (7 hours)

Partial Derivatives of a Function of Two Variables and More Than Two Variables, Second-order Partial derivatives, The Chain Rule for Functions of Two and Three variables, Extreme Values and Saddle Points, Lagrange Multipliers, Taylor's Formula for Two Variables (Without proofs)

Learning Outcomes:

At the end of this unit, the student will be able to

- find partial derivatives of various functions
- apply chain rule for functions of two and three variables
- evaluate maxima and minima of functions

Unit II: Double integrals (6 hours)

Double and iterated Integrals over Rectangles, Double Integrals over General Regions, Area by Double Integration : Area of bounded region in a plane, Double Integrals in Polar Form. (Without proofs)

Learning Outcomes:

At the end of this unit, the student will be able to

- evaluate double integrals of functions of several variables in two dimensions in Cartesian and polar coordinates.
- calculate the areas bounded by a region using double integration techniques.

Unit III: Triple integrals (5 hours)

Triple Integrals in Rectangular Coordinates: Triple Integrals, Volume of a Region in Space, Finding limits of integration, Triple Integrals in Cylindrical and Spherical Coordinates. (Without proofs)

Learning Outcomes:

At the end of this unit, the student will be able to

- find limits of integration
- evaluate multiple integrals in Cartesian, cylindrical and spherical geometries.
- find volumes using triple integrals.

Unit IV: Integrals and Vector fields (8 hours)

Vector Fields and Line Integrals: Line Integrals of Vector Fields, Line Integrals with Respect to dx, dy, or dz, Work Done by a Force over a Curve in Space, Green's Theorem in the Plane: Tangential form, Using Green's Theorem to Evaluate the Line Integral and Verification, Surface Integrals: Surface Integrals of Vector Fields, Stokes' Theorem (Without proofs)

Learning Outcomes:

At the end of this unit, the student will be able to

- find the work done in moving a particle along the path over a force field.
- find the rate of flow of a fluid across a surface.
- apply Green's and Stokes' theorem in evaluation of line, surface and volume integrals.

Textbook:

1. Joel Hass, Christopher Heil, Maurice D. Weir, Thomas' Calculus, Fourteenth edition, Pearson Addison Wesley (2018).

References:

1. Erwin Kreyszig, Advanced Engineering Mathematics,10/e, John Wiley & Sons, 2018.
2. B. S. Grewal, Higher Engineering Mathematics, 44/e, Khanna publishers, 2017.
3. Hyghes-Hallett, Gleason, McCallum et al. Multivariable Variable Calculus (6th Edn) John Wiley and Sons New York, 2013.
4. James Stewart. Multivariate Calculus, Concepts and Contexts. (3rd Edn) Thomson/Brooks/Cole, Canada, 2005.

Course Outcomes:

At the end of the course, the student will be able to

- utilize functions of several variables in optimization.
- employ the tools of calculus for calculating the areas.
- calculate volumes using multiple integrals.
- determine the work done and rate of flow of a fluid using vector calculus

MATH 1021: TRANSFORM TECHNIQUES

L	T	P	C
2	0	0	2

Preamble

This course is designed to impact the knowledge on (Laplace, Fourier) transforms and applications of these transforms on differential equations.

Course Objectives:

- To introduce and explain the concepts of Laplace transforms and properties.
- To demonstrate the evaluation of Laplace transforms of special functions and additional properties.
- To impart knowledge on obtaining Fourier series
- To introduce and explain the concepts of Fourier transforms and properties.
- To explain the evaluation of Fourier transforms of various function and then applications to boundary value problem.
- To demonstrate and understand the transform techniques using available software

Unit-1: Laplace transforms (5 hrs)

Introduction, transforms of elementary functions, properties of Laplace transforms, Transforms of derivatives, transforms of Integrals, Multiplication by t^n, Division by t.

Learning Outcomes:

After completion of this unit student able to

- find Laplace transform of a function (L3).
- examine the properties of Laplace transforms(L4).
- determine Laplace transform of functions like transforms of Integrals, Multiplication by t^n, Division by t (L4).

Unit-2: Applications of Laplace transforms (5 hrs)

Evaluation of integrals by Laplace transforms, Inverse transforms, Solution of Differential equations.

Learning Outcomes:

After completion of this unit student able to

- find the inverse Laplace transform of a function(L3)
- Solve ordinary differential equations by using Laplace transformation technique(L3).

Unit-3: Fourier Series (6 hrs)

Introduction, Conditions for a Fourier expansion, Functions having points of discontinuity, Change of interval.

Learning Outcomes:

After completion of this unit student able to

- find the Fourier series of a given function (L3)

- find the Fourier series by changing the given interval (L3)

MATH1031: DIFFERENTIAL EQUATIONS

L	T	P	C
2	0	0	2

Preamble

This course is designed to impact the knowledge on ordinary, partial differential equations and their applications.

Course Objectives:

- To familiarize the students with the basic concepts of ordinary differential equations.
- To demonstrate the evaluation and applications of first order differential equations.
- To explain the evaluations of linear homogeneous and non-homogeneous differential equations.
- To familiarize the students with the basic concepts of partial differential equations.
- To explain the concepts of first order partial differential equations.
- To demonstrate the evaluation of differential equations using math software

Unit-1: First Order Ordinary Differential Equations (5 hrs)

Order and Degree of an Ordinary Differential Equation(ODE),ODE's of first order and first degree, Variable separable method, Linear Equations, Bernoulli's Equations.

Learning Outcomes:

- apply various methods to solve first order and first degree differential equations (L3).
- distinguish between linear and non linear differential equations (L4).
- solve linear differential equations (L3).

Unit-2: Linear Ordinary Differential Equations of High Order (6 hrs)

Definitions, Complete Solution, Operator D, Complimentary function, Inverse operator, Rules for finding particular integral (e^{ax}, sinbx/cosbx, x^m& $e^{ax}v(x)$)

Learning Outcomes:

- classify the solutions of linear differential equations of higher order (L3)
- identify the essential characteristics of linear differential equations with constant coefficients (L3)
- solve the linear differential equations with constant coefficients by appropriate methods (L3)

Unit-3: Applications of Linear Ordinary Differential Equations of Higher Order (5 hrs)

Method of Variation of Parameters, Simple Harmonic Motion, Oscillations of a Spring

Learning Outcomes:

- solve the linear differential equations with Method of Variation of Parameters (L3)

- Solve application problems such as Simple Harmonic Motion and Oscillations of a string using linear ordinary differential equations of higher order (L3).

Unit-4:Introduction to Partial Differential Equations (5 hrs)

Introduction, Formation of Partial Differential Equation(PDE), Solutions of a PDE, Equations solvable by direct integration, Linear equations of the first order.

Learning Outcomes:

- find the partial differential equation (L3).
- find the solution of a partial differential equation (L3).
- solve PDE by direct integration (L3)

Unit-5: Partial Differential Equations of Second Order (5 hrs)

Homogeneous linear equations with constant coefficients, Rules for finding the complementary function and particular integral,Working procedure to solve the equations.

Learning Outcomes:

- apply a range of techniques to find solutions of PDEs (L3)
- identify the basic properties of PDEs (L3)
- find the solutions of homogenous and non-homogenous linear partial differential equations (L3).

Text Books:

1. Simmons, G.F., Differential Equations with Applications and Historical Notes, Second Edition, McGraw-Hill, Inc., 1991.
2. B. S. Grewal, Higher Engineering Mathematics, 44/e, Khanna publishers, 2017.

References:

1. Shepley L. Ross, *Differential Equations*, 3rd Ed., John Wiley and Sons, 1984
2. Sneddon, *Elements of Partial Differential Equations*, McGraw-Hill, International Edition, 1967.
3. Erwin Kreyszig, Advanced Engineering Mathematics,10/e, John Wiley & Sons, 2018.

Course Outcomes:

- form and find the solution of an ordinary differential equation (L3).
- apply the concept of differential equations to solve real world problems (L3).
- evaluate linear homogeneous and non homogeneous differential equations (L4)
- form and find the solution of a partial differential equations of first order (L3).
- evaluate second order partial differential equations (L4).
- evaluate solution of differential equations using computational tool (L4)

MATH1041: DISCRETE MATHEMATICS

L	T	P	C
2	0	0	2

Preamble :

Discrete Mathematics introduces students to the mathematics of networks, social choice, and decision making . This course provides students with a hands-on exploration of the relevancy of mathematics in the real world. This course reflects the rigor taught in many entry-level mathematics courses.

Course Objectives:

- To introduce basics of mathematical logical operators and connectives
- To impart knowledge on normal forms and rules of inference.
- To impart knowledge on partially ordered and total ordered sets.
- To familiarize closed form solution of linear recurrence relations by various methods.
- To impart knowledge on basic concepts of algebraic structures.
- To write program structures, and understand when programming is most applicable

Unit-1: Logic Operators and Connectives (5 hrs)

Negation, conjunction, disjunction, conditional and bi-conditional, well formed formulae, tautologies, equivalence of formulae, duality, tautological implications.

Learning outcomes:

After completion of this unit, student will be able to

- construct the truth table for given expressions (L3)
- identify tautologies, Contradiction or at least satisfiable and solve the decision problem. (L3)
- find equivalence formulas (L3)

Unit-2: Mathematical logic (5 hrs)

Conjunctive and disjunctive normal forms- principal disjunctive and conjunctive normal forms, Rules of inference for propositional calculus (Rule P, Rule T and CP rule).

Learning Outcomes:

After completion of this unit, student will be able to

- implement logic for mathematical proofs (L4)
- apply inference theory to verify the consistence of data (L3)

Unit-3: Sets and Relations (5 hrs)

Basic concepts of set theory, Power set, relations, properties of binary relations in a set, Equivalence relations, composition of binary relations, Partial ordering, Partially ordered set.Hasse diagram.

Learning Outcomes:

After completion of this unit, student will be able to

- identify different types of sets and relations (L3)
- test the given set is an equivalence relation or not (L4)

Unit-4: Recurrence relations **(5hrs)**

Recurrence relations, solving linear recurrence relations by characteristic roots method, system of recurrence relations.

Learning Outcomes:

After completion of this unit, student will be able to

- construct recurrence relations of the sequences (L3)
- solve homogeneous linear recurrence relations (L3)
- solve complementary function and particular integral for non-homogeneous linear recurrence relations (L3)

Unit-5: Algebraic Structures **(6 hrs)**

Algebraic Structures-Semi group, Monoid ,Groups, subgroups, cosets((definition and examples) Lagrange's theorem on finite groups

Learning Outcomes:

After completion of this unit, student will be able to

- test the given algebraic structure is a group or not (L3)
- identify different types of groups (L2)
- understand the significance and applications of Lagrange's theorem (L3)

Text Books:

1. J.P. Tremblay and R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, Tata McGraw Hill, 1997.
2. Kenneth H. Rosen, Discrete Mathematics and Applications, Seventh edition, Tata McGrawHill,2012.

Reference books:

1. Bhishma Rao, Mathematical Foundations of Computer Science, SciTech Publications (India) Pvt Ltd.
2. Discrete Mathematical Structures,Sixth edition-Kolman,Busby,Ross

Course Outcomes:

Upon successful completion of this course the student should be able to

- Check the validity of a statement formula (L2)
- analyze the concepts in set theory and relations (L3)
- find a general solution of recurrence equation (L3)
- build the algebraic structures (L3)
- Apply Lagrange's theorem on finite groups (L3)
- Convert problem solving strategies to procedural algorithms (L3)

MATH1051: GRAPH THEORY

L	T	P	C
2	0	0	2

Preamble
This course introduces basic concepts in Graph Theory, including properties and characterization of graph/trees and graph theoretic algorithms, which are widely used in Mathematical modelling and has got applications across Computer Science and other branches in Engineering.

Course Objectives:
- To introduce basics of group theory and its applications
- To impart knowledge on basic concepts of paths and circuits
- To impart knowledge on Trees, spanning trees, shortest spanning trees
- To familiarize in the matrix representation of graphs
- To transform scientific problems into generic computational models

Unit-1: Basics of graphs (5 hrs)
Finite and Infinite Graphs, Incidence and Degree, Isolated Vertex, Pendant Vertex, and Null Graph, complete graph, Bi-partite and complete Bi-partite graphs.
Learning Outcomes:
After completion of this unit, student will be able to
- understand the basic terminology of the graph theory (L2).
- find the vertex of the graph and identify the types of vertices of the graph(L3).

Unit-2: Matrix representation of graphs: (5hrs)
Adjacency Matrix, Incidence Matrix, Path Matrix(Definition and examples),
Learning Outcomes:
After completion of this unit, student will be able to
- identify the types of matrix representation of graph (L3)
- Find a path matrix of a connected graph (L3)

Unit-3: Paths and circuits (6 hrs)
Paths, and Circuits, Connected Graphs, Disconnected Graphs, and Components, Euler Graphs,Hamiltonian graphs(Definition,examples and without proofs)
Learning Outcomes:
After completion of this unit, student will be able to
- identify different types of paths and their properties (L3)
- construct Euler and Hamiltonian graphs (L3)

Unit-4: Trees (5 hrs)
Trees and their properties, spanning trees, minimal spanning trees,
Kruskal's algorithm for finding a minimal spanning tree,
Learning Outcomes:
After completion of this unit, student will be able to

- construct the spanning trees from graphs (L3)
- build minimal spanning tree by Kruskal's algorithms (L3)

Unit 5: Applications of Trees and Fundamental circuits (5 hrs)
Preorder, in order and post order traversals, Prefix and Postfix notations of an arithmetic expression, parsing trees.

Learning Outcomes:
After completion of this unit, student will be able to

- Identify tree traversals (L3)
- construct parsing trees for algebraic expressions (L3)

Text Book:

1. J.P. Tremblay and R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, Tata McGraw Hill, 1997.
2. Narsingh Deo, Graph Theory with Applications to Engineering and Computer Science, Prentice Hall of India, 2006.

Reference Book:

1. Bhishma Rao, Mathematical Foundations of Computer Science, SciTech Publications (India) Pvt Ltd.
2. Kenneth H. Rosen, Discrete Mathematics and Applications, Seventh edition, Tata McGrawHill,2012.

Course Outcomes:
Upon successful completion of this course the student should be able to

- analyse the concepts in graph theory (L4)
- apply graph theory concepts in core subjects such as data structures and network theory effectively (L3)
- Identify different types of paths (L3)
- Construct minimum spanning tree using some algorithms (L3)
- Identify tree traversals (L3)
- Solve the graphical problems which are accessed in available software (L3)

MATH1061 - INTRODUCTION TO MATHEMATICS I

L	T	P	C
2	**0**	**0**	**2**

This course is designed to provide an introduction to the mathematics required for basic physics, engineering mathematics, and introductory engineering courses.

Course Objectives:

- To explain the concepts of Trigonometry.
- To explain the basic concepts of differentiation and differential equations
- To teach the evaluation of definite and indefinite integrals.

Unit- I : **3 hrs**

Representations for Scalars, Vectors, Matrices and Tensors.
Coordinate systems: cartesian and polar coordinate systems.

Learning Outcomes:

At the end of this unit, the student will be able to

- Describe representational forms (L1)
- Understand the basis of coordinate systems (L1)

3 hrs

Unit- II : Trigonometry

Trigonometric functions, periodicity, trigonometric ratio of compound angles, multiple and sub multiple angles, transformations, brief introduction of inverse trigonometric, hyperbolic and inverse hyperbolic functions.

Learning Outcomes:

At the end of this unit, the student will be able to

- identify trigonometric functions and their properties (L3)
- apply the trigonometric ratio techniques of compound angles, multiple and sub multiple angles in calculations (L3)
- find inverse trigonometric and hyperbolic functions (L3)

8 hrs

Unit- III : Differential Calculus

Limits and Continuity: Definition of right hand limit, left hand limit, standard limits

1) $\operatorname{Lim}_{x \to a} \frac{x^n - a^n}{x - a}$ 2) $\lim_{\theta \to 0} \frac{\sin\theta}{\theta}$ 3) $\lim_{n \to 0} \left(1 + \frac{1}{n}\right)^n$ 4) $\lim_{x \to 0} \frac{e^x - 1}{x}$

5) $\lim_{x \to 0} \frac{a^x - 1}{x}$

(without proofs)**,** definition of continuity and simple illustrations.

Differentiation: Introduction, definition, differentiation of a function at a point and on an interval, derivative of a function, differentiation of sum, difference, product and quotient of functions, differentiation of algebraic, exponential, logarithmic functions, composite, implicit, parametric, hyperbolic, inverse hyperbolic functions, logarithmic differentiation, derivatives of first and second order.

Learning Outcomes:

After completing this unit, the student will be able to

- find derivative of sum, difference, product and quotient of functions (L3)
- apply differentiation techniques in different forms of functions (L3)
- calculate the derivatives of simple functions (L4)

8 hrs

Unit IV: Integration

Indefinite Integrals: Integration as the inverse process of differentiation, standard forms, properties of integrals, integration by the method of substitution covering algebraic, trigonometric, exponential functions, integration by parts, logarithmic functions, inverse trigonometric functions.

Definite Integrals: Definition of a definite integral and its properties (without proof), formulae

Of $\int_0^{\pi/2} Sin^n\theta\, d\theta$, $\int_0^{\pi/2} \cos^n\theta\, d\theta$ and $\int_0^{\pi/2} \cos^n\theta\, Sin^m\theta\, d\theta$ (without proofs).

Learning Outcomes:

After completing this unit, the student will be able to

- find integrals of special functions (L3)
- apply partial fractions technique on evaluation of integrals of rational functions (L3)
- solve definite integrals in trigonometric functions (L3)
    - solve simple integrals (L3)
    - apply substitution and by parts techniques in evaluation of integrals (L3)
    - find logarithmic, inverse trigonometric functions (L3)

10 hrs

Unit V: Introduction to differential equations and Multivariable calculus

Linear first order differential equations with constant coefficients, linear second order differential equations with constant coefficients (Definitions only). Only basic concepts of Partial differentiation. Only basic concepts of Differential forms: gradient, divergence and curl. Introduction to line, surface and volume integrals (without problems) illustrated with Stokes, Gauss, and Green's theorems (Only statements).

Learning Outcomes:

- solve problems involving trigonometric functions (L3)
- understand the principles of differential and integral calculus (L3)
- solve first order linear differential equations with constant coefficients (L3)
- solve first order linear differential equations with constant coefficients (L3)
- understand the basic concepts of vector calculus (L1)

Course Outcomes:

After the completion of the course the student should be able to

- solve problems involving trigonometric functions (L3)
- understand the principles of differential and integral calculus (L3)
- solve first order linear differential equations with constant coefficients (L3)
- solve first order linear differential equations with constant coefficients (L3)
- understand the basic concepts of vector calculus (L1)

Text Books:

1. Text book for Intermediate Mathematics, Board of Intermediate Education, AP, Volumes IA, IB & IIA, 2018.
2. NCERT class XI and XII (part 1) Mathematics text books.

References:

1. V. Venkateswara Rao, N. Krishna Murthy, B.V.S. Sharma, Intermediate Mathematics, S.Chand & Company Ltd., Volume I & II.
2. Chandrika Prasad, A first Course in Mathematics.
3. Text book for Intermediate Mathematics, Deepti Publications.

MATH1071 - INTRODUCTION TO MATHEMATICS II

L	T	P	C
2	0	0	2

This course is designed to provide an introduction to the mathematics required for basic physics, engineering mathematics, and introductory engineering courses.

Course Objectives:

- To describe the basic concepts of matrices
- To introduce complex numbers and their properties.
- To teach the technqiues based on partial fractions
- To explain the concepts of straight lines and circles

Unit I: Matrices **8hr**

Matrices, determinants, definition, types of matrices, algebra of matrices, properties of determinants of 2 X 2, 3 X 3 matrices, inverse of a matrix, solving simultaneous linear equations in two and three variables using matrix inverse method, Cramer's rule and Gauss Jordan method. Eigenvalues and Eigenvector of matrices.

Learning Outcomes:

At the end of this unit, the student will be able to

- find determinants of matrices (L3)
- apply crammer‟s rule for solving linear equations (L3)
- find inverse of a matrix (L3)

Unit- II : Complex Numbers **6 hrs**

Complex number as an ordered pair of real numbers, representation of $z = (a, b)$ in the form $(a + ib)$ conjugate complex numbers, modulus and amplitude of a complex number, geometrical representation of a complex number, Argand diagram.

Learning Outcomes:

- solve arithmetic problems involving complex numbers (L3)
- find the conjugate, modulus and amplitude of a complex number (L3)
- describe the relationship between a complex number and Argand plane (L3)

Unit III: Partial Fractions **6 hrs**

Introduction, resolving $g(x)$ into partial fractions when $g(x)$ contains non repeated linear factors, repeated linear factors, repeated and non-repeated irreducible quadratic factors.

Learning Outcomes:

After completing this unit, the student will be able to

- find a fractional function and resolve it into partial fractions (L3)
- make use of resolving techniques of repeated and non repeated linear factors (L3)
- apply this technique in evaluation of integrals (L3)

Unit IV: Co-ordinate Geometry **14 hrs**

Straight lines: Recapitulation of general equation of a straight line, forms of equation of a straight line: slope intercept form, intercept form, point -slope form, two point form, normal form $x \cos\square \square y \sin \square \square p$, point of intersection of two straight lines, line passing through the point of intersection of two given lines, condition for concurrency of three straight lines, angle between two intersecting lines, condition for perpendicularity and parallelism, length of the perpendicular from a point to a straight line, distance between two parallel lines (without proofs).

Circles: Equation of a circle, standard form, centre and radius, equation of a circle with a given line segment as diameter, equation of a circle through three non collinear points, parametric equations of a circle, position of a straight line in the plane of the circle.

3D Geometry: Equation of a plane, Intersection of two planes, Equation of a sphere in spherical and cartesian coordinates, Intersection of a plane and a sphere.

Learning Outcomes:

After completing this unit, the student will be able to

- identify the equation to straight line in different forms(L3)
- find the length of permutation from a point to a straight line(L3)
- find the equation of a circle passing through three non collinear points(L3)

Course Outcomes:

After the completion of the course the student should be able to

- describe the properties of matrices (L3)
- describe the properties of complex numbers (L3)
- illustrate straight line and circle properties(L3)

Text Books:

1. Text book for Intermediate Mathematics, Board of Intermediate Education, AP, Volumes IB, IIA & IIB, 2018.
2. NCERT class XI and XII (part 1 & 2) Mathematics text books.

References:

1. V. Venkateswara Rao, N. Krishna Murthy, B.V.S. Sharma, Intermediate Mathematics, S. Chand & Company Ltd., Volume I & II.
2. Chandrika Prasad, A first Course in Mathematics.
3. Text book for Intermediate Mathematics, Deepti Publications.

DIFFERENCE EQUATIONS

L T P C
2 0 0 2

Preamble: Difference equations is the study of equation which involves the difference of a discrete function. In this course, the student can form a difference equation, solving linear higher order difference equations using analytical techniques, simultaneous linear difference equations and also find the solution of linear higher order difference equations and simultaneous difference equations using Z-transforms.

Course Objectives:

1. Student is able to know how to find the order of a difference equation and complementary function of a difference equation.
2. Student is able to know how to find the particular solution of a difference equation and also find the solutions of simultaneous linear difference equations.
3. Student is able to know how to find Z-transforms a discrete function using properties and using to basic theorems.
4. Student is able to know how to find the inverse Z-transforms a function and also using convolution theorem.
5. Student is able to know how to find the solution of a difference equation using Z-transforms

UNIT-I: (Difference equations-I) (5 hrs)

Introduction, definition of order, and solution of difference equation, formation of difference equations, linear difference equations, complementary function, rule for finding complementary function.

Learning outcomes:

- Student will be able to know how to find the order of a difference equation and complementary function of a difference equation.

UNIT-II: (Difference equations-II) (5 hrs)

Particular integrals, Rule for finding particular integrals, simultaneous linear difference equations.

Learning outcomes:

- Student will be able to know how to find the particular solution of a difference equation and also find the solutions of simultaneous linear difference equations.

UNIT-III: (Z-transforms) (5 hrs)

Introduction, Definition, some standard Z-transforms, linear property, damping rule, Shifting U_n to the **right and to the left, Multiplication by n, two basic theorems.**

Learning outcomes:

Student will be able to know how to find Z-transforms a discrete function using properties and using to basic theorems.

UNIT-IV: (Inverse Z-transforms) (5 hrs)

Convergence of Z-transforms, evaluation of inverse Z-transforms, properties, convolution theorem.

Learning outcomes:

Student will be to know how to find the inverse Z-transforms a function and also using convolution theorem.

UNIT-V: (Applications of Z-transforms) (5 hrs)
Solving difference equations and simultaneous linear difference equations with constant coefficients by Z-transforms.

Learning outcomes:
Student will be able to know how to find the solution of a difference equation using Z-transforms.

Text Book:

1. "Higher Engineering Mathematics" by B.S. Grewal published by Khanna Publishers

Reference books:

1. Advanced Engineering mathematics by Irvin Kreyszig

Course Outcomes:

1. Able to find the order of a difference equation and complementary function of a difference equation.
2. Able to find the particular solution of a difference equation and also find the solutions of simultaneous linear difference equations.
3. Able to find Z-transforms a discrete function using properties and using to basic theorems.
4. Able to find the inverse Z-transforms a function and also using convolution theorem.
5. Able to find the solution of a difference equation using Z-transforms

NUMERICAL TECHNIQUES

L	T	P	C
2	0	0	2

Preamble

This course is designed to enhance problem solving skills of engineering students using a powerful problem-solving tool namely numerical Techniques. The tool is capable of handling large systems of equations, nonlinearities and complicated geometries that are common in engineering practice but often impossible to solve analytically.

Course Objectives:

- To familiarize the students with numerical solutions of nonlinear and systems of linear equations.
- To get exposed to finite differences and interpolation.
- To demonstrate the numerical differentiation and integration.
- To explain the numerical solutions of ordinary differential equations

Unit-1: **(6 hours)**

Solution of algebraic and transcendental equations: Regula-falsi method and Newton-Raphson method. **Solution of linear system of equations-**Iterative methods: Gauss Jacobi method, Gauss Seidel method, and finding the eigenvalues of a matrix by Power method.

Learning Outcomes:

At the end of this unit, the student will be able to

- find approximate roots of an equation by using different numerical methods (L3).
- solve system of linear equations using various techniques (L3).
- find eigenvalues of a matrix (L3).

Unit-2: **(5 hours)**

Interpolation: Difference operators (shifting, delta, del) and difference tables, Newton's forward and backward interpolation formulae, Divided difference formula, and Lagrange's interpolation formula.

Learning Outcomes:

At the end of this unit, the student will be able to

- find a function using various methods (L3).

Unit-3: **(5 hours)**

Numerical Differentiation: Derivatives using forward, and backward difference formulae.
Numerical Integration: Trapezoidal rule, Simpson's 1/3rd rule, Simpson's 3/8th rule.

Learning Outcomes:

At the end of this unit, the student will be able to

- find differentiation of a function by using different numerical methods (L3)
- find integration of a function by using different numerical methods (L3)

Unit-4: **(5 hours)**

Numerical solutions of ordinary differential equations-1: Picard's method, Taylor's series method, Euler's method, and Modified Euler's method.

Learning Outcomes:

At the end of this unit, the student will be able to

- solve first order differential equation using various methods (L3).

Unit-5: (5 hours)

Numerical solutions of ordinary differential equations-2: Runge-Kutta method (second and fourth order), Predictor-Corrector methods-Adams-Bashforth and Milne's methods.

Learning Outcomes:

At the end of this unit, the student will be able to

- solve first order differential equation using predictor-corrector methods (L3).

Text Book(s):

1. B. S. Grewal, Higher Engineering Mathematics, 44/e, Khanna Publishers, 2017.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10/e, John Wiley & Sons, 2018.

References:

1. M.K. Jain, S.R.K. Iyengar, R.K. Jain, Numerical Methods for Scientific and Engineering Computation, 5/e, New Age International(P) Limited, 2007.
2. S.S. Sastry, Introductory methods of Numerical Analysis,4/e,PHI Learning Publications,2009.
3. H.C Saxena, Finite Differences and Numerical Analysis, Chand and Company Pvt. Ltd., New Delhi.

Course Outcomes:

At the end of the course, the student will be able to

- analyze how root finding techniques can be used to solve practical engineering problems (L4).
- apply various interpolation techniques to solve practical problems (L3).
- apply numerical differentiation and integration whenever and wherever routine methods are not applicable (L3).
- solve differential equations using various numerical methods (L3).
- know the strengths and weaknesses of the various methods and be able to decide which ones are appropriate for a particular problem (L3)

OPERATIONS RESEARCH

L	T	P	C
2	0	0	2

Preamble:

Operations Research (OR), also known as management science, has become an indispensable tool in scientific management. Operations Research focuses on developing and analyzing strategic and tactical levels to aid in decision-making and decision-making on the operational level. The essential tools of OR are algorithms, procedures that create and improve solutions to a point at which optimal or, at least, satisfactory solutions have been found.

Course Objectives: This course is designed to:

- introduce the fundamentals of Operations Research to the students at the undergraduate level
- solve different types of optimization problems of various categories and applying modern methodologies in the area of optimization
- help students to develop a deep understanding of the classical and numerical optimization techniques and problem-solving capabilities

Unit – I **4 hours**

Linear Programming: Formulation of LPP, convex sets and their properties, slack and surplus variables, Basic solution, Basic feasible solution, non-degenerate and degenerate basic feasible solutions, optimal solution, General, Standard, and Canonical form of LPP.

Learning Outcomes :

After completion of this unit, the student will be able to:

- understand the problem of linear programming problem (L2)
- understand the definitions of Basic solution(BS), Basic Feasible Solution(BFS), Non-degenerate BFS, Degenerate BFS, and optimal solution of LPP (L2)
- know convex sets and some essential theoretical concepts about convex sets (L2)
- writing standard and canonical forms of LPP (L3)

Unit – II **8 hours**

Simplex Method: Simplex method, Degeneracy in LPP, Artificial variables techniques-Two Phase method, Big M-method.

Learning Outcomes:

After completion of this unit, the student will be able to:

- prepare simplex table (L4)
- apply the simplex algorithm for finding the optimal solution of given LPP (L2)
- know the cases of existence of degeneracy in LPP (L4)
- solving LPP by artificial variable techniques like II-phase and Big M-methods (L3)

Unit – III **5 hours**

Duality: Duality in linear programming, primal-dual relationships, weak duality theorem, strong duality theorem, and dual simplex method.

Learning Outcomes:

After completion of this unit, the student will be able to:

- find the relation between primal and dual problems (L3)
- know the advantage of writing the dual problem (L4)
- apply dual simplex method (L2)
- know the properties of duality (L4)

Unit – IV **4 hours**

Integer Programming: Gomory's cutting plane method, Branch and Bound method for solving integer linear programming problems.

Learning Outcomes :

After completion of this unit, the student will be able to:

- understand the problem of Integer programming problem (L2)
- apply the technique of cutting plane methods (L2)
- apply Gomory's cutting plane method to solve ILPP (L2)
- apply branch and bound method to solve ILPP (L2)

Unit – V **5 hours**

Sensitivity Analysis: Introduction to sensitivity analysis, variations in the price vector, variations in the requirement vector, addition of a new decision variable to the existing problem.

Learning Outcomes :

After completion of this unit, the student will be able to:

- understand the meaning of sensitivity analysis (L2)
- apply sensitivity analysis to find variations in price vector (L2)
- find variations in requirement vector (L3)
- find the extent to which an additional decision variable can be introduced to the problem (L3)

Course outcomes:

On successful completion of this course, students will be able to:

- understand the linear programming problem, its formation, and basic definitions of solutions
- understand the simplex method, which is a very efficient algorithm to solve a linear programming problem
- understand the dual primal relationship, properties of duality, and the dual simplex algorithm
- find integer solutions to LPP by cutting plane methods
- find variations in price and requirement vectors and retaining optimality

Text Books:

1. Operations Research by S.D.Sarma, Kedarnath, Ramnath and company, 15th edition, 2008.
2. Operations Research An Introduction by Hamdy A. Taha, 8th edition, Pearson, 2007.

Reference Books:

1. Linear Programming by R K Gupta, Krishna Prakashan Mandir, 13th edition 2014.
2. Operations Research Theory and Applications by J K Sharma, 4th edition, Macmillan Publishers India Ltd, 2009.

COMPLEX VARIABLES

L T P C
2 0 0 2

Preamble

This course is designed to familiarize the students with complex analysis, nature of a series, evaluation of integrals using Cauchy's theorem.

Course Objectives

- To explain the concept of complex functions and analytic functions.
- To explain the concept of conformal mapping.
- To explain the concept of Cauchy's theorem and residue theorem.
- To explain the convergence of series such as Taylor's and Laurent.
- To explain the concept of Cauchy's theorem and residue theorem.

MODULE – I **6 hours**

Functions of a Complex variable: Limit and continuity, Differentiation, Analytic functions, Cauchy-Riemann equations, harmonic functions, finding harmonic conjugates- applications to flow problems.

After completion of this unit student able to

- Identify continuous and differentiable complex functions (L3)
- apply Cauchy-Riemann equations to complex functions in order to determine whether a given continuous function is analytic (L3)
- give an account of the concepts of analytic function and harmonic function and to explain the role of the Cauchy-Riemann equations(L3).

Module - II **5 hours**

Geometrical representation of f(z) – Some standard transformations – Bilinear transformation - Conformal mappings. Special conformal transformations ($w = z^2$, $w= z+1/z$, $w = e^z$, $w= \cosh z$) .

Learning Outcomes:

After completion of this unit student able to

- To know the geometrical representation of an analytical functions(L2)
- explain the concept of conformal mapping, describe its relation to analytic functions, and know the mapping properties of the elementary functions(L3)

MODULE – III **5 hours**

Complex Integration: Integration of complex functions - Cauchy's theorem - Cauchy's integral formula.

Learning Outcomes:

After completion of this unit student able to

- define and evaluate complex contour integrals(L3);
- give an account of and use the Cauchy integral theorem, the Cauchy integral formula and some of their consequences(L3);

MODULE – IV **5 hours**

Series representation of analytic functions
convergent series of analytic functions, Laurent ‘s and Taylor series, zeros and singularities of an analytic function

Learning Outcomes:
After completion of this unit student able to
- analyze simple sequences and series of functions with respect to uniform convergence, describe the convergence properties of a power series, and determine the Taylor series or the Laurent series of an analytic function in a given region (L3);
- Determining the nature of the singularities and calculating residues (L2)

MODULE – V **5 hours**
Calculus of residues – Residue- Cauchy Residue theorem – Calculation of residues (All theorems without proof).

Learning Outcomes:
After completion of this unit student able to
- make use of the Cauchy residue theorem to evaluate certain integrals (L3)

Text Book:
1. B.S.Grewal, Higher Engineering Mathematics, 42nd Edition, Khanna Publishers, New Delhi, 2012.

Reference Books:
1. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics Narosa Publishing House, New Delhi, 2014.
2. N. P. Bali and Manish Goyal, A Text Book of Engineering Mathematics, 8th Edition, Lakshmi Publications, New Delhi, 2012.

Course Outcomes
1. Make use of differentiation and integration of complex functions in engineering problems (L3)
2. Concept of conformal mappings (L3).
3. Use Cauchy’s theorem and Cauchy’s integral formula to evaluate the line integrals (L3)
4. Apply Taylor’s and Laurent’s series to expand complex functions and know about the convergence region (L3).
5. Evaluation of integrals using Residue theorem(L3).

NUMBER THEORY

L	T	P	C
2	0	0	2

PREAMBLE

This course is designed to explain the basics and applications of number theory for the students of Computer Science. The core courses of these branches encounter with concepts like prime factorization, modular arithmetic, and quadratic reciprocities in number theory. The first unit of the course provide a strong platform for such encounters and the other units focuses on applications of number theory.

Course Objectives

- To teach basic concepts of number theory focusing on Computational aspects.
- To teach the concepts of factorization of integers.
- To teach Format's theorem and quadratic residues.
- To explain Chines remainder theorem and Euclidean algorithm.
- To explain polynomial arithmetic.

Unit 1 **(5 hrs)**

Basic Concepts in Number Theory: Topics in elementary number theory, Divisibility, Greatest Common Divisor

Learning Outcomes:

After completion of this unit, student will be able to

- develop the basics of number theory: (L3)
- perceive the concept of divisibility: (L5)

Unit 2 **(5 hrs)**

Euclidean Algorithm, Factorization of integers, Congruence, Modular arithmetic**,** some applications to factorizing, finite fields

Learning Outcomes: After completion of this unit, student will be able to

- understand the basics modular arithmetic: (L3)
- know some concepts on factorization: (L5)

Unit 3 **(5 hrs)**

Quadratic residues, Fermat's theorem, Euler ϕ function, Cauchy 's theorem

Learning Outcomes:

After completion of this unit, student will be able to

- learn some theorems on number theory: (L3)
- perceive the concept of quadratic residues (L5)

Unit 4 **(5 hrs)**

Chinese Remainder theorem, Primality testing algorithm, Euclid's algorithm for integers

Learning Outcomes:

After completion of this unit, student will be able to

- learn some theorems on number theory: (L3)
- apply primality testing algorithm (L5)

Unit 5 **(5 hrs)**

Polynomial Arithmetic, Primitive roots, Legendre symbol, Jacobi symbol

Learning Outcomes:

After completion of this unit, student will be able to

- learn polynomial arithmetic: (L3)
- perceive the Legendre and Jacobi symbols (L5)

Text Book

1. Elementary Number Theory | 7th Edition by David Burton, Mc Graw Hill Education

References

1. Basic Number Theory by S.B. Malik,S. Chand publishers

LINEAR ALGEBRA

L	T	P	C
2	0	0	2

Preamble
This course is designed to gain knowledge in the concepts of Linear Algebra focusing on basics of matrices, vector spaces and singular value decomposition to understand the basic concepts of Linear Algebra in the applications of image processing and machine learning.

Course Objectives:
- To familiarize with theory of matrices and tools for solving system of linear equations
- To impart knowledge on Eigen values and Eigen vectors.
- To teach basic concepts of vector spaces and their properties.
- To explain the concepts of inner product spaces.
- To familiarize with concept of singular value decomposition and its applications.

Unit-1: Fundamentals of Matrices: **(5 hours)**
Introduction to Matrices and Rank of a matrix, Echelon form, solving system of linear equations.
Learning Outcomes:
At the end of this unit, the student will be able to
- Reduce given matrices to Echelon form, (L3)
- solve the system of linear equations (L3)

Unit-2: Eigen values and Eigen vectors: **(5 hours)**
Eigen values and Eigen vectors, positive definite matrices, Linear dependence and Linear independence.
Learning Outcomes:
At the end of this unit, the student will be able to
- calculate Eigen values and Eigen vectors(L4)
- examine the definiteness of the matrix (L3)

Unit-3: Vector Spaces: **(6 hours)**
Vector space, linear combination of vectors, linear span, basis and dimension, linear Transformation.
Learning Outcomes:
At the end of this unit, the student will be able to
- examine whether a set of vectors form a basis(L3)
- analyze properties of a linear transformations(L4)

Unit-4: Inner Product Spaces **(5 hours)**
Inner Product Spaces, examples of inner product spaces, norm and length of a vector cauchy-schwarz's inequality.
Learning Outcomes:

At the end of this unit, the student will be able to

- understand an inner product(L3)
- apply Cauchy-Schwartz's inequality(L3)

Unit-V: **Singular value decomposition** **(5 hours)**

Singular values, computing singular value decomposition and Introduction to principal component analysis.

Learning Outcomes:

At the end of this unit, the student will be able to

- singular value decomposition and computing. (L4)
- understand singular value decomposition and principal Component analysis(L5).

Text Books:

1. Higher Engineering Mathematics, B. S. Grewal.
2. Linear Algebra, Schaum's Outline,4th edition, Seymour Lipchutz,Marc Lipson

Reference Books:

1. Advanced Engineering Mathematics, 7th Edition, Peter V. O'Neil.
2. Advanced Engineering Mathematics, 2nd Edition, Michael. D. Greenberg.
3. Introduction to linear algebra, 5th Edition, Gilbert Strang.
4. Applied Mathematics (Vol. I & II) , by P. N. Wartikar& J. N. Wartikar.
5. Digital Image Processing, R C Gonzalez and R E Woods.

Course Outcomes:

At the end of the course the student will be able to

- solve the system of linear equations (L3)
- calculate Eigen values and Eigen vectors(L4)
- Finding the basis(L4)
- learn Singular value decomposition and principal Component analysis (L5)

PROBABILITY THEORY AND RANDOM VARIABLES

L	T	P	C
2	0	0	2

Preamble

To expose the students to the basics of probability theory and random processes essential for their subsequent study of analog and digital communication.

Course Objectives:

- To know about various random life length models and their uses in finding the reliability of different electronic devices.
- To learn about basic properties and characteristics of various random processes with reference to signal and trunk processes.

Unit 1: Probability **5 hours**

Axioms of probability theory. Probability spaces. Joint and conditional probabilities. Bayes' Theorem- Independent events.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand events and how to assign probabilities to outcomes (L3)
- Solve applications involving probabilities (L4)

Unit 2: Random Variable **5 hours**

Random variables and random vectors. Distributions and densities. Independent random variables. Functions of one and two random variables.

Learning Outcomes:

At the end of this unit, the student will be able to

- evaluate moments and cumulative distribution functions for both discrete and continuous random variables (L3)
- characterize functions of random variables (L5)

Unit 3: Multiple Random Variables **6 hours**

Vector random variables, joint distribution and density functions, properties, conditional distribution and density, statistical independence, distribution and density of a sum of random variables, central limit theorem.

Learning Outcomes:

At the end of this unit, the student will be able to

- describe conditional and independent events and conditional random variables (L3)
- describe independent events and independent random variables and their sums (L3)

Unit 4: Expected Value of a Function of Random Variables **6 hours**

Joint moments about the origin, joint central moments, jointly Gaussian random variables - two random variables case, N random variable case.

Learning Outcomes:

At the end of this unit, the student will be able to

- characterize jointly multiple discrete and continuous random variables (L5)

- describe N Random variables independent events and independent random variables and their sums (L3)
- characterize jointly multiple discrete and continuous random variables (L5)

Unit 5: Random Process **6 hours**

Temporal characteristics - the random process concept, stationarity and statistical independence, correlation functions, Gaussian random processes, Poisson random process.

Learning Outcomes:

At the end of this unit, the student will be able to

- explain basic concepts of a random process, calculate the mean, variance, autocorrelation, and power spectral density of a stationary random process (L3)
- apply the knowledge of random variables in real life situations (L5)

Text Book(s)

1. Peyton Z. Peebles, Probability, Random Variables and Random Signal Principles, 4/e, Tata McGraw Hill, 2002.
2. Athanasios Papoulis, S. Unnikrishnan Pillai, Probability, Random Variables and Stochastic Processes, 4/e, Tata McGraw Hill, 2002.

References

1. Simon Haykin, Communication Systems, 4/e, Wiley Student Edition, 2006.
2. Henry Stark, John W. Woods, Probability and Random Processes with Application to Signal Processing, 3/e, Pearson Education, 2002.

Course Learning Outcomes:

Upon successful completion of this course, the student should be able to

- Analyze the outcomes of random experiments and develop the concept of random variables and obtain probabilities through them (L3)
- define single random variables in terms of their PDF and CDF, and calculate moments such as the mean and variance (L3)
- explore the random experiments specified by multiple random variables and study the Distribution of them (L4)
- apply the fundamentals of probability theory and random processes to practical engineering problems, and identify and interpret the key parameters that underlie the random nature of the problems (L5)

RANDOM PROCESSES

L	T	P	C
2	0	0	2

Preamble

This course is designed to impart knowledge on random processes needed in applications such as signal processing, digital communications, speech processing, data modelling, etc.

Course Objectives:

1. To familiarize the students in the concepts of probability and random variables.
2. To study Random Processes, its types, distribution, and density functions.
3. To study Gaussian and Poisson processes.
4. To apply random process to signal processing in communication systems.
5. To apply skills in analysing random phenomena which occur in Electrical and Electronics Engineering applications.

Unit-1: Random Processes: (6 hours)

Temporal characteristics - the random processes concept, Classification of random processes, stationarity and statistical independence. Time averages and Ergodicity.

Learning Outcomes:

At the end of this unit, the student will be able to:

- solve the problems on multiple random variables, joint distribution and statistical independence, (L1)
- understand the classifications of random processes and concepts such as strict stationarity, wide-sense stationarity (L2)
- apply the concept on time averages and ergodicity (L3)

Unit-2: Correlation and Covariance functions: (5 hours)

Auto correlation, Cross correlation, Properties. Covariance functions. Gaussian random processes, Poisson random processes:

Learning Outcomes:

At the end of this unit, the student will be able to:

- know the definition of auto correlation and its application(L1)
- to understand about the correlation functions(L2)
- demonstrate the specific applications to Poisson and Gaussian processes and representation of low pass and band pass noise models (L2)

Unit-3: Density functions : (5 hours)

Probability density and joint probability density functions, Properties.

Learning Outcomes:

At the end of this unit, the student will be able to:

- know about joint probability density functions and its applications (L1)
- apply concept of joint density functions in random process (L3)
- apply the probability models and function of random variables based on single & multiple random variables (L3)

Unit-4:Spectral densities functions - I : **(5 hours)**
Spectral characteristics, the power density spectrum: Properties, relationship between power density spectrum and autocorrelation function

Learning Outcomes:
At the end of this unit, the student will be able to:
- understand the concept of power density functions (L2)
- apply substitution to compute power density function properties (L3)
- apply the concepts of power density functions and auto correlation (L3)

Unit-5 Spectral densities functions-II : **(5 hours)**
Cross-power density spectrum, Properties, relationship between cross power spectrum and cross-correlation function.
Learning Outcomes:
At the end of this unit, the student will be able to:
- develop an appreciation of the role of random processes in system modelling (L1)
- apply the concepts of filtering and prediction of a random process (L3)
- apply the specialised knowledge in random processes to solve practical engineering problems. (L3)

Course Outcomes:
At the end of the course, the student will be able to:
- solve the problems on multiple random variables, joint distribution and independence
- solve the problems Gaussian and Poisson processes
- understand the concept of random processes and determine covariance and spectral density of stationary random processes
- characterize the random signals in communication systems with their autocorrelation and power spectral density functions

Textbook (s)
1. Peyton Z. Peebles, Probability, Random Variables and Random Signal Principles, 4/e, Tata McGraw Hill, 2002.

References
1. Athanasios Papoulis, S. Unnikrishnan Pillai, Probability, Random Variables and Stochastic Processes, 4/e, Tata McGraw Hill, 2002.
2. Simon Haykin, Communication Systems, 4/e, Wiley Student Edition, 2006.
3. Henry Stark, John W. Woods, Probability and Random Processes with Application to Signal Processing, 3/e, Pearson Education, 2002.

OPTIMIZATION METHODS

L	T	P	C
2	0	0	2

Preamble:

Optimization is the art of finding the best result under given conditions. In this fast-expanding world, an engineer has to use many Optimization methods, as it is the most significant in decision-making, design, manufacturing, maintenance, planning, and scheduling.

Course Objectives: This course is designed to:
- introduce various optimization methods for solving real-world problems
- find optimal solutions to transportation, assignment, and sequencing problems
- know project planning and scheduling
- study the network analysis techniques through CPM and PERT

Unit – I **6 hours**

Transportation Problem: Introduction and LP formulation of Transportation Problem, feasible solution, basic feasible solution, finding Initial basic feasible solutions by North West corner rule, Least-cost entry method, Vogel's approximation method, Transportation Algorithm (MODI Method) to find an optimal solution.

Learning Outcomes:

After completion of this unit, the student will be able to:
- understand the problem of transportation problem (L2)
- find initial BFS by various methods (L3)
- apply MODI method for finding optimal transportation cost (L3)

Unit – II **5 hours**

Assignment Problems: Introduction to Assignment Problem, Mathematical formulation, Hungarian Method for finding optimal solution, unbalanced assignment problem, Travelling Salesman Problem.

After completion of this unit, the student will be able to:
- understand the problem of assignment problem(L2)
- apply the technique of solving the assignment problem using the Hungarian Method (L3)
- find an optimal solution to unbalanced assignment problem (L3)
- find the optimal route for the salesman (L3)

Unit – III **4 hours**

Sequencing Problem: Introduction, Basic terminology, Algorithms to obtain optimal solutions for sequencing problems with n jobs and two machines and n jobs and k machines.

Learning Outcomes:

After completion of this unit, the student will be able to:
- find optimal job sequencing (L3)
- find the optimal sequence for processing n jobs through two machines (L3)
- convert k machine problem into two machine problem (L4)
- find the optimal sequence for processing n jobs through k machines (L3)

Unit – IV **4 hours**

Network Analysis in Project planning: Project, Project Planning, Project Scheduling, Project Controlling, Work breakdown structure, Network Techniques, terms used in network-activity, event, path, network, dummy activity, looping, Fulkerson's rule, network diagram, and activity on node diagram.

Learning Outcomes :

By the end of this unit, the student will be able to:

- understand the problem of network models (L2)
- know the terms activity, node, labeling (L3)
- know the rules to draw the network diagram (L3)
- construct network diagram (L2)

Unit – V **7 hours**

PERT and CPM: Critical path method (CPM), Measure of activity, Critical path analysis, the four floats, subcritical and supercritical activities, slack, Programme evaluation and review technique (PERT), time estimates, frequency distribution curve for PERT

Learning Outcomes:

After completion of this unit, the student will be able to:

- know the technique of Critical Path Method (CPM) (L3)
- know the technique of PERT (L3)
- find time estimates (L3)
- estimate the probability of completing the project (L2)

Course outcomes:

On successful completion of this course, students will be able to:

- apply MODI method for finding optimal transportation cost
- apply Hungarian Method for solving assignment problems and finding an optimal route to the salesman
- understand the process of finding optimal sequencing for processing jobs on machines
- understand the network terminology and construction
- apply CPM and PERT techniques for project management

Text Books:

1. Operations Research by S.D.Sarma, Kedarnath, Ramnath and company, 15th edition, 2008.
2. Operations Research An Introduction by Hamdy A. Taha, 8th edition, Pearson, 2007.

Reference Books:

1. Linear Programming by R K Gupta, Krishna Prakashan Mandir, 13th edition 2014.
2. Operations Research Theory and Applications by J K Sharma, 4th edition, Macmillan Publishers India Ltd, 2009.

COMPUTATIONAL METHODS

L T P C
3 0 0 3

Preamble:

It is designed for the students for the basic understanding of techniques for numerical solution of algebraic equations, differentiation, integration used to solve engineering application problems.

Course Objectives:

- Develop the mathematical skills in the areas of numerical methods.
- Focus on the theory and applications of numerical methods in many engineering subjects which require solutions of linear systems, finding eigenvalues, eigenvectors, interpolation, and applications, solving ODEs, PDEs.
- Help in the foundation of computational mathematics for postgraduate courses, specialized studies, and research.
- Train in developing the codes for implementing the numerical methods using any programming languages.
- Formulate a mathematical model for a given engineering problem

UNIT I 9 hours

Mathematical Modeling of Engineering Problems:

Approximations: Accuracy and precision, round-off and truncation errors, error problem with example problems. **Roots of Equations:** Formulations of linear and non-linear algebraic equations, solution with bisection, Newton-Raphson and Secant methods. Application to practical problems. **Algebraic Equations**: Formulation of linear algebraic equations from engineering problems, solution of these problems by Gauss elimination method, pitfalls of elimination and techniques for improving the solutions, Gauss Seidel iteration for solving sparse equations by avoiding storage of zero coefficients in matrix, convergence of iteration methods. LU decomposition methods for symmetric (Chelosky) matrices.

Learning Outcomes:

After completion of this unit the student will be able to

- Find the root for linear and non-linear algebraic equations by using iterative methods. (l1)
- Estimate the true error and approximate error between the iterations of the mathematical procedure. (l5)
- Formulate system of linear equations from engineering problem and solve using any of the numerical procedure(l6)

UNIT II 9 hours

Eigenvalues and Eigenvectors Problems: Formulation of equations to column, truss, spring-mass and friction problems. Solutions for the largest and smallest eigenvalues and corresponding eigenvectors. **Interpolation Methods:** Polynomial interpolation, Lagrange interpolation polynomials with equi- spaced data. **Regression or Curve Fitting:** Linear regression by least squares method.

Learning Outcomes:

After completion of this unit the student will be able to

- Interpolate a polynomial with any given data(L4)
- Fit a curve using linear regression(L3)
- Calculate Eigenvalues and corresponding Eigenvectors for a given system of equations.(L3)

UNIT III **8 hours**

Initial Value Problems: Ordinary differential equations, Euler, Heun's and Ralston methods. Runge- Kutta method of 2nd and 4th order, application to vibration and heat transfer problems. **Boundary Value Problems:** Linear and nonlinear ordinary differential equations, boundary value problems over semi-infinite domain, solution of nonlinear equations by finite difference method.

Learning Outcomes:

After completion of this unit the student will be able to

- Solve ODE's with R-K 2^{nd} and 4^{th} order methods. (L3)
- Interpret the boundary conditions for initial value and boundary value problems. (L2)
- Appreciate the merits of various numerical methods for solving ODE's.(L5)

UNIT IV **8 hours**

Laplace Equations: Finite difference discretization of computational domain, different types of boundary conditions, solution to elliptic equations. **Parabolic Transient Diffusion Equations:** Explicit and implicit formulation, Crank Nicolson Method.

Learning Outcomes:

After completion of this unit the student will be able to

- Classify the given partial differential equation.(l2)
- Discretize the given domain by finite difference method for both elliptic and parabolic pde's. (l3)
- Apply the boundary conditions for any given problem satisfying the physics of the problem.(l2)

UNIT V **8 hours**

Numerical Integration: Trapezoidal, Simpson's 1/3 and 3/8 rule and Gauss quadrature method.

Learning Outcomes:

After completion of this unit the student will be able to

- Solve the integration problem by using numerical methods. (l3)
- Understand the application of simpson's $1/3^{rd}$ and $3/8^{th}$ methods.(l2)

List of Computational Exercises:

1. Determine the real root for a given polynomial equation by (i) Bisection, (ii) Newton-Raphson until the approximate error falls below 0.5%.
2. Solve the system of simultaneous linear equations by

(i) Naïve -Gauss elimination
(ii) Gaussian elimination with partial pivoting
(iii) Gauss -Seidal method.
(iv) LU decomposition

3. Implement power method to find Eigenvalues and Eigenvectors for Spring mass system
4. Solve the parabolic partial differential equations by using explicit, implicit and semi-implicit methods
5. Solve the elliptic partial differential equations by finite difference techniques.
6. Finding the integral for a second-order polynomial using Gauss quadrature formula.
7. Solve numerical differentiation problems using Runge-Kutta 2^{nd} and 4^{th} order methods.
8. Find the integral by numerical methods such as Trapezoidal and Simpson's rule.

Course Outcomes:

At the end of the course, the student will be able to:

- Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions to otherwise intractable mathematical problems.
- Derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations.
- Analyse and evaluate the accuracy of common numerical methods.
- Implement numerical methods using any programming language (matlab, scilab, python…)
- Write efficient, well-documented code and present numerical results in an informative way.

Text Book(s)

1. S.P. Venkateshan, P. Swaminathan, Computational Methods in Engineering, 1/e, Ane Publisher, 2014.
2. S.C. Chapra, R.P. Canale, Numerical Methods for Engineers, 6/e, Tata McGraw-Hill, 2012.

Reference

1. S.K. Gupta, Numerical Methods for Engineers, 1/e, New Age International, 2005.

PROBABILITY AND STATISTICS

L	T	P	C
3	0	0	3

Course Objectives:

- To familiarize the students with the foundations of probability and statistical methods
- To impart concepts in probability and statistical methods in engineering applications.

Unit I: Data Science and Probability **10 hrs**

Data Science: Statistics introduction, Population vs Sample, collection of data, primary and secondary data, types of variable: dependent and independent Categorical and Continuous variables, data visualization, Measures of central tendency, Measures of dispersion (variance).

Probability: Probability axioms, addition law and multiplicative law of probability, conditional probability, Baye's theorem (without proof).

Learning Outcomes:

At the end of this unit, the student will be able to

- summarize the basic concepts of data science and its importance in engineering (L3)
- analyze the data quantitatively or categorically , measure of averages, variability (L4)
- define the terms trial, events, sample space, probability, and laws of probability (L3)
- make use of probabilities of events in finite sample spaces from experiments (L3)
- apply Baye's theorem to real time problems (L3)

Unit II: Random Variable and Probability Distributions **8 hrs**

Random variables (discrete and continuous), probability density functions, probability distribution - Binomial, Poisson and normal distribution-their properties (mathematical expectation and variance).

Learning Outcomes:

At the end of this unit, the student will be able to

- explain the notion of random variable, distribution functions and expected value(L3)
- apply Binomial and Poisson distributions to compute probabilities, theoretical frequencies (L3)
- explain the properties of normal distribution and its applications (L3)

Unit III: Correlation, Regression and Estimation **8 hrs**

Correlation, correlation coefficient, rank correlation, regression, lines of regression, regression coefficients, principle of least squares and curve fitting (straight Line, parabola and exponential curves). **Estimation:** Parameter, statistic, sampling distribution, point estimation, properties of estimators, interval estimation.

Learning Outcomes:

At the end of this unit, the student will be able to

- identify different trends in scatter plots, strengths of association between two numerical variables (L3)
- make use of the line of best fit as a tool for summarizing a linear relationship and predicting future observed values (L3)
- estimate the value of a population parameter, computation of point and its interval (L3)

Unit IV: Testing of Hypothesis and Large Sample Tests **8 hrs**

Formulation of null hypothesis, alternative hypothesis, the critical region, two types of errors, level of significance, and power of the test. **Large Sample Tests**: Test for single proportion, difference of proportions, test for single mean and difference of means. Confidence interval for parameters in one sample and two sample problems

Learning Outcomes:

At the end of this unit, the student will be able to

- identify the difference between one- and two-tailed hypothesis tests (L3)
- analyze the testing of hypothesis for large samples (L4)

Unit V: Small Sample Tests **6 hrs**

Student t-distribution (test for single mean, two means and paired t-test), testing of equality of variances (F-test), $\chi 2$ - test for goodness of fit, $\chi 2$ - test for independence of attributes.

Learning Outcomes:

At the end of this unit, the student will be able to

- analyze the testing of hypothesis for small samples (L4)
- test for the Chi-square goodness of fit and independence of attributes (L4)

Text Books:

1. Miller and Freunds, Probability and Statistics for Engineers,7/e, Pearson, 2008.
2. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, 11/e, Sultan Chand & Sons Publications, 2012.

References:

1. S. Ross, A First Course in Probability, Pearson Education India, 2002.
2. W. Feller, An Introduction to Probability Theory and its Applications, 1/e, Wiley, 1968.

Course Outcomes:

Upon successful completion of this course, the student should be able to

- classify the concepts of data science and its importance (L3)
- apply discrete and continuous probability distributions (L3)
- explain the association of characteristics through correlation and regression tools (L3)
- identify the components of a classical hypothesis test (L3)
- infer the statistical inferential methods based on small and large sampling tests (L4)

MECH1011: ENGINEERING VISUALIZATION AND PRODUCT REALIZATION

L	T	P	C
0	0	4	2

The course enables the students to convey the ideas and information graphically that come across in engineering. This course includes projections of lines, planes, solids sectional views, and utility of drafting and modelling packages in orthographic and isometric drawings.

Course Objectives

- Create awareness of the engineering drawing as the language of engineers.
- Familiarize how industry communicates, practices for accuracy in presenting the technical information.
- Develop the engineering imagination essential for successful design.
- Train in 2D and 3D modeling softwares.
- Teach assembly of simple components and their animation.
- Teach basic 3D printing software for preparation of simple components

Manual Drawing: (8 P hours)

Introduction to Engineering graphics: Principles of Engineering Graphics and their significance-Conventions in drawing-lettering - BIS conventions. Dimensioning, sectioning and datum planes

Free hand sketching (4 P hours)

Free hand sketching of isometric & orthographic views and interpretation of drawings.

Computer Aided Drafting (12 P hours)

Introduction to CAD software: Basic drawing and editing commands: line, circle, rectangle, erase, view, undo, redo, snap, object editing, moving, copying, rotating, scaling, mirroring, layers, templates, polylines, trimming, extending, stretching, fillets, arrays, dimensions. Dimensioning principles and conventional representations.

Assemble drawings (12 P hours)

Constraints and assembly drawings. Engineering animation including motion curves, coordinating multiple moving parts under joint-constraints and the notion and impact of lighting and camera.

3D printing (8 P hours)

introduction to 3D printing software. slicing, grading and rendering of simple geometries using software

Project by group of students in the following themes (12 P hours)

IC engine model and 3D printed mini model
Belt drive for a bike
Four-wheel drivable ATV robot
Toy making - Carrom board, chess board & pieces model toy train, avengers
Buildings, bridges dams etc.
Wind turbine model
Design of Programmable Intelligent Controllers – PIC
Design of Printed Circuit Boards
Arduino Board Design and 3D Printing of Enclosures for Arduino Boards
Design of Radar and 3D Printing of Radar Models
Design of Mini Motherboards

Course Outcomes

After completing the course, the student will be able to

- utilize Engineering visualization as Language of Engineers. (L3)
- prepare drawings as per international standards. (L3)
- create 2D and 3D models using CAD packages. (L3)
- use 3D printing software and create model for printing of simple objects

MECH1021: WORKSHOP

L	T	P	C
0	0	4	2

This course enables the students to familiarize with the basic fabrication practices and to explore the various devices, tools and equipment used. Hands-on exercise is provided in various trade sections. Essentially student should understand the labor involved, machinery or equipment necessary, time required to fabricate and should be able to estimate the cost of the product or job work which are fundamental tasks for engineering plans.

Course Objectives

- Explain tools used in carpentry, fitting and sheet metal and practice procedure of doing experiments.
- Make the students to learn types of basic electric circuit connections and PCBs.
- Provide training to prepare FRP composites.
- Train the students on preparing 3D plastics using injection molding.
- Demonstrate on utilizing 3D printer for printing 3D objects

List of Jobs

1. Wood Working - Cross halving Joint/Dove Tail Joint/End Bridle Joint (Any two)
2. Sheet Metal working - Taper tray/conical funnel/Elbow pipe (Any Two) (including soldering).
3. Fitting- V fit/Dove Tail fit/ Semicircular fit (Any Two)
4. Electrical Wiring -Parallel and series connection
5. Electrical Wiring -Two-way switch connection
6. Electrical Wiring- Wiring of lighting systems
7. Injection molding-Make any two plastic components using injection molding machine.
8. 3D printing Demonstartion

Text Books

1. P. Kannaiah, K. L. Narayana, 'Workshop Manual', 2/e, Scitech Publications, India, 2007.
2. B. L Juneja , 'Workshop Practice ', 1/e, Cengage Learning ,Delhi, 2015

Additional Reading

1. K Mallick, 'Fiber-Reinforced Composites: Materials, Manufacturing, and Design', 3/e, CBC Press, New York, 2007.

Course Outcomes:

After completion of this lab the student will be able to

- Summarize application of different power tools (L1)
- Develop different parts with metal sheet/wood working/fits in real time applications. (L3)
- Demonstrate electrical circuits in various applications. (L2)
- Prepare models using injection molding m/c . (L3)
- Familiarize with 3D printer operations (L1)

MECH1031: DESIGN THINKING

L	T	P	J	S	C
0	0	2	0	0	1.0

Course Pre-requisite(s):Engineering Visualization and Product Realization

Design is a realization of a concept or idea into a configuration, drawing or product. Design Thinking is the cognitive and practical process by which design concepts are developed by designers. Innovation is a new idea or a new concept. Product development is the creation of a new or different product that offers new benefits to the end-user. This course introduces design thinking in product innovation.

Course Objectives

1. To familiarize the product design process
2. To introduce the basics of design thinking
3. To bring awareness on idea generation
4. To familiarize the role of design thinking in services design

Topic	Type
Each member of the group has to ask (vocally) the group members different questions about a product that they would like to design. Write down the questions and answers and submit as a word or pdf document.	Exercise
Each member of the group must ask (vocally) the group members questions about the product chosen in the previous experiment. This helps to gain indepth insights as well as new findings and information in order to grasp the problem or situation holistically or simply to find relevant questions for an interview. Write down the questions and answers and submit as a word or pdf document	Exercise
Identify relevant factors of influence that constitute the basis for a new or improved product or offer; then analyze it in a targeted manner. ➢ Make sure that you are sufficiently creative in the analysis process, because the focus is on technical “details”. ➢ Boost the efficiency of the analysis process by avoiding empty runs. ➢ Make use of a standardized procedure in order to examine the problem and solution space again with the help of data.	Exercise
➢ Do research, talk with people, and have empathy to formulate profound stories. ➢ Summarize the results from the “understand” and “observe” phases and discuss with the team. ➢ Highlight unexpected results and generate new perspectives. ➢ In general, share insights, ideas, and results (solutions) with others.	Exercise
➢ Explore untapped market opportunities. ➢ Provide differentiated and new offers based on the user needs. ➢ Adapt a strategy to new market needs by understanding the competitive edge. ➢ Establish the right vision for the design challenge or a road map for stepby-step implementation and control mechanisms.	Exercise
➢ Find out at an early stage whether the basic need is satisfied and the product attracts interest on the market. ➢ Find out through iterative testing whether the user need is met with a minimally functional product and how the product should be enhanced. ➢ Find out through user feedback how much demand there is for the product before developing further details and features. ➢ Minimize the risk of investing in a solution for which there is little demand on the market, thus saving time, money, and energy.	Exercise

➢ Perform a true A/B test or several variants of a prototype in the form of a multi-variants test or as split testing. ➢ Do a quantitative evaluation. ➢ Carry out a qualitative survey and evaluate the number and content of feedbacks. ➢ Compare individual variants of a function or a prototype (e.g. buttons, visuals, arrangement).	Exercise
➢ Collect and appraise experiences made in the project in a structured manner. ➢ Learn from experience and make use of it in the next project. ➢ Facilitate a positive attitude toward mistakes and appreciate progress. ➢ Identify and document the findings; make them applicable and usable.	Exercise
Case Studies : Example : Software Prototyping, Additive Manufacturing; Design of Arduino Boards for various applications etc	Exercise

Texbook(s)	**Topics**
1. Pahl, Beitz, Feldhusen, Grote,'Engineering Design: a systematic approach',3rd,Springer Science & Business Media,London,2007,978-1846283185	All Exercises
2. Christoph Meinel,Larry Leifer,Hasso Plattner,'Design Thinking Understand – Improve – Apply',1st,Springer,Berlin, Heidelberg,2011,978-3-642-13756-3	All Exercises

Additional Reading(s)	**Topics**
1. Marc Stickdorn, Jakob Schneider,'This is Service Design Thinking: Basics, Tools, Cases',1st,WILEY,United States,2012,978-1-118-15630-8	All Exercises

Journal(s)	**Topics**

Website(s)	**Topics**

Course Outcomes(COs)

1 Innovate new methods in product development
2 2 Apply Design Thinking in developing the new designs
3 Select ideas from ideation methods in new product development
4 Use Design Thinking in developing software products
5 Apply principles of Design Thinking in service design

CSEN1011 - PROBLEM SOLVING AND PROGRAMMING WITH C

L	T	P	C
0	0	6	3

The course is designed to enable the student to write programs for problem solving. After an introduction to program logic design using algorithms and flowcharts, converting the logic into programs is taught. The features of structured programming are explained with the C programming language as an example. This course lays the foundation both for developing program logic and for writing programs in C according to the developed logic.

Course Objectives:

1. Familiarize the student with the steps involved in writing and running a compiled program.
2. Enable the student to build program logic with algorithms and flowcharts.
3. Explain with the features and constructs of C programming such as data types, expressions, loops, functions, arrays, pointers, and files.
4. Demonstrate the handling of variables and input-output operations in C.
5. Train the student to convert program logic into C language code using a top-down approach.

Module I: Introduction to Computer Problem-Solving 12 P

Introduction, the Problem-Solving Aspect, Top-Down Design, Introduction to the idea of an algorithm, Introduction to Flowchart using Raptor tool.

Introduction to C Language – Structure of a C Program, Keywords, Identifiers, Data Types (int, float, char, unsigned int) and Variable declaration, Constants, Input / Output function. Operators, Expressions, Precedence and Associativity, Expression Evaluation, Type conversions.

Exercises: Construct a flowchart and write a program to

- Develop a calculator to convert time, distance, area, volume and temperature from one unit to another.
- Calculate simple and compound interest for various parameters specified by the user
- To enter marks of five subjects and calculate total, average and percentage.
- Calculate net salary of employee given basic,da,hra,pf and lic
- retrieve remainder after division of two numbers without using mod operator
- Convert an upper-case character to a lower-case character.
- Swap two numbers
- Enter two angles of a triangle and find the third angle.
- Check Least Significant Bit (LSB) of a number
- Input any number from user and check whether nth bit of the given number is set (1) or not (0)(hint: Use bitwise operators)

Learning Outcomes

After completion of this unit the student will be able to

- Develop algorithms and basic flowcharts for performing Input, Output and Computations (L3)
- Interpret the structure of C program and various key features of C (L2)
- Translate mathematical expressions to C notation using operators (L2).

Module II: Control Structures 15 P

- **Control Structures:** Selection Statements (making decisions) – if, if-else, nested if, else if ladder and switch statements. Repetition statements (loops)-while, for, do-while statements, Nested Loops.
- Unconditional statements-break, continue, goto.
- Pointers – Pointer variable, pointer declaration, Initialization of pointer, accessing variables through pointers, pointers to pointers, pointers to void.

Exercises: Construct a Flowchart and Write a Program to

- Check whether the triangle is equilateral, isosceles, or scalene triangle.
- Check whether entered year is a leap year or not
- Find minimum among three numbers.
- Check whether a number is divisible by 5 and 11 or not.
- Check whether a number is positive, negative or zero using switch case.
- Design a calculator that performs arithmetic operations on two numbers using switch case
- Find Roots of a Quadratic Equation
- Find factorial of a number
- Check whether number is a palindrome or not
- Check whether number is perfect or not
- Convert a decimal number to binary number
- To find the sum of the series [1-X^2/2!+X^4/4!- ....].
- Print following patterns

  ```
  *
  *
  * *
  * * *
  * * * *

  A
  B B
  C CC
  D D D D
  E E E EE

  1
  2 3
  4 5 6
  7 8 9 10
  ```
- Calculate the greatest common divisor of two numbers
- Generate first n numbers in the Fibonacci series
- Generate n prime numbers
- Swap two numbers using pointers.
- Performs all the five arithmetic operations using Pointers.

Learning Outcomes:

After completion of this unit the student will be able to

- Construct C programs using various conditional statements (L3).

- Develop C programs using loops and nested loops (L6).
- Demonstrate the usage of pointers (L3).

Module III: Functions 15 P

Functions-Designing Structured Programs, user defined function- function definition, function prototype, function call, Types of functions. Parameter Passing by value, parameter passing by address, Recursive functions. Dynamic Memory allocation Functions, pointers to functions. Storage classes-auto, register, static, extern.

Exercises: Write a program using functions to

- Print even and odd numbers in a given range
- Find power of a number
- Return maximum of given two numbers
- To print all strong numbers between given interval using functions.
- Check whether a number is prime, Armstrong or perfect number using functions.
- Demonstrate call by value and call by reference mechanisms.
- Find power of any number using recursion.
- Generate Fibonacci series using recursion
- Find product of two numbers using recursion
- Find the sum of digits of a number. Number must be passed to a function using pointers.
- Find GCD (HCF) of two numbers using recursion.
- Find LCM of two numbers using recursion.

Learning Outcomes:

After completion of this unit the student will be able to

- understand the concept of subprograms and recursion (L2).
- apply the in-built functions to develop custom functions for solving problems (L3).
- make use of parameter passing mechanisms (L3).
- infer the effect of storage classes on variables (L2).

Module IV: Arrays and Strings 15 P

Arrays – Declaration and Definition of Array, accessing elements in array, Storing values in array, linear search, binary search, bubble sort, Two – dimensional arrays, multidimensional arrays. Arrays and Pointers, Pointer Arithmetic and arrays, array of pointers, Passing array to function. Strings – Declaration and Definition of String, String Initialization, unformatted I/O functions, arrays of strings, string manipulation functions, string and pointers.

Exercises: Write a program to

- Find minimum and maximum element in an array
- Implement linear search.
- Sort an array in descending order.
- Given a two-dimensional array of integers and a row index, return the largest element in that row.
- Find transpose of a matrix.
- Perform multiplication of two matrices
- Count total number of vowels and consonants in a string.
- Reverse the given string without using String handling functions.
- Sort strings in dictionary order

- To perform addition of two matrices.
- Read an array of elements of size ‘n’ and find the largest and smallest number using functions
- find total number of alphabets, digits or special character in a string using function

Learning Outcomes:

After completion of this unit the student will be able to

- develop programs for storing and managing collections of items using arrays (L3).
- make use of the in-built functions to manipulate strings (L3).
- solve problems related to arrays and strings (L3).

Module V: Structures and Files 15 P

Structures–Declaration, initialization, accessing structures, operations on structures, structures containing arrays, structures containing pointers, nested structures, self-referential structures, arrays of structures, structures and functions, structures and pointers, unions.

Files – Concept of a file, Opening and Closing files, file input / output functions (standard library input / output functions for text files)

Exercises: Write a program to

- Store information of a student using structure
- Add two complex numbers by passing structures to a function
- Store information of 10 students using structures
- Store Employee information using nested structure
- Read file contents and display on console.
- Read numbers from a file and write even and odd numbers to separate file.
- Count characters, words and lines in a text file.

Learning Outcomes:

After completion of this unit, the student will be able to:

- develop programs using structures and unions for storing dissimilar data items (L6).
- compare the utilization of memory by structures and unions (L5).
- make use of files and file operations to store and retrieve data (L3).

Text Books(s)

1. B. A. Forouzan and R. F. Gilberg, Computer Science: A Structured Programming Approach Using C, 3/e, Cengage Learning

Reference Book(s)

1. Jeri R Hanly, Elliot B Koffman, Problem Solving and Program Design in C, 7/e, Pearson Education, 2012.
2. B.W. Kernighan and Dennis M. Ritchie, The C Programming Language, 2/E, Pearson education, 2015.
3. B. Gottfried, Programming with C, 3/e, Schaum’s outlines, McGraw Hill (India), 2017.
4. P. Dey and M Ghosh, Programming in C, 2/e, Oxford University Press, 2011.

Course Outcomes:

After completion of this course the student will be able to

- Build logic for solving a problem and translate it into a program. (L3).
- Define variables and construct expressions using C language (L1).
- Utilize arrays, structures and unions for storing and manipulating data (L3).
- Develop efficient, modular programs using functions (L3).
- Write programs to store and retrieve data using files (L3).

Additional Exercises:

- Given numbers x, y, and target, return whichever of x and y is closer to the target. If they have the same distance, return the smaller of the two
- There are three friends Ram, Raheem and Robert. Ram's age is 20, Raheem is aged three times more than his friend Ram. After 8 years, he would be two and a half times of Ram's age. After further 8 years, how many times would he be of Rams age? Robert's age is 25 now. Now program your computer to determine the final ages of all the three people after 16 years and also show who is elder.
- Given an actual time and an alarm clock time, both in "military" format (such as 0730 for 7:30am), print how many more minutes before the alarm rings. But if the time is after the alarm, print "Alarm already went off".
- Let there be a scenario where you and your friend are going to a restaurant. You have lunch there every fourth day, and he has his lunch there every sixth day. How many days before you meet again for lunch at the same restaurant?
- Two friends Suresh and Ramesh have **m** red candies and **n** green candies respectively. They want to arrange the candies in such a way that each row contains equal number of candies and also each row should have only red candies or green candies. Help them to arrange the candies in such a way that there are maximum number of candies in each row.
- On a chessboard, positions are marked with a letter between a and h for the column and a number between 1 and 8 for the row. Given two position strings, return true if they have the same colour.
- Given two strings s0 and s1, return whether they are anagrams of each other.
- Write a program to encrypt and decrypt a password which is alphanumeric
- Given a string, return the string with the first and second half swapped. If the string has odd length, leave the middle character in place.
- Given an array of integers, return the second-largest element.
- Given lists of integers people, jobs, profits. Each person i in people have people[i] amount of strength, and performing job j requires jobs[j] amount of strength and nets profits[j] amount of profit. Given that each person can perform at most one job, although a job can be assigned to more than one person, return the maximum amount of profit that can be attained.
- Mr. Roxy has arranged a party at his house on the New Year's Eve. He has invited all his friends - both men and women (men in more number). Your task is to generate the number of ways in which the invitees stand in a line so that no two women stand next to each other. Note that the number of men is more than the number of women and Roxy doesn't invite more than 20 guests. If there are more than 20 guests or an arrangement as per the given constraints is not possible, print 'invalid'.
- Two friends have entered their date of birth and they want to know who is elder among them. Make a structure named Date to store the elements day, month and year to store the dates.

Case Study:

- Create a structure containing book information like accession number, name of author, book title and flag to know whether book is issued or not. Create a menu in which the following functions can be done: Display book information,   Add a new book, Display all the books in the library of a particular author, Display the number of books of a particular title, Display the total number of books in the library, Issue a book (If we issue a book, then its number gets decreased by 1 and if we add a book, its number gets increased by 1)
- Ranjan is maintaining a store. Whenever a customer purchases from the store, a bill is generated. Record the customer name, amount due, the amount paid, mobile number with purchased items in file. At the end of day print the total income generated by store.
- Contact Management System- Create structure to store Contact information like name,gender,mail,phone number and address. Users can add new contact and can also edit and delete existing contact. (Hint: Use Files to store data)

CSEN1021 - PROGRAMMING WITH PYTHON

	L	T	P	C
	0	0	6	3

Course Objectives:

- To elucidate problem solving through python programming language
- To introduce function-oriented programming paradigm through python
- To train in development of solutions using modular concepts
- To teach practical Python solution patterns

Module I: Introduction to Python **12 H**

Python – Numbers, Strings, Variables, operators, expressions, statements, String operations, Math function calls, Input/output statements, Conditional If, while and for loops.

Exercises:

- Accept input from user and store it in variable and print the value.
- Use of print statements and use of (.format)for printing different data types.
- Take 2 numbers as user input and add, multiply, divide, subtract, remainder and print the output (Same operations on floating point input as well)
- Conversion of one unit to another (such as hours to minutes, miles to km and etc)
- Usage of mathematical functions in python like math.ceil, floor, fabs, fmod, trunc, pow, sqrt etc.
- Building a mathematical calculator that can perform operations according to user input. Use decision making statement.
- Accepting 5 different subject marks from user and displaying the grade of the student.
- Printing all even numbers, odd numbers, count of even numbers, count of odd numbers within a given range.
    - Compute the factorial of a given number. b) Compute GCD of two given numbers. c) Generate Fibonacci series up to N numbers.
- Check whether the given input is a) palindrome b) strong c) perfect
- Compute compound interest using loop for a certain principal and interest amount

Learning Outcomes:

After completion of this unit the student will be able to

- solve simple problems using control structures, input and output statements. (L3)
- develop user defined functions (recursive and non-recursive). (L3)

Module II: Functions **15H**

User defined Functions, parameters to functions, recursive functions. Lists, Tuples, Dictionaries, Strings.

Exercises:

- Create a function which accepts two inputs from the user and compute ${}^{n}C_{r}$
- Recursive function to compute GCD of 2 numbers
- Recursive function to find product of two numbers
- Recursive function to generate Fibonacci series
- Program to print a specified list after removing the 0th, 4th and 5th elements. Sample List : ['Red', 'Green', 'White', 'Black', 'Pink', 'Yellow'] Expected Output : ['Green', 'White', 'Black']
- Program to get the difference between the two lists.
- Program to find the second smallest number and second largest number in a list.
- Given a list of numbers of list, write a Python program to create a list of tuples having first element as the number and second element as the square of the number.
- Given list of tuples, remove all the tuples with length K.
  Input : test_list = [(4, 5), (4,), (8, 6, 7), (1,), (3, 4, 6, 7)], K = 2
  Output : [(4,), (8, 6, 7), (1,), (3, 4, 6, 7)]
  Explanation : (4, 5) of len = 2 is removed.
- Program to generate and print a dictionary that contains a number (between 1 and n) in the form (x, x*x).
  Sample Input: (n=5) :
  Expected Output : {1: 1, 2: 4, 3: 9, 4: 16, 5: 25}
- Program to remove a key from a dictionary
- Program to get the maximum and minimum value in a dictionary.
- Program to perform operations on string using unicodes ,splitting of string,accessing elements of string using locations
- Program for Counting occurrence of a certain element in a string, getting indexes that have matching elements.For ex -.In Rabbit count how many times b has occurred . Example-I have to go to a doctor and get myself checked. Count the number of occurrences of ‘to’.
- Program for replacing one substring by another For example - Rabbit - Replace ‘bb’ by ‘cc’
- Program to Acronym generator for any user input (ex-input is Random memory access then output should be RMA).Example - Random number (RN)
- Python function that accepts a string and calculates the number of uppercase letters and lowercase letters.
- Program to count the number of strings where the string length is 2 or more and the first and last character are same from a given list of strings
- Sample List : ['abc', 'xyz', 'aba', '1221'] Expected Result : 2

Learning Outcomes:
After completion of this unit the student will be able to

- understand the concept of subprograms and recursion (L2).
- apply the in-built functions to develop custom functions for solving problems (L3).
- make use of parameter passing mechanisms (L3).
- develop user defined functions (recursive and non-recursive). (L3)
- summarize the features of lists, tuples, dictionaries, strings and files. (L2)

Module III: Files and Packages 15 H

Files—Python Read Files, Python Write/create Files, Python Delete Files.
Pandas -- Read/write from csv, excel, json files, add/ drop columns/rows, aggregations, applying functions.
Exercises

- read an entire text file.
- read the first n lines of a file.
- append text to a file and display the text.
- Read numbers from a file and write even and odd numbers to separate files.
- Count characters, words and lines in a text file.
- To write a list to a file.
- Given a CSV file or excel file to read it into a dataframe and display it.
- Given a dataframe, select rows based on a condition.
- Given is a dataframe showing the name, occupation, salary of people. Find the average salary per occupation.
- To convert Python objects into JSON strings. Print all the values.
- Write a Pandas program to read specific columns from a given excel file.

Learning Outcomes:
After completion of this unit the student will be able to

- read data from files of different formats and perform operations like slicing, insert, delete, update(L3).
- Ability to define and use of Packages(L2).

Module IV: Operations in database with suitable libraries **15 H**

SQLite3: CRUD operations (Create, Read, Update, and Delete) to manage data stored in a database. Matplotlib -- Visualizing data with different plots, use of subplots. User defined packages, define test cases.
Exercises
Special commands to sqlite3 (dot-commands)
Rules for "dot-commands"
Changing Output Formats
Querying the database schema
Redirecting I/O
Writing results to a file
Reading SQL from a file
File I/O Functions
The edit() SQL function
Importing CSV files
Export to CSV

Export to Excel
Reference - https://www.sqlite.org/cli.html
Matplotlib can be practiced by considering a dataset and visualizing it.
It is left to the instructor to choose appropriate dataset.

Learning Outcomes:
After completion of this unit the student will be able to
- visualize the data (L4).
- Understanding the various operations performed with SQLite3. (L2)
- make use of SQLite3 operations to store and retrieve data (L3).

Module V: Regular Expressions **15 H**
Regular expression: meta character, regEx functions, special sequences, Web scrapping, Extracting data.
Exercises
Write a Python program to check that a string contains only a certain set of characters (in this case a-z, A-Z and 0-9).
Write a Python program that matches a string that has an a followed by zero or more b's
Write a Python program that matches a string that has an a followed by one or more b's
Write a Python program that matches a string that has an a followed by zero or one 'b'
Write a Python program that matches a string that has an a followed by three 'b'
Write a Python program to find sequences of lowercase letters joined with an underscore
Write a Python program to test if a given page is found or not on the server.
Write a Python program to download and display the content of robot.txt for en.wikipedia.org.
Write a Python program to get the number of datasets currently listed on data.gov
Write a Python program to extract and display all the header tags from en.wikipedia.org/wiki/Main_Page
Learning Outcomes:
After completion of this unit, the student will be able to:
- make use of Web scrapping operations (L3).
- Use regular expressions to extract data from strings.(L3)

Text Books(s)
1. Programming with python, T R Padmanabhan, Springer
2. Python Programming: Using Problem Solving Approach, Reema Thareja, Oxford University Press

Reference Book(s)
1. Programming with python, T R Padmanabhan, Springer
2. Python Programming: Using Problem Solving Approach, Reema Thareja, Oxford University Press
3. Python for Data Analysis, Wes McKinney, O.Reeilly

Course Outcomes:
- After completion of this course the student will be able to
- Define variables and construct expressions (L1).
- Utilize arrays, storing and manipulating data (L3).
- Develop efficient, modular programs using functions (L3).
- Write programs to store and retrieve data using files (L3).

APPLICATIONS OF ARTIFICIAL INTELLIGENCE

L T P C
0 0 2 1

The surge in the production of data has led to the development of various technologies. The term "Artificial Intelligence (AI)" has become ubiquitous in everyday applications from virtual assistants to self-driving cars. Several applications such as Healthcare, Finance, Bioinformatics etc. are benefitting from the advances in the domain. The global market for artificial intelligence is going to face a phenomenal growth over the coming years with organizations across the world capitalizing on the disruptive technologies that AI is offering. This course introduces the recent applications of AI namely, Virtual Assistants, Computer Vision, along with trending topics such as Deep Learning and Reinforcement Learning. The idea of the course is to introduce the basic concepts of AI as well as latest trends in the domain. This course is envisaged to provide a basic understanding on latest developments of AI to all disciplines engineering undergraduates.

Course Objectives:

- Provide introduction to basic concepts of artificial intelligence.
- Explore applications of AI
- Explore the scope, advantages of intelligent systems
- Experiment with different machine learning concept
- Exposure to AI-intensive computing and information system framework

Week-1: 2 L

Introduction to Artificial intelligence: Basics of AL Agents and Environment, The Nature of Environment.

List of Experiment(s):

1. Implementation of toy Problems (8-Puzzle,Wumpus World, Vacuum-clean Example, etc)

Week-2: 2 P

Applications of AI: Game Playing, [Deep Blue in Chess, IBM Watson in Jeopardy, Google's Deep Mind in AlphaGo]

List of Experiment(s):

1. Implementation of (Sudoku, Crossword Puzzle, or WumpusWorld, etc)

Learning Outcomes:

The student will be able to:

- Understand the basics in AI.
- Recognize various domains in AI.

Week-3: 2 P

Conceptual introduction to Machine Learning: Supervised, Unsupervised, and Semi-Supervised Learning.

List of Experiment(s):

1. Supervise - Perform Data Labelling for various images using object recognition

Week-4: 2 P

Reinforcement Learning, Introduction to Neural Networks, Deep Learning.

List of Experiment(s):

1. Explore the effect of different hyperparameters while implementing a Simple Fully Connected Neural Network. (https://playground.tensorflow.org)

Learning Outcomes:
The student will be able to:

- Define machine learning and forms of learning
- Identify types of Neural Networks

Week-5: 2 P

Image Processing & Computer Vision: Introduction to Image processing, Image Noise, Removal of Noise from Images, Color Enhancement, Edge Detection.

List of Experiment(s):

1. Lobe.ai - Build custom models using the visual tool for Object recognition and sentiment analysis that can convert facial expressions into emoticons

Week-6: 2 P

Segmentation. Feature Detection & Recognition. Classification of images. Face recognition, Deep Learning algorithms for Object detection & Recognition.

List of Experiment(s):

1. Teachable Machine Brain.JS In Browser Object Recognition through
2. Haar Cascade Object detection for Eye and Face in Python using Open CV

Learning Outcomes:
The student will be able to:

- Identify the concepts of image processing
- Implement the methods in computer vision

Week-7: 2 P

Conceptual introduction to Natural Language Processing: Speech Recognition & Synthesis: Speech Fundamentals, Speech Analysis, Speech Modelling.

List of Experiment(s):

1. Sentiment Analysis and Polarity detection

Week-8: 2 P

Speech Recognition, Speech Synthesis, Text-to-Speech, Sentiment Analysis, Segmentation and recognition.

List of Experiment(s):

1. Text to Speech recognition and Synthesis through APIs

Learning Outcomes:
The student will be able to:

- Understand the basics of Speech Processing
- Describe natural language processing and concepts for converting speech to different forms

Week-9: 2 P

Introduction to o Chatbot, Architecture of a Chatbot. NLP in the cloud, NL Interface, How to Build a Chatbot, Transformative user experience of chatbots, DesigningElements of a chatbot, Best practices for chatbot development. NLP components. NLP wrapper to chatbots. Audiobots and Musicbots.

List of Experiment(s):

1. Building a Chatbot using IBM Watson visual studio
2. Building a Chatbot using Pandora bots
3. Build a virtual assistant for Wikipedia using Wolfram Alpha and Python

Learning Outcomes:
The student will be able to:

- Understand basic architecture of chatbots.
- Implement chatbots for various applications.

Week-10: 2 P

Smart Applications: Smart Manufacturing, Smart Agriculture, Smart Healthcare, Smart Education, Smart Grids, Smart Transportation andAutonomous Vehicles, Smart Homes, Smart Cities

List of Experiment(s):

1. Build a smart application specific to the domain of the student.

Learning Outcomes:

The student will be able to:

- Understand the application of intelligence in various domains
- Correlate Artificial Intelligence to advanced applications

Text Books(s)

1. Tom Markiewicz& Josh Zheng, Getting started with Artificial intelligence, Published by O'Reilly Media,20l7
2. Stuart J. Russell and Peter Norvig, Artificial Intelligence A Modern Approach.

Reference Book(s)

1. Aurtlien Giron. Hands on Machine Learning with Scikit-Learn and TensorFlow concepts,Tools, and Techniques to Build intelligent Systems , Published by O'Reilly Mcdia,20l 7
2. Build an AI Assistant with wolfram alpha and Wikipedia in python.https://medium .com/@salisuwy/build-an-ai-assistant-with-wolfram-alpha-and-wikipedia-in-python-d9bc8ac838fe.
3. Joseph Howse, Prateek Joshi, Michael Beyeler - Opencv Computer Vision Projects withPython-Publishing (201 6).
4. Curated datasets on kaggle https://www.kaggle.com/datasets.

Course Outcomes:

- Able to grasp the concepts of artificial intelligence, machine learning, natural language processing, image processing
- Recognize various domains in which Al can be applied
- Implement the methods in processing an image:
- Implement simple of chatbots
- identify smart applications:

PROBABILITY AND STATISTICS

L	T	P	C
3	0	0	3

Course Objectives:

- To familiarize the students with the foundations of probability and statistical methods
- To impart concepts in probability and statistical methods in engineering applications.

Unit I: Data Science and Probability **10 hrs**

Data Science: Statistics introduction, Population vs Sample, collection of data, primary and secondary data, types of variable: dependent and independent Categorical and Continuous variables, data visualization, Measures of central tendency, Measures of dispersion (variance).

Probability: Probability axioms, addition law and multiplicative law of probability, conditional probability, Baye's theorem (without proof).

Learning Outcomes:

At the end of this unit, the student will be able to

- summarize the basic concepts of data science and its importance in engineering (L3)
- analyze the data quantitatively or categorically , measure of averages, variability (L4)
- define the terms trial, events, sample space, probability, and laws of probability (L3)
- make use of probabilities of events in finite sample spaces from experiments (L3)
- apply Baye's theorem to real time problems (L3)

Unit II: Random Variable and Probability Distributions **8 hrs**

Random variables (discrete and continuous), probability density functions, probability distribution - Binomial, Poisson and normal distribution-their properties (mathematical expectation and variance).

Learning Outcomes:

At the end of this unit, the student will be able to

- explain the notion of random variable, distribution functions and expected value(L3)
- apply Binomial and Poisson distributions to compute probabilities, theoretical frequencies (L3)
- explain the properties of normal distribution and its applications (L3)

Unit III: Correlation, Regression and Estimation **8 hrs**

Correlation, correlation coefficient, rank correlation, regression, lines of regression, regression coefficients, principle of least squares and curve fitting (straight Line, parabola and exponential curves). **Estimation:** Parameter, statistic, sampling distribution, point estimation, properties of estimators, interval estimation.

Learning Outcomes:

At the end of this unit, the student will be able to

- identify different trends in scatter plots, strengths of association between two numerical variables (L3)
- make use of the line of best fit as a tool for summarizing a linear relationship and predicting future observed values (L3)
- estimate the value of a population parameter, computation of point and its interval (L3)

Unit IV: Testing of Hypothesis and Large Sample Tests **8 hrs**

Formulation of null hypothesis, alternative hypothesis, the critical region, two types of errors, level of significance, and power of the test. **Large Sample Tests**: Test for single proportion, difference of proportions, test for single mean and difference of means. Confidence interval for parameters in one sample and two sample problems

Learning Outcomes:

At the end of this unit, the student will be able to

- identify the difference between one- and two-tailed hypothesis tests (L3)
- analyze the testing of hypothesis for large samples (L4)

Unit V: Small Sample Tests **6 hrs**

Student t-distribution (test for single mean, two means and paired t-test), testing of equality of variances (F-test), $\chi 2$ - test for goodness of fit, $\chi 2$ - test for independence of attributes.

Learning Outcomes:

At the end of this unit, the student will be able to

- analyze the testing of hypothesis for small samples (L4)
- test for the Chi-square goodness of fit and independence of attributes (L4)

Text Books:

1. Miller and Freunds, Probability and Statistics for Engineers,7/e, Pearson, 2008.
2. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, 11/e, Sultan Chand & Sons Publications, 2012.

References:

1. S. Ross, A First Course in Probability, Pearson Education India, 2002.
2. W. Feller, An Introduction to Probability Theory and its Applications, 1/e, Wiley, 1968.

Course Outcomes:

Upon successful completion of this course, the student should be able to

- classify the concepts of data science and its importance (L3)
- apply discrete and continuous probability distributions (L3)
- explain the association of characteristics through correlation and regression tools (L3)
- identify the components of a classical hypothesis test (L3)
- infer the statistical inferential methods based on small and large sampling tests (L4)

EECE1001: BASIC ELECTRICAL AND ELECTRONICS ENGINEERING

L	T	P	C
2	1	2	4

This course introduces the fundamental principles and building blocks of electrical and electronics engineering. The first three units cover the electric circuit laws, theorems, and principles of electrical machines. The last two units cover semiconductor devices and their applications.

Course Objectives:
- To impart the analysis and design aspects of DC networks in electrical and electronic circuits
- To explain the basic concepts of AC networks used in electrical and electronic circuits.
- To demonstrate the importance and operating principles of electrical machines (transformers, motors and generators)
- To impart the knowledge about the characteristics, working principles and applications of semiconductor diodes, Metal Oxide Semiconductor Field Effect Transistors (MOSFETs).
- To expose basic concepts and applications of Operational Amplifier and configurations.

Unit I: **7L**

DC Circuits: Basic circuit elements and sources, Ohms law, Kirchhoff's laws, series and parallel connection of circuit elements, Node voltage analysis, Mesh current analysis, Superposition, Thevenin's and maximum power transfer theorem.

Learning Outcomes

After completion of this unit the student will be able to
- state Ohms law and Kirchhoff's Laws (L1).
- calculate equivalent resistance of series and parallel connections in a circuit (L1).
- able to calculate voltage and current using voltage and current division methods (L2).
- determine the current, voltage and power in the given electrical circuit (L4).
- apply various theorems to analyze an electric circuit (L3).

Unit II: **8L**

AC Circuits: Alternating voltages and currents, AC values, single phase RL, RC, RLC series circuits, power in AC circuits, Power Factor, three phase systems-Star and Delta Connection-Three phase power measurement.

Learning Outcomes:

After completion of this unit, the student will be able to
- describe AC voltages and currents (L1).
- analyse Series RL, RC and RLC circuits (L4).
- Learn calculations of power factor and power measurement (L2)
- Understand star and delta connections in three phase systems (L3).

Unit III: **9L**

Electrical Machines: Construction, working principle and application of DC machines, Transformers, single phase and three phase Induction motors, special machines-Stepper motor, Servo motor and BLDC motor.

Learning Outcomes:

After completion of this unit, the student will be able to

- Understand working principle of dc machines (L1).
- demonstrate principle operation of transformer (L3).
- discuss about open and short- circuit tests of transformer (L2).
- explain the working principle of three phase induction motor (L5).
- gain knowledge on applications as special machines, stepper motor (L1).
- Identify and choose servo motor and BLDC motor applications (L2).

Unit IV: **8L**

Semiconductor Devices: p-n Junction diode - Basic operating principle, current-voltage characteristics, rectifier circuits (half-wave, full-wave, rectifier with filter capacitor), Zener diode as Voltage Regulator; Metal oxide semiconductor field effect transistor (MOSFET): Operation of NMOS and PMOS FETs, MOSFET as an amplifier and switch.

Learning Outcomes:

After completion of this unit, the student will be able to

- describe the device structure and physical operation of a diode (L1).
- discuss V-I characteristics of diodes (L2).
- explain the use of diode as switch and in electronic circuits (L2).
- describe the construction and operation of n-channel and p-channel MOSFETs (L1).
- explain the use of MOSFET as an amplifier and bidirectional switch(L2).

Unit V: **8L**

Operational Amplifiers: The Ideal Op-amp, The Inverting Configuration, The closed loop gain, Effect of Finite open-loop gain, The Noninverting Configuration, The closed loop gain, Characteristics of Non-Inverting Configuration, Difference amplifiers, A Single Op-amp difference amplifier. Adders, subtractors, integrators, differentiators, filter circuits using Opamps,

Learning Outcomes:

After completion of this unit the student will be able to

- list the characteristics of an ideal Op Amp (L1).
- design the Inverting and Noninverting configurations of Op-Amp(L2).
- construct a single Op-amp difference amplifier (L3).
- List several applications of opamps

Basic Electrical and Electronics Engineering Laboratory

List of Experiments:

1. Verification of Kirchhoff's Laws.
2. Verification of DC Superposition Theorem.
3. Verification of Thevenin's Theorem.
4. Verification of Maximum power transfer Theorem.
5. Load test on DC generator.
6. Load test on single phase transformer.
7. Measurement of voltage, current and power factor of single phase RL, RC series circuits.
8. Measurement of voltage, current and power factor of single phase RLC series circuit.
9. Measurement of power in a three phase circuit.
10. Current Voltage Characteristics of a p-n Junction Diode/LED.
11. Diode Rectifier Circuits.

12. Voltage Regulation with Zener Diodes.
13. Design of a MOSTFET amplifier and MOSFET inverter/NOR gate
14. Inverting and Non-inverting Amplifier Design with Op-amps.
15. Simulation experiments using PSPICE

(a) Diode and Transistor Circuit Analysis.
(b) MOSFET Amplifier design.
(c) Inverting and Noninverting Amplifier Design with Op-amps.

Text Book(s):

1. D. P. Kothari, I. J. Nagrath, Basic Electrical and Electronics Engineering, 1/e, McGraw Hill Education (India) Private Limited, 2017.
2. B. L. Theraja, Fundamentals of Electrical Engineering and Electronics, 1/e, S. Chand Publishing, New Delhi, 2006.
3. Adel S. Sedra and Kenneth C. Smith, Microelectronic Circuits 6/e, Oxford University Press, 2014.

References:

1. S.K. Bhattacharya, Basic Electrical and Electronics Engineering, Pearson Education, 2011.
2. Dharma Raj Cheruku, B T Krishna, Electronic Devices and Circuits, 2/e, Pearson Education, 2008.
3. R. K. Rajput, Basic Electrical and Electronics Engineering, University Science Press, New Delhi, 2012.

Course Outcomes:

After completion of this course, the student will be able to

- predict and analyse the behaviour of an electrical circuit (L3).
- analyse the performance quantities such as losses, efficiency and identify applications of DC machines (L4).
- explain the use of transformers in transmission and distribution of electric power and other applications (L2).
- demonstrate the operation and applications of various electronic devices (L2).
- construct Inverting and Noninverting configurations of Op-amp (L3).

INTERNSHIP I

L T P C J
0 0 0 1 1

Prerequisite: Completion of minimum of four semesters

Course Objectives:
The course is designed to expose the students to expected industry skills and industry environment and to take up onsite assignment as trainees or interns.

Expected Course Outcome:

At the end of this internship the student should be able to:

1. Have an exposure to industrial practices and to work in teams
2. identify skill set required to participate activity in real-time projects relevant to the industry
3. Understand the impact of engineering solutions in a global, economic, environmental and societal context
4. formulate technical background required to participate in Internship 2

Contents: 1 **Week**

One week of work at industry site. Supervised by an expert at the industry.

Mode of Evaluation: Internship Report, Presentation and Project Review

INTERNSHIP II

L T P C J
0 0 0 1 3

Prerequisite: Completion of minimum of six semesters

Course Objectives:
The course is designed to expose the students to industry environment and to take up onsite assignment as trainees or interns.

Expected Course Outcome:

At the end of this internship the student should be able to:

1. Have an exposure to industrial practices and to work in teams
2. Communicate effectively
3. Understand the impact of engineering solutions in a global, economic, environmental and societal context
4. Develop the ability to engage in research and to involve in life-long learning
5. Comprehend contemporary issues
6. Engage in establishing his/her digital footprint

Contents: 1 **Week**

Four weeks of work at industry site. Supervised by an expert at the industry

Mode of Evaluation: Internship Report, Presentation and Project Review

COMPREHENSIVE EXAMINATION

L T P J C
1 0 0 0 1

Prerequisite: Completion of minimum of six semesters

Course Objectives:
1. Designed to test the students on the electronics and communication engineering concepts, and tools, and the process of identifying and solving engineering problems.

Course Outcomes
The students will be able to
1. Apply knowledge of mathematics, science, and engineering
2. Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health care and safety, manufacturability, and sustainability

Module:1 Networks, Signals and Systems
Network solution methods: nodal and mesh analysis; Network theorems: superposition, Thevenin and Norton‟s maximum power transfer; ye-Delta transformation; Steady state sinusoidal analysis using phasors; Time domain analysis of simple linear circuits; Solution of network equations using Laplace transform; Frequency domain analysis of RLC circuits; Linear 2-port network parameters: driving point and transfer functions; State equations for networks and Network Synthesis (RL,RC,LC and RLC Synthesis): Positive real functions, hurwitz polynomial, foster and cauer forms. Continuous-time signals: LTI System & Properties,Fourier series and Fourier transform representations, sampling and aliasing concepts and applications; Discrete-time signals: discrete time Fourier transform (DTFT), DFT, FFT, Z-transform. Interconnection of systems; Filter design concepts, phase and group delay concepts

Module:2 Electronic Devices and Circuits
Energy bands in intrinsic and extrinsic silicon; Carrier transport: diffusion current, drift current, mobility and resistivity; Generation and recombination of carriers; Poisson and continuity equations; P-N junction, Zener diode, BJT, LED, photo diode and solar cell; MOS Transistor Theory: nMOS, pMOS Enhancement Transistor, ideal I-V characteristics, MOS capacitor, C-V characteristics, DC transfer Characteristics of CMOS inverter.

Small signal equivalent circuits of diodes, BJTs and MOSFETs; Simple diode circuits: clipping, clamping and rectifiers; Special diodes, Single-stage BJT and MOSFET amplifiers: biasing, bias stability, mid-frequency small signal analysis and frequency response; BJT and MOSFET amplifiers: multi-stage, differential, feedback, tuned amplifiers, power and operational; Simple opamp circuits; Active filters; Sinusoidal oscillators: criterion for oscillation, single-transistor and op-amp configurations; Function generators, 555 timers, open and closed loop applications of Comparators, Voltage Regulators, regulator protection methods, noise analysis of electronic circuits, PLLs and Data converters

Module 3: Digital Circuits
Number systems; Combinatorial circuits: Boolean algebra, minimization of functions using Boolean identities and Karnaugh map, logic gates and their static CMOS implementations, arithmetic circuits, code converters, multiplexers, decoders and PLAs; Sequential circuits: latches and flip-flops, counters, shift- registers and finite state machines; Data converters: sample and hold circuits, ADCs and DACs; Semiconductor memories: ROM, SRAM, DRAM; 8-bit microcontroller (8051): architecture, programming, memory and I/O interfacing.

Module:4 Electromagnetics
Electrostatics; Maxwell‟s equations: differential and integral forms and their interpretation boundary conditions, wave equation, Poynting vector; Plane waves and properties: reflection and refraction, polarization, phase and group velocity, propagation through various media, skin depth; Transmission lines: equations, characteristic impedance, impedance matching, S-parameters, Smith chart; Waveguides: modes, boundary conditions, cut-off frequencies, Rader range equvation, Friss formula; Antennas: antenna types, radiation pattern, gain and directivity, return loss, antenna arrays; Wave Propagation, Antenna design considerations - Microstrip and Horn antennas. Basics of radar; Properties and characteristics of light sources (Laser and LED) and detectors; Light propagation in optical fibers.

Module 5: Control Systems
Basic control system components; Feedback principle; Transfer function; Block diagram representation; Signal flow graph; Transient and steady-state analysis of LTI systems; Frequency response; Routh-Hurwitz and Nyquist stability criteria; Bode and root-locus plots; Closed loop control system design by Nichols plot , PID controller design, Lag, lead and lag-lead compensation, States space models, states space equations and solutions, states space methods for controller designs and non-linear control systems and its applications.

Module 6: Communications
Random processes: autocorrelation and power spectral density, properties of white noise, filtering of random signals through LTI systems; Analog communications: amplitude modulation and demodulation, angle modulation and demodulation, spectra of AM and FM, superheterodyne receivers, circuits for analog communications; Information theory: entropy, mutual information and channel capacity theorem. Digital communications: PCM, DPCM, digital modulation schemes, amplitude, phase and frequency shift keying (ASK, PSK, FSK), QAM, MAP and ML decoding, matched filter receiver, calculation of bandwidth, SNR and BER for digital modulation; Fundamentals of error correction, Hamming codes; inter-symbol interference and its mitigation; Wireless Communication: Structure of a Wireless Communication Link, Modulation Techniques: QPSK, MSK, GMSK. Basics of TDMA, FDMA and CDMA.

Mode of Evaluation: 12 Quizzes with Multiple Choice Questions. Best 10 quizzes are considered for computing 100M. Student shall score atleast 80% in atleast 8 quizzes to be considered for grading

CAPSTONE PROJECT – INTRODUCTION

L T P S J C
0 0 0 0 2 2

Course Objectives:
To provide sufficient hands-on learning experience related to the design, development and analysis of suitable product / process so as to enhance the technical skill sets in the chosen field.

Course Outcome:
At the end of the course the student will be able to
1. Formulate specific problem statements for ill-defined real life problems with reasonable assumptions and constraints.
2. Perform literature search and / or patent search in the area of interest.
3. Conduct experiments / Design and Analysis / solution iterations and document the results.
4. Perform error analysis / benchmarking / costing
5. Synthesis the results and arrive at scientific conclusions / products / solution
6. Document the results in the form of technical report / presentation

Course Logistics
Capstone Project may be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, applied research and any other related activities.

1. Project can be for one or two semesters based on the completion of required number of credits as per the academic regulations.
2. Can be individual work or a group project, with a maximum of 3 students.
3. In case of group projects, the individual project report of each student should specify the individual's contribution to the group project.
4. Carried out inside or outside the university, in any relevant industry or research institution.
5. Publications in the peer reviewed journals / International Conferences will be an added advantage

Mode of Evaluation: Periodic reviews, Presentation, Final oral viva, Poster submission

HSMCH102 - UNIVERSAL HUMAN VALUES 2: UNDERSTANDING HARMONY

L T P C
2 1 0 3

Human Values Courses: During the Induction Program, students would get an initial exposure to human values through Universal Human Values – I. This exposure is to be augmented by this compulsory full semester foundation course.

OBJECTIVE: The objective of the course is four fold:

1. Development of a holistic perspective based on self- exploration about themselves (human being), family, society and nature/existence.
2. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
3. Strengthening of self-reflection.
4. Development of commitment and courage to act.

COURSE TOPICS: The course has 28 lectures and 14 practice sessions in 5 modules:

Module 1: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education

1. Purpose and motivation for the course, recapitulation from Universal Human Values-I.
2. Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration.
3. Continuous Happiness and Prosperity- A look at basic Human Aspirations
4. Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority.
5. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario
6. Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking.

Module 2: Understanding Harmony in the Human Being - Harmony in Myself!

1. Understanding human being as a co-existence of the sentient 'I' and the material 'Body'.
2. Understanding the needs of Self ('I') and 'Body' - happiness and physical facility.
3. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer).
4. Understanding the characteristics and activities of 'I' and harmony in 'I'.
5. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail.

6. Programs to ensure Sanyam and Health.

Include practice sessions to discuss the role others have played in making material goods available tome. Identifying from one's own life.

Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease

Module 3: Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship

1. Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship
2. Understanding the meaning of Trust; Difference between intention and competence
3. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship
4. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals
5. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives.

Module 4: Understanding Harmony in the Nature and Existence - Whole existence as Coexistence

1. Understanding the harmony in the Nature
2. Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self-regulation in nature.
3. Understanding Existence as Co-existence of mutually interacting units in all-pervasive space.
4. Holistic perception of harmony at all levels of existence.
5. Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

Module 5: Implications of the above Holistic Understanding of Harmony on Professional Ethics

1. Natural acceptance of human values
2. Definitiveness of Ethical Human Conduct
3. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order

4. Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems.
5. Case studies of typical holistic technologies, management models and production systems
6. Strategy for transition from the present state to Universal Human Order:
   a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers
   b. At the level of society: as mutually enriching institutions and organizations
7. Sum up.

Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions e.g. To discuss the conduct as an engineer or scientist etc.

READINGS: Text Book

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010

Reference Books

1. Jeevan Vidya: EkParichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi.
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj - PanditSunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)

Lectures hours are to be used for interactive discussion, placing the proposals about the topics at hand and motivating students to reflect, explore and verify them. Tutorial hours are to be used for practice sessions.

While analysing and discussing the topic, the faculty mentor’s role is in pointing to essential elements to help in sorting them out from the surface elements. In other words, help the students explore the important or critical elements.

In the discussions, particularly during practice sessions (tutorials), the mentor encourages the student to connect with one’s own self and do self- observation, self-reflection and self-exploration.

Scenarios may be used to initiate discussion. The student is encouraged to take up “ordinary” situations rather than” extra-ordinary” situations.

Such observations and their analyses are shared and discussed with other students and faculty mentor, in a group sitting.

Tutorials (experiments or practical) are important for the course. The difference is that the laboratory is everyday life, and practical are how you behave and work in real life. Depending on the nature of topics, worksheets, home assignment and/or activity are included. The practice sessions (tutorials)would also provide support to a student in performing actions commensurate to his/her beliefs. It is
intended that this would lead to development of commitment, namely behaving and working based on basic human values.

It is recommended that this content be placed before the student as it is, in the form of a basic foundation course, without including anything else or excluding any part of this content. Additional content may be offered in separate, higher courses.

This course is to be taught by faculty from every teaching department, including HSS faculty.

Teacher preparation with a minimum exposure to at least one 8- day FDP on Universal Human Values is deemed essential.

ASSESSMENT:
This is a compulsory credit course. The assessment is to provide a fair state of development of the student, so participation in classroom discussions, self-assessment, peer assessment etc. will be used in evaluation.

Example:
Assessment by faculty mentor: 10 marks
Self-assessment: 10 marks
Assessment by peers: 10 marks
Socially relevant project/Group Activities/Assignments: 20 marks Semester End Examination: 50 marks
The overall pass percentage is 40%. In case the student fails, he/she must repeat the course.

OUTCOME OF THE COURSE: By the end of the course, students are expected to become more aware of themselves, and their surroundings (family, society, nature); they would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.

They would have better critical ability. They would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society). It is hoped that they would be able to apply what they have learnt to their own self in different day-to- day settings in real life, at least a beginning would be made in this direction.

This is only an introductory foundational input. It would be desirable to follow it up by

a) faculty-student or mentor-mentee programs throughout their time with the institution
b) Higher level courses on human values in every aspect of living. E.g. as a professional

PROJECT EXHIBITION I

L T P S J C
0 0 0 0 1 1

Course Objectives:
To provide platform for the student to exhibit their project work to

a) Excite interested students in continuing/initiating in the work of interest
b) Attract startups/industry to commercialize the project work
c) acquire comments on improving the quality of the work from other students/academicians/industry

Mode of Evaluation: Poster submission, Viva-Voce Examination

PROJECT EXHIBITION II

L T P S J C
0 0 0 0 1 1

Course Objectives:
To provide platform for the student to exhibit their project work to

a) Excite interested students in continuing/initiating in the work of interest
b) Attract startups/industry to commercialize the project work
c) acquire comments on improving the quality of the work from other students/academicians/industry

Mode of Evaluation: Poster submission, Viva-Voce Examination

Program core courses

SEMESTER III

<table>
<tr><td rowspan="6"></td><td>Course Code</td><td>Course Title</td><td>L</td><td>T</td><td>P</td><td>J</td><td>S</td><td>C</td></tr>
<tr><td></td><td>PC1: ENGINEERING MECHANICS</td><td>3</td><td>0</td><td>10</td><td>0</td><td>0</td><td>8</td></tr>
<tr><td>Course Owner</td><td>Department of MechanicalEngineering</td><td colspan="4">Syllabus version</td><td colspan="2">1.0</td></tr>
<tr><td>Course Pre-requisite(s)</td><td>Introduction to MechanicalEngineering Drawing and Design, Engineering Mathematics & Calculus, Engineering Physics.</td><td colspan="4">Contact hours</td><td colspan="2">30</td></tr>
<tr><td>Course Co-requisite(s)</td><td>Mechanics of solids, Design of machine elements and Kinematics and Dynamics ofmachinery</td><td colspan="4">Date Approved</td><td colspan="2"></td></tr>
<tr><td>Alternate Exposure</td><td colspan="7"></td></tr>
</table>

Course Description:
This course introduces the principles required to solve engineering mechanics problems. Concepts will be appliedin this course from previous courses you have taken in basic mathematics and physics. It addresses the modelling and analysis of static and dynamic equilibrium problems with an emphasis on real-world engineering applicationsand problem solving.

Course Objectives:
1. To Explain the conditions for mechanical equilibrium of the systems subjected to forces and moments.
2. To Compute geometric properties such as centroid and moment of inertia of various plane sections.
3. To Explain kinematics of particles and rigid bodies.
4. To Analyze the rigid bodies under dynamic conditions.
5. To Expose the concepts of work-energy, conservation of energy and momentum to rigid bodies.

Course Outcomes:
1. Apply equilibrium concepts on mechanical systems
2. Analyze the forces and moments on the mechanical systems
3. Calculate the physical properties of rigid bodies in engineering systems.
4. Understand the role of friction in engineering practices
5. Analyze various static and dynamic engineering mechanical systems and understand the mechanics andidentify the drawbacks/problems.

UNIT I **9 Hrs**

Introduction to Engineering Mechanics: Fundamental laws of mechanics, parallelogram law and triangular law,vector operations, Resultant of coplanar and concurrent forces, Components of forces in space, Equilibrium of a particle and a rigid body, free body diagrams.
Learning Outcomes:
At the end of this unit, the student will be able to
recognize the significance of Engineering Mechanics in engineering applications . [**L-1**]calculate the resultant of forces and moments of the system of forces . [**L-3**]
draw free body diagrams of mechanical systems under loads . [**L-3**]apply the concept of mechanical equilibrium of the systems . [**L-3**]

UNIT II **9 Hrs**
Friction and Analysis of Structures:

Introduction to the concept of dry friction, Equilibrium of rigid bodies subjected to dry friction, Examples demonstrating the application of frictions on wedges, screws, and Free body diagrams involving frictional forces. Trusses, Frames and Machines, analysis of forces in trusses using the method of joints and the method of sections;Special conditions in truss members: zero-force members, Condition of statically determinate system.

Learning Outcomes:

At the end of this unit, the student will be able to

- comprehend the role of friction in enginnering applications. [**L-2**]
- identify different types of trusses. [**L-2**]
- analyze the plane trusses by method of joints and the method of sections. [**L-4**]

UNIT III **9 Hrs**

Properties of Surfaces and Moment of Inertia

Center of gravity and centroid, Moment of inertia, Theorems of Pappus and Guldinus, Moment of inertia for simple geometries, Parallel-axis theorem, Perpendicular-axis theorem, Polar moment of area, Radius of gyration, Application to Composite areas, Mass moment of inertia.

Learning Outcomes:

At the end of this unit, the student will be able to

- locate thecentre of gravity of plane figures. [**L-1**]
- calculate the centre of gravity of composite plane shapes. [**L-3**]
- understand the concepts of moment of inertia and radius of gyration. [**L-2**]
- determine moment of inertia for composite plane shapes. [**L-3**]

UNIT IV **9 Hrs**

Kinematics

Kinematics of particles – Rectilinear motion of particles, curvilinear motion of particles, Kinematics of rigid bodies, rotation of a rigid body about a fixed axis, angular momentum of rigid bodies and energy relations for rigid bodies,projectile motion.

Learning Outcomes:

At the end of this unit, the student will be able to

- develop equations of motion for particles and rigid bodies in motion. [**L-3**]
- find velocity and acceleration in rectilinear and curvilinear motions. [**L-3**]
- trace the path of projectile. [**L-2**]

UNIT V **9 Hrs**

Kinetics and Ideal systems

Kinetics of particles, system of particles, Kinetics of rigid bodies -translation and rotation motion of a rigid body, plane motion of rigid bodies, energy and momentum methods, Principle of conservation of energy, conservation oflinear momentum, principle of momentum and impulse, types of impact.

Learning Outcomes:

At the end of this unit, the student will be able to

- apply Newton's laws and D'Alembert's principle in rectilinear translation. [**L-3**]
- apply the principle of work and energy in dynamic systems. [**L-3**]
- use of principles of momentum and impulse on dynamic systems . [**L-3**]

Text Books

1 N.H. Dubey, Engineering Mechanics: Statics and Dynamics, Tata McGraw Hill, 2014.
2 S. Timoshenko, D.H. Young, J.V. Rao, Sukumar Pati, Engineering Mechanics (in SI **UNIT** s), 5/e, McGrawHill, 2013.
3 Irving Shames, G.K.M. Rao, Engineering Mechanics: Statics and Dynam-ics, 4/e, Pearson, 2009.

Reference Books

1 Basudeb Bhattacharya, Engineering Mechanics, 2/e, Oxford University Press (India), 2015.

2 K.L. Kumar, Veenu Kumar, Engineering Mechanics, 4/e, Tata McGraw Hill, 2010
3 S.S. Bhavikatti, Engineering Mechanics, 4/e, New Age International, 2008

Evaluation Procedure						
Continuous Evaluation	Total 70 Marks					
	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2
Sem End Examination	Total 30 Marks					

Course Outcome - Programe Outcome Mapping															
Course Outcomes :	**Programme Outcomes**														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	2	2	0	0	0	1	0	0	0	0	0	0	1	0	0
2	2	2	0	0	0	1	0	0	0	0	0	0	1	0	0
3	2	2	0	0	0	1	0	0	0	0	0	0	1	0	0
4	2	2	0	0	0	1	0	0	0	0	0	0	1	0	0
5	2	2	0	1	0	1	0	0	0	0	0	0	1	0	0

Course Code	Course Title	L	T	P	J	S	C
19EME203	PC2: THERMODYNAMICS	3	0	10	0	0	8
Course Owner	Department of Mechanical Engineering	**Syllabus version**				1.0	
Course Pre-requisite(s)	Mathematics & Calculus,Engineering Physics.	**Contact hours**				30	
Course Co-requisite(s)	None	**Date Approved**					
Alternate Exposure							

Course Description

This course focuses on the basics of Thermodynamics, various Laws of Thermodynamics such as First law of Thermodynamics, Second Law of Thermodynamics, Zeroth law of Thermodynamics, and Entropy, availability and irreversibility, basics of pure substance and steam calculations, and the thermodynamic relations, gas power cycles,and basics of refrigeration and air-conditioning.

Course Objectives:

1 To understand the concepts of heat, work, energy, and different laws of thermodynamics
2 To familiarize the basic understanding of entropy, availability, and its application to open and closed systems.
3 To impart the concepts of Thermodynamic relations, Properties of pure substance and steam calculations.
4 To introduce the concepts of gas power cycles.
5 To familiarize refrigeration and air conditions concepts and understand the working principles.

Course Outcomes:

1 The student will demonstrate basic understanding and knowledge of thermodynamic properties and differentlaws of thermodynamics.
2 The student will describe basic knowledge of entropy, availability, and its application to open and closedsystems.
3 The student will explain basic understanding of Thermodynamic relation and steam based analysis.
4 The student will demonstrate the knowledge of gas power cycles and their analysis.
5 The student will explain the basic understanding of Refrigeration and Air conditioning principles.

Specific Instructional Objectives

1 The student must use the steam tables
2 The student must use the refrigeration tables.

UNIT I **10 Hrs**

Introduction and Basic Laws of Thermodynamics
Introduction: Basic concepts of thermodynamics, Zeroth law of thermodynamics.
First law of Thermodynamics: Joule's experiment - first law of thermodynamics, corollaries-PMM-1, first law applied to non-flow and flow process- limitations of first law of thermodynamics. **Second Law of Thermodynamics:** Kelvin - Planck statement and Clausius statement and their equivalence, corollaries - PMM-2, reversibility and irreversibility, cause of irreversibility - Carnot cycle, heat engine, heat pumpand refrigerator, Carnot theorem, Carnot efficiency
Learning outcomes
At the end of this Unit, the student will be able to

- explain energy balance for closed systems and open systems. (L3)
- solve simple thermodynamics problems. (L3)
- apply second law of thermodynamics in design of heat engine, refrigerator and heat pump.(L3)
- enumerate the causes for poor performance of thermodynamic systems.(L3)

UNIT II **8 Hrs**

Entropy and Availability

Entropy: Clausius inequality -Concept of Entropy- entropy equation for different processes and systems Availability and Irreversibility: Definition of exergy and energy, expressions for availability and irreversibility. Availability in steady flow, non-flow processes, irreversibility.

Learning outcomes

At the end of this Unit, the student will be able to

- apply entropy affects to estimate the performance of systems. (L3)
- evaluate entropy changes in a wide range of processes and determine the reversibility or irreversibility of a process.(L3)

explain thermo-economics.(L3

UNIT III **8 Hrs**

Thermodynamic relations and Properties of pure substance

Thermodynamic Relations: Maxwell relations, TdS equations, difference in heat capacities, ratio of heat capacities,Energy equation, Joule Thompson coefficient, Clausius-Clapeyron equation. Properties of Pure substance: Pure Substances, P-V-T surfaces, T-s and h-s diagram, Mollier chart, dryness fraction, property tables, analysis of steam undergoing various thermodynamic processes using Mollier chart– steam calorimetry.

Vapour Power Cycles: simple Rankine cycle, concepts of regeneration and reheat, analysis of Rankine Cycle.

Learning outcomes

At the end of this Unit, the student will be able to

- apply properties of steam to design steam systems.(L3)
- examine steam systems using conservation equations.(L3)
- evaluate the performance of steam systems.(L4)

UNIT IV **8 Hrs**

Gas Power cycles

Gas Power Cycles: Otto, Diesel and dual cycles, Brayton cycle, Sterling Cycle, Atkinson Cycle, Ericsson Cycle, Lenoir Cycle, representation on P-V and T -S diagrams - description and efficiencies, mean effective pressures. Comparison of Otto, Diesel, and dual cycle

Learning outcomes

At the end of this Unit, the student will be able to

- examine the importance of compression ratio. (L2)
- explain the cycles on which internal combustion engines work. (L3)
- understand working of IC engines on the basis of thermodynamic cycles. (L2)
- Evaluate the cycles used in gas turbines. (L4)

UNIT V **8 Hrs**

Refrigeration, Psychrometry, and Airconditioning

Refrigeration: Bell-Coleman cycle - vapour compression cycle, effect of vapour condition on COP of VCR, vapour absorption cycle, properties of common refrigerants Principles of Psychrometry and Air Conditioning: Psychometric terms, psychometric processes and air conditioning systems.

Learning outcomes:

After completion of this unit, students will be able to

- Outline the operation of refrigerators. (L2)
- identify different refrigerants and applications.(L3)
- Use properties of moist air in calculations for air-conditioning system. (L3)

Text Books

1 1 P.K.Nag,EngineeringThermodynamics, 5/e, Tata McGrawHill, 2013

2 Yunus A. Cengel, Michaela A. Boles, Thermodynamics, 7/e, Tata McGraw Hill, 2011.

3

Reference Books

1 J.B.Jones and G.A.Hawkins, Introduction to Thermodynamics, 2/e, John Wiley & Sons,2012.
2 Moran, Michael J. and Howard N. Shapiro, Fundamentals of Engineering Thermodynamics, 3/e, Wiley, 2015
3 Claus Borgnakke Richard E. Sonntag, Fundamentals of Thermodynamics, 7/e, Wiley, 2009
4 R.K. Rajput, S.Chand& Co., Thermal Engineering, 6/e, Laxmi publications, 2010.

Evaluation Procedure						
Continuous Evaluation	**Total 70 Marks**					
	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2
Sem End Examination	Total 30 Marks					

Course Outcome - Programe Outcome Mapping														
Course Outcomes :	**Programme Outcomes**													
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	3	2	1								2		3	3	1
2		3			1						2		3	3	0
3	2			1	2	1							3	3	0
4	3	2	1	2	2	3					2		3	3	1
5	3	2	1	2	2	3					2		3	3	1
6															

Course Code	Course Title	L	T	P	J	S	C
	PC3: MATERIAL SCIENCE AND ENGINEERING	3	0	0	0	0	3
Course Owner	Department of MechanicalEngineering	**Syllabus version**				1.0	
Course Pre-requisite(s)	• Basic atomic structures • Modern periodic table • Chemical reactions	**Contact hours**				30	
Course Co-requisite(s)	• Various mechanical properties of materials • Stress strain diagram	**Date Approved**					
Alternate Exposure							

Course Description:

The focus of the course is on crystal structures of metals. The course addresses both theoretical and practical aspects of materials engineering. It imparts knowledge on the microstructure, mechanical properties and heat treatment methods of ferrous and nonferrous metals and alloys. This course also gives an insight in to the properties and applications of ceramics, polymers, composites and nanomaterials.

Course Objectives:

1. To teach the principles of physical metallurgy, i.e. crystallography of metals, constitution of alloys andconstruction of phase diagrams.
2. To explain the methods to change the properties of steels through various heat treatment processes.
3. To explain the properties and applications of commercially important steels and cast irons with theirengineering constraints.
4. To explain the properties and applications of important non ferrous metals/alloys.
5. To familiarize students with the structure, properties and applications of ceramics, polymers, compositematerials and nanomaterials.

Course Outcomes:

1. Explain the crystallography of metals, constitution of alloys and also can construct binary phase diagrams.(L2)
2. Select an appropriate heat treatment method to modify the properties of steels. (L3)
3. Select a suitable type of steel, cast iron for a given application. (L3)
4. Choose an appropriate non ferrous metal/alloy for various applications. (L3)
5. Explain the structure, properties and applications of composite, polymer, ceramicmaterials and nanomaterials. (L2)

UNIT I **8Hrs**

Crystal Structure of Metals

Crystal Structures: UNIT cells, Metallic crystal structures. Imperfection in solids: Point, Line and Volumeimperfections.

Constitution of Alloys: Necessity of Alloying, substitutional and interstitial solid solutions, Intermediate alloyphases.

Phase diagrams: Phase rule, methods of construction of phase diagrams, lever rule. Eutectic, peritectic, peritectoidand monotectic reactions.

Learning Outcomes::

At the end of this **UNIT** the student will be able to

• Recall crystallography of various metals.(L1)

• Distinguish between metals and alloys. (L4)

• Construct binary phase diagrams.(L3)
• Identify various invariant reactions in binary phase diagrams.(L3)

UNIT II **8Hrs**

Heat treatment of steels

Iron – Iron carbide diagram: Study of Iron - Iron carbide diagram and microstructural aspects of ferrite, cementite,austenite, ledeburite and pearlite.

Heat Treatment of Steels: Annealing, normalizing, hardening and tempering. Isothermal transformation diagrams for steels and microstructure development. Continuous cooling curves and interpretation of final microstructures and properties. Austempering martempering. Case hardening: Carburizing, nitriding, cyaniding, carbo-nitriding, flame and induction hardening.

Learning Outcomes::

At the end of this **UNIT** the student will be able to

• Construct iron iron-carbide diagram and identify phases in it. (L4)
• Explain the importance of heat treatment of metals and alloys. (L2)
• Summarize the effect of heat of treatment on modification of properties of steels. (L2)
• Develop a heat treatment cycle based on properties required. (L3)
• Explain the principles of various surface hardening methods. (L2)

UNIT III **8Hrs**

Steels and cast irons

Steels: Plain carbon steels, use and limitations of plain carbon steels. Classification of alloys steels. Microstructure,properties and applications of alloy steels - stainless steels and tool steels. Cast Irons: Microstructure, properties and applications of white cast iron, malleable cast iron, grey cast iron and nodular cast irons.

Learning Outcomes::

At the end of this **UNIT** the student will be able to

• Explain the uses and limitations of plain carbon steels. (L2)
• Classify various types of alloy steels and explain their microstructure, properties and applications. (L2)
• Identify various types of cast irons and explain their microstructure, properties and applications. (L3)
• Compare properties of steels and cast irons and their limitations. (L4)

UNIT IV **8Hrs**

Non-ferrous Metals and Alloys

Non-ferrous Metals and Alloys: Microstructure, properties and applications of copper and its alloys, aluminium and its alloys. Study of Al-Cu phase diagram, precipitation hardening. Microstructure, properties and applicationsof titanium and its alloys.

Learning Outcomes::

At the end of this **UNIT** the student will be able to

• Identify the differences between ferrous and non-ferrous metals and alloys. (L3)
• Explain the importance of non-ferrous metals and alloys in engineering applications. (L2)
• Explain various microstructures, properties and applications of commercially important non-ferrous alloys. (L2)
• Identity the difference between hardening method of ferrous and non-ferrous alloys. (L3)

UNIT V **8Hrs**

Ceramics, Polymers and Composites

Ceramics, Polymers and Composites: Structure, properties and applications of ceramics, polymers and composites.Introduction to super alloys and nanomaterials.

Learning Outcomes::

At the end of this **UNIT** the student will be able to

- Explain the structure, properties and applications of ceramics. (L2)
- Summarize the structure and properties of polymers and composites and their uses. (L2)
- Explain the properties of nanomaterials and their applications.(L2)
- Identify the difference between the micro and nano scale materials and their uses. (L3)

Text Books

1. S.H. Avner, Introduction to Physical Metallurgy, 2/e, Tata McGraw Hill, 1997.
2. R. Balasubramaniam, Callister's, Material Science and Engineering, 2/e, Wiley India, 2014.

Reference Books

1. Y. Lakhtin, Engineering Physical Metallurgy, University Press of the Pacific, 2000.
2. V. Raghavan, Material Science and Engineering, 5/e, Prentice Hall of India, 2004.
3. L.H. VanVlack, Elements of Material Science and Engineering, 6/e, Pearson Education, 2008.

Evaluation Procedure						
Continuous Evaluation	**Total 70 Marks**					
	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2
	10	10	10	10	15	15
Sem End Examination	Total 30 Marks					

Course Outcome - Programe Outcome Mapping															
Course Outcomes :	**Programme Outcomes**														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	3	0	0	0	1	1	0	0	0	1	1	1	0	0	1
2	3	3	3	0	1	1	0	0	0	1	1	1	0	0	1
3	3	0	3	0	1	1	0	0	0	1	1	1	0	0	1
4	3	3	3	0	1	1	0	0	0	1	1	1	0	0	1
5	3	2	0	0	1	1	0	0	0	1	1	1	0	0	1
6															

	Course Code	Course Title	L	T	P	J	S	C
		METALLURGY LABORATORY	0	0	2	0	0	1
	Course Owner	Department of MechanicalEngineering	**Syllabus version**				1.0	
	Course Pre-requisite(s)	Structure of metals Microscope lens	**Contact hours**				30	
	Course Co-requisite(s)	None	**Date Approved**					
	Alternate Exposure							

Course Description

The metallurgy lab is mainly intended to study the microstructures of various metals and alloys through the metallography techniques. Metallography consists of the microscopic study of the microstructural characteristics of a metal or alloy. It is possible to determine grain size and the size, shape and distribution of various phases andinclusions which have great effect on the mechanical properties of the metal. The lab is also intended to study themicrostructures of various heat treated alloys.

Course Objectives:

1. Explain the method of preparation of specimen to observe microstructure of given pure metals.
2. Make the students learn about the microstructure of steels.
3. Provide necessary hands on experience on studying the microstructures of cast irons and non ferrousmetals and alloys.
4. Give hands on experience on study of microstructures of heat treated steels.
5. To give practical knowledge on measuring the hardness of steels.

Course Outcomes:

1. Prepare the specimen to observe microstructure of given pure metals.
2. Study the microstructure of steels.
3. Study the microstructures of cast irons and non ferrous metals and alloys.
4. Study the microstructures of heat treated steels.
5. Measure the hardness of steels and non ferrous metals and alloys.

List of Experiments:

1. Preparation and study of crystal structure models of simple cubic, body centred cubic, face centred cubicand hexagonal close packed structures.
2. Preparation and study of microstructure of pure metals like iron, copper and aluminium
3. Preparation and study of microstructure of mild steels, low carbon steels and high – c- steels
4. Preparation and study of microstructures of white, malleable, grey and nodular cast irons
5. Preparation and study of microstructures of aluminium alloys
6. Preparation and study of microstructures of copper alloys
7. Preparation and study of microstructures of annealed, normalized and hardened steels.
8. Preparation and study of microstructures of welds.
9. To find out the hardness of annealed, normalized and hardened steels.
10. To find out the microstructure and hardness of cold worked specimen
11. To find out the hardness of welded specimen across various zones
12. To find the corrosion potentials of different metals and alloys

Evaluation Procedure														
Continuous	**Total 100 Marks**													
	Exp1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8	Exp 9	Exp10	Exp11	Exp12	Exp13	Exp14
	0	10	10	10	10	10	10	10	10	10	10			

Evaluation	Exp15													
Term End Examination	Total XX Marks													

Course Outcome - Program Outcome Mapping															
Course Outcomes :	**Programme Outcomes**														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	2	1	3	0	0	0	0	0	0	0	1	0	1	1	0
2	2	1	3	0	1	0	0	0	0	2	1	0	2	2	0
3	2	1	3	0	0	0	0	0	0	0	1	0	0	0	0
4	2	1	3	0	0	0	0	0	0	0	1	0	0	0	0
5	2	0	3	0	0	0	0	0	0	0	1	0	0	0	0
6															

<table>
<tr><td rowspan="6"></td><td>Course Code</td><td>Course Title</td><td>L</td><td>T</td><td>P</td><td>J</td><td>S</td><td>C</td></tr>
<tr><td>PC0</td><td>PC0: COMPUTER AIDED MACHINE DRAWING</td><td>0</td><td>0</td><td>4</td><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Course Owner</td><td>Department of Mechanical Engineering</td><td colspan="4">Syllabus version</td><td colspan="2">1.0</td></tr>
<tr><td>Course Pre-requisite(s)</td><td>Engineering Visualisation andProduct Realisation</td><td colspan="4">Contact hours</td><td colspan="2">30</td></tr>
<tr><td>Course Co-requisite(s)</td><td>None</td><td colspan="4">Date Approved</td><td colspan="2"></td></tr>
<tr><td>Alternate Exposure</td><td colspan="7"></td></tr>
</table>

Course Description

This course familiarizes the students to representation of mechanical components such as threads, keys, joints etc.and introduces modeling software to represent assembling and disassembling of mechanical components with emphasis on dimensioning and tolerance. This course acts as a prerequisite to computer aided engineering software to perform structural and thermal analysis on structures.

Course Objectives:

1 Introduce conventional representations of materials and machine components.
2 Train to use software for 2D and 3D modelling and create of 2D assembly drawings from3D assemblies
3 Expose with thread profiles, riveted, welded and key joints
4 Teach solid modelling of machine parts and their sections
5 Familiarize with limits, fits and tolerances in mating components

Course Outcomes:

1 Demonstrate the conventional representations of material and machine components.
2 Model riveted, welded and key joints using CAD system
3 Create solid models and sectional views of machine components
4 Generate solid models of machine parts and assemble them
5 Translate 3D assemblies into 2D drawings

List of Experiments:

1. Drawing of thread profiles. Hexagonal and square-Headed bolts and nuts
2. Bolted joint, bolted joint with washer and lock nut, stud joint, screw joints
3. Riveted joints: Drawing of rivet, lap joint, butt joint with single strap, single riveted, double riveteddouble strap joints
4. Keys: Taper key, sunk taper key, round key, saddle key, feather key, woodruff key.
5. Shaft coupling: bushed pin-type flange coupling, universal coupling, Old ham's coupling.
6. Screw Jack Assembly and Lathe Tail Stock Assembly drawings
7. Connecting rod and Knuckle Joint Assembly Drawings
8. Limits fits and tolerances Usage In Production drawing
9. Detailed part drawings of CROSS HEAD AND ECCENTRIC
10. Welded joints: Lap joint and T joint with fillet, butt joint with conventions

Text Books

1. N D Bhatt,' Machine Drawing', 50th,Charotar Publishing House,Gujarat,India, 2016, 9789380358895
2. K L Narayana,P Kannaiah,K Venkat Reddy,'Production Drawing',3rd,New Age International, New Delhi,India, 2014, 9788122435016

Reference Books

1. Cecil Jensen, Jay Helsel and Donald D. Voisinet, Computer Aided Engineering Drawing, Tata McGrawHill, 2000
2. K.L. Narayana, Production Drawing, 3/e, NewAge International Publishers, 2014

Online Resources

1 https://www.youtube.com/watch?v=vcPF-l8waEA(Lathe Tail Stock)
2 https://www.youtube.com/watch?v=r7ajkX1DrYw(Screw Jack)
3 https://www.youtube.com/watch?v=I4KiyOK-cJI(UNIVERSAL COUPLING)
4 https://www.youtube.com/watch?v=CdQ7B6tHwLU(Eccentric animation)

Mapping	**Experiment Related Books**													
	Exp1	Exp2	Exp3	Exp4	Exp5	Exp6	Exp7	Exp8	Exp9	Exp10				
	TB1	TB1	TB1	TB1	TB1	TB1	TB1	TB1	TB2	TB2				

Evaluation Procedure														
Continuous Evaluation	**Total 100 Marks**													
	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8	Exp 9	Exp10				
	10	10	10	10	10	10	10	10	10	10				
Term End Examination	Total 100 Marks													

Course Outcome - Program Outcome Mapping															
Course Outcomes :	**Programme Outcomes**														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	3	2	3	0	3	0	0	0	1	0	0	0	3	0	1
2	1	1	1	0	2	0	0	0	1	0	0	0	0	1	0
3	1	2	3	0	2	0	0	0	1	0	0	0	2	1	1
4	1	3	3	0	2	0	0	0	1	0	0	0	3	1	0
5	1	3	3	0	2	0	0	0	2	0	0	0	2	1	1
Date of Approval															

SEMESTER – IV

Course Code	Course Title	L	T	P	J	S	C
PC4	PC4: MANUFACTURING PROCESSES	3	0	0	0	0	3
Course Owner	Department of MechanicalEngineering	**Syllabus version**				1.0	
Course Pre-requisite(s)	Knowledge in material scienceKnowledge in mechanics Knowledge in basic mathematics	**Contact hours**				30	
Course Co-requisite(s)	Modern manufacturing methods Automation in manufacturing	**Date Approved**					
Alternate Exposure							

Course Description:

This course emphasizes the basics of various manufacturing processes so that the student will able to choose an appropriate manufacturing process for a given application. The course enables the students of mechanical engineering to gain hands on experience and skills necessary to perform traditional manufacturing operations such as moulding, casting and welding. It also introduces the students to modern manufacturing techniques such as development of components and use of power tools. The major objective of this course is to make sure that all the mechanical engineering graduates gain practical exposure to manufacturing methods and various manufacturingtools.

Course Objectives:

1. To explain different casting processes, metal forming, rolling and extrusion processes.
2. To familiarize with different welding processes and welding defects and forging and sheet metal formingmethods.
3. To teach various cutting tools, lathe operations and shaping and slotting machine operations.
4. To impart various metal cutting processes like milling and grinding.
5. To explain the principles of drilling and boring operations

Course Outcomes:

1. Explain the principles of various casting processes, metal forming, rolling and extrusion processes. (L2)
2. Explain forging, sheet metal forming and various metal joining processes. (L2)
3. Explain the basic principles of lathe, shaping, slotting and planning operations. (L2)
4. Explain the Milling and grinding operations. (L2)
5. Explain drilling and boring operations. (L2)

Specific Instructional Objectives

1. Student will select the right casting, metal forming, rolling and extrusion process for aspecific application.
2. Student will select the rightforging, sheet metal and metal joining process for a specific application.
3. Student will chose the right milling, grinding, drilling and boring operation for a specific application.

UNIT I **10 Hrs**

Introduction: Importance and selection of manufacturing processes. Casting Processes: Introduction to casting process. Process steps. Pattern: types, materials and allowance.

Cores: Types of cores, core prints. Principles and design of gating system. Various casting defects. Metal Forming: Introduction, nature of plastic deformation, hot and cold working of metals, mechanics of metal forming. Rolling: Principle, types of rolling mill and products, roll passes. Extrusion: Basic extrusion process and its characteristics, hot extrusion and cold extrusion, wire drawing, tube drawing.

Learning Outcomes::
At the end of this **UNIT** , the student will be able to
• Select suitable manufacturing process for a given product. (L3)
• Describe steps involved in metal casting, pattern making. (L2)
• Choose gating systems and risers. (L3)
• Identify the various casting defects. (L3)
• Compare cold working and hot working processes. (L2)
• Explain the working of rolling mills. (L2)
• Evaluate the forces and power in rolling and extrusion processes. (L3)
• Summarize the working of various extrusion processes. (L2)

UNIT II **9 Hrs**

Forging: Principle of forging. Types: Smith forging, drop forging, forging hammers, rotary forging and forging defects. Sheet metal forming: Mechanics of sheet metal working, blanking, piercing, bending, stamping. Metal Joining Processes: Classification of welding processes, types of welds and welded joints, arc welding, weld bead geometry, submerged arc welding, gas tungsten arc welding, gas metal arc welding. Applications, advantages anddisadvantages of the above processes. Soldering and brazing: Types and their applications. Welding defects: causesand remedies.

Learning Outcomes::
At the end of this **UNIT** , the student will be able to
• Identify the principles of forging, tools and dies. (L3)
• Summarize the various operations of sheet metal forming. (L2)
• Classify various welding processes. (L2)
• Summarize the applications, advantages of various welding processes. (L2)
• Identify the defects in welding. (L3)

UNIT III **10 Hrs**

Lathe and Lathe Operations: Principle of working, specifications, types of lathes, operations performed, work holders and tool holders. Taper turning, thread turning attachments for lathes. Turret and capstan lathes - Principle of working, collect chucks, other work holders - tool holding devices. Shaping, Slotting and planning machines - Principles of working - principal parts, specification, classification, operations performed, machining time calculations.

Learning Outcomes:
At the end of this **UNIT** , the student will be able to
- Explain the specifications and operations performed lathe and shaping machines.(l2)
- Understand the principles of lathe operations. (l2)
- Identify parts of lathe, slotting, shaping and planning machines.(l2)
- Differentiate shaping, slotting and planning processes (l2)

UNIT IV **8 Hrs**

Milling operations and Milling machines-Principle of working, specifications. Classifications of milling machines,machining operations.
Grinding and grinding machines: Grinding process, types of grinding machines, grinding process parameters,honing, lapping, other finishing processes.

Learning Outcomes::
At the end of this **UNIT** , the student will be able to
- Explain the specifications and operations performed milling and grinding machines.(l2)

- Understand the principles of abrasive processes. (l2)
- Identify parts of milling and grinding machines.(l2)

UNIT V **8 Hrs**

Drilling and Drilling Machines: Principle of working, specifications, types and operations performed. Tool holdingdevices. Nomenclature of twist drill.
Boring and Boring Machines- Principle of working, specifications, types, and operations performed - tool holdingdevices - nomenclature of boring tools.

Learning Outcomes:
At the end of this unit, the student will be able to
- Explain the specifications and principle of working of drilling and boring machines.(l2)
- Explain various operations performed on drilling and boring machines (l2)
- Identify parts of drilling and boring machines.(l2)

Text Books
1. S. Kalpakjain and S.R.Schmid, Manufacturing Engineering and Technology, 7/e, Pearson, 2018.
2. P.N.Rao, Manufacturing Technology – Volume I, 5/e, McGraw-Hill Education, 2018.
3. P.N. Rao, Manufacturing Technology: Metal Cutting and Machine Tools, (Volume 2), 5/e,Tata McGraw-Hill Education, 2018

Reference Books

1 P.C.Sharma, A Text book of Production Technology, 8/e, S Chand Publishing, 2014.
2 P. Mikell. Groover, Fundamentals of Modern Manufacturing: Materials, Processes and Systems,4/e,
John Wiley and Sons Inc, 2010

Evaluation Procedure						
Continuous Evaluation	**Total 70 Marks**					
	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2
	10	10	10	10	15	15
Sem End Examination	Total 30 Marks					

Course Outcome - Programe Outcome Mapping															
Course Outcomes :	**Programme Outcomes**														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	3	3	3	0	2	1	0	1	1	2	1	1	1	0	1
2	3	3	3	0	2	1	0	1	1	2	1	1	1	0	1
3	3	3	3	0	2	1	0	1	1	2	1	1	1	0	1
4	3	3	3	0	2	1	0	1	1	2	1	1	1	0	1
5	3	3	3	0	2	1	0	1	1	2	1	1	1	0	1
6															

	Course Code	Course Title	L	T	P	J	S	C
		MANUFACTURING PROCESSES LABORATORY	3	0	2	0	0	4
	Course Owner	Department of MechanicalEngineering	**Syllabus version**				1.0	
	Course Pre-requisite(s)	Knowledge of basic equipmentoperation.	**Contact hours**				30	
	Course Co-requisite(s)	None	**Date Approved**					
	Alternate Exposure							

Course Description

The Manufacturing Processes (MP) Laboratory provides students with the opportunity to study and practice manufacturing processes. This lab provides students experiential learning with the nature and technique of manufacturing processes. Students can set up and operate machines, manufacture parts, measure process variables,and inspect manufactured parts. Skills acquired from time in the lab are integrated with prior and subsequent learning of other engineering topics such as engineering materials and quality planning and control. The MP Laboratory includes facilities to demonstrate and explore examples of casting, moulding, forming, machining, heat-treating, and joining processes.Course Objectives:

1 Explain the method of preparation of moulds using patterns.
2 Make the students learn how to make different types of welded joints.
3 Provide necessary hands on experience on using of lathe, drilling, and milling machines
4 Give hands on experience on shaping, planning and slotting machines.
5 To give sufficient practical knowledge on grinding operations.

Course Outcomes:

1 Understand the procedure of making moulds using patterns and preparation of casting.
2 Make different types of welded joints using various welding machines.
3 Gain hands on experience on using of lathe, drilling, milling machines
4 Gain hands on experience on shaping, planning and slotting machines.
5 Gain practical knowledge on grinding operations.

List of Experiments:

1 Preparation of a green sand mould using single piece pattern and split pattern
2 Preparation of aluminium alloy specimen by stir casting technique
3 Lap joint, butt joint and T joint using arc welding.
4 Lap Joint Using TIG Welding.
5 Lap Joint Using MIG Welding.
6 Lap joint using resistance spot welding.
7 Job on step turning, taper turning, knurling, thread cutting on lathe machine.
8 Perform drilling, reaming and tapping operations.
9 Job on milling (Groove cutting/Gear cutting).
10 Job on shaping and planning.
11 Job on slotting.
12 Job on cylindrical and surface grinding.

Evaluation Procedure														
Continuous Evaluation	**Total 100 Marks (Any 10 experiments)**													
	Exp1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8	Exp 9	Exp10	Exp11	Exp12	Exp13	Exp14
	0	10	10	10	10	10	10	10	10	10	10	10		
	Exp15													

Term End Examination	Total XX Marks

Course Outcome - Program Outcome Mapping															
Course Outcomes :	**Programme Outcomes**														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	1	3	3	0	1	1	0	1	1	2	1	2	1	0	1
2	1	3	3	0	1	1	0	1	1	2	1	2	1	0	1
3	1	3	3	0	1	1	0	1	1	2	1	2	1	0	1
4	1	3	3	0	1	1	0	1	1	2	1	2	1	0	1
5	1	3	3	0	1	1	0	1	1	2	1	2	1	0	1
6															

	Course Code	Course Title	L	T	P	J	S	C
	PC5	**PC5: STRENGTH OF MATERIALS**	4	0	2	0	0	5
	Course Owner	Department of Mechanical Engineering	Syllabus version				1.0	
	Course Pre-requisite(s)	Engineering Mechanics: Statics	Contact hours				30	
	Course Co-requisite(s)	None	Date Approved					
	Alternate Exposure	Mathematics						

Course Description

This course helps in understanding the material behaviour of solid structures such as beams, shafts and other members. It covers the design calculations related to safety, reliability and life of structures and other mechanical components and hence central to the whole activity of engineering design.

Course Objectives:

1 Introduce the concepts of stresses, strains and their relationships.
2 Explain shear force and bending moment diagrams and to calculate stresses in beams.
3 Impart the concept of biaxial stresses and strains and their application in thin cylinders.
4 Teach stresses and strains in a circular shaft subject to various types of loads.
5 Describe energy methods and theories of failure.

Course Outcomes:

1 Understand the concepts of stress and strain due to various types of loading. (L2)
2 Draw shear force and bending moment diagrams and calculate stresses in beams. (L3)
3 Determine principal stresses and power transmitted by shafts (L3)
4 Analyse the stresses and strains in thin cylinders and spheres (L4)
5 Evaluate the structural integrity of components using theories of failure (L5)

Specific Instructional Objectives

1. Images and results of failure of different type's materials
2. Demonstration of software for plotting of stress-strain data and shear force and bending moment diagrams
3. Solving of problems modelled on GATE/IES and other competitive exams

UNIT I **10 Hrs**

Simple Stresses and Strains & Axial Stresses

Simple Stresses and Strains: Introduction to stresses and strains, Stress-Strain Diagram – Application to various materials: Ductile and Brittle, Types of Loads & Stresses (elastic materials) – Axial, Bending, Torsional, Differenttypes of elastic Moduli – Relationship between them.

Axial Stresses: Simple and Compound bars, Taper bars, Thermal stresses in axial bars

Learning Outcomes:

After completing this unit , the student will be able to

• determine the stresses and deformations due to axial loads in simple structures. (L3)
• understand the relationships between various elastic constants. (L1)
• analyse the stresses in bars due to temperature change.(L4)

UNIT II **10 Hrs**

Bending of Beams & Stresses in Beams

Bending of Beams: Euler beam theory, Types of beams – simply supported, cantilever and overhang beams,Shear force and Bending Moment diagram

Stresses in Beams: Flexural formula, Bending stresses in beams, Shear stresses in beams.

Learning Outcomes::

After completing this **UNIT** , the student will be able to

• draw shear force and bending moment diagrams for various types of loading (L3)
• determine bending and shear stresses in beams under different loading. (L3)

UNIT III **8 Hrs**

Complex stresses & Torsion of Circular Shafts

Complex stresses: Biaxial state of stress with and without shear- principal stresses - Mohr's circle.

Torsion of Circular Shafts: Torsion equation - solid and hollow circular shaft, Torsional rigidity - power transmittedby the shafts.

Learning Outcomes::

After completing this **UNIT** , the student will be able to

- construct the Mohr’s circle for calculating principal stresses. L3)
- analyse circular shafts subjected to twisting couple. (L4)
- determine stresses in shafts subjected to combined loads.(L3)

UNIT IV **8 Hrs**

Thin Cylinders & Stresses due to combined loadings

Thin Cylinders: Stresses in thin cylindrical and spherical shells, Volumetric change in thin pressure vessels.Stresses due to combined loadings: Combined stresses due to axial load, torsion, bending, and shear.

Learning Outcomes::

After completing this **UNIT** , the student will be able to

- assess hoop and longitudinal stresses in thin cylinders. (L3)
- calculate volumetric strains in thin cylinders. (L3)
- determine stresses in members subjected to combined loads.(L3)

UNIT V **9 Hrs**

Energy Methods & Theories of Failure

Energy Methods: Strain Energy due to Axial Loading, Bending, Torsion and Transverse loading Theories of Failure: Yield Criteria for Ductile Materials: Maximum-Shearing-Stress Criterion, Maximum- Distortion-Energy Criterion. Fracture Criteria for Brittle Materials: Maximum-Normal-Stress Criterion, Mohr’s Failure Criterion.

Learning Outcomes::

After completing this **UNIT** , the student will be able to

- Compute the strain energy due to axial, bending, and torsion loading
- Analyse failure criterion based on theories of failure for ductile and brittle materials.

Text Books

1. F. P. Beer, E. R. Johnston Jr., J. T. DeWolf, D. F. Mazurek & S. Sanghi, Mechanics of Materials,8/e,
   McGraw Hill Education (India) , 2020.
2. S. S. Rattan, Strength of materials, 3/e, Tata McGraw-Hill, 2016.

Reference Books

1 R. C. Hibbeler, Mechanics of Materials (SI Edition), 9/e, Pearson Education, 2018.
2 B. C. Punmia, Ashok K. Jain, Arun K. Jain, Mechanics of Materials, R/e, Laxmi Publications, 2017.

Evaluation Procedure						
Continuous Evaluation	Total 70 Marks					
	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2
	10	10	10	10	15	15

Evaluation Procedure						
Continuous Evaluation	Total 70 Marks					
	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2
	10	10	10	10	15	15

Sem End Examinatio n	Total 30 Marks

Course Outcome - Programe Outcome Mapping															
Course Outcomes :	Programme Outcomes														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	3	1	1	1	0	1	0	0	0	0	1	1	3	2	1
2	3	1	3	1	0	1	0	0	0	0	1	1	3	2	1
3	3	1	3	1	0	1	0	0	0	0	1	1	3	2	1
4	3	1	2	1	0	1	0	0	0	0	1	1	3	2	1
5	3	1	3	1	0	1	0	0	0	1	1	1	3	2	1
6															

Course Code	Course Title	L	T	P	J	S	C
	Strength of Materials (Laboratory)	3	0	2	0	0	4
Course Owner	Department of MechanicalEngineering	**Syllabus version**	1.0				
Course Pre-requisite(s)	Knowledge of strength of materials and engineeringmechanics .	**Contact hours**	30				
Course Co-requisite(s)	None	**Date Approved**					
Alternate Exposure							

Practical Experiments

Topic	Type
Preparation of tensile testing samples using ASTM or ASME standards.	Exercise
Metallographic sample preparation (Mounting and Polishing)	Exercise
Study the Stress Strain Characteristics of Metals by using UTM (analysis of Tensile Stress-Strain Data).	Experiment
Compression test using UTM – Applications & comparison with Tensile results	Experiment
Determination of hardness using different hardness testing Machines-Brinnels, MicroVickers, andRockwells.	Experiment
Impact Test by using Izod and Charpy Methods.	Experiment
Deflection test on Beams using UTM.	Experiment
Torsion Test on Circular Shafts.	Experiment
Creep and Stress Relaxation tests	Experiment
Fatigue Test – Analysis of results	Exercise

Course Code	Course Title	L	T	P	J	S	C
PC6	PC6: APPLIED THERMODYNAMICS	4	0	2	0	0	5
Course Owner	Department of MechanicalEngineering	**Syllabus version**				1.0	
Course Pre-requisite(s)	Thermodynamics	**Contact hours**				30	
Course Co-requisite(s)	None	**Date Approved**					
Alternate Exposure							

Course Description

The course Applied Thermodynamics is the application of the Engineering Thermodynamics. This course mainly focus on air-standard and vapour cycles where thermodynamic process involving energy conversion takes place in power plants, compressors, turbines or rocket engines, IC engines. The knowledge of this course is essential in solving several practical applications in the power sector

Course Objectives:

1 provide fundamental concepts of thermodynamic cycles used in steam power plants, IC engines and gasturbines
2 familiarize the performance parameters and combustion process in SI and CI engines
3 familiarize concepts of thermodynamic cycles used in steam power plants and gas turbines
4 impart knowledge on the working of nozzles, and compressors
5 to understand the working of rockets and jet propulsions

Course Outcomes:

1. Compare thermodynamic relations and air standard cycles. (L2)
2. Explain working of IC engines with combustion process. (L2)
3. Conduct engine test to determine performance characteristics
4. Apply energy balance to design vapour power and gas power cycles.(L3)
5. Apply the principles of jet propulsions and rocketry for different applications.(L3)

UNIT I

IC Engines

IC Engines: Components, classification and working of IC engines, comparison of two stroke and four stroke engines, comparison of SI and CI Engines, Valve and Port Timing Diagrams, Fuel systems- simple carburettor,Multi point fuel injection, Common rail Direct Injection system, Cooling systems and lubricating systems.

Ignition system - Battery, Magneto and Electronic systems.

Learning outcomes

At the end of this Unit, the student will be able to

- examine the importance of compression ratio. (L2)
- explain the cycles on which internal combustion engines work. (L3)
- understand working of IC engines on the basis of thermodynamic cycles. (L2)

UNIT II

Performance of IC Engines

Performance test - Measurement of Brake power, Indicated power, Fuel consumption, Air consumption; Heat balance test, Morse test and Retardation test on IC engine. Combustion process - pre ignition, Knocking and detonation, Fuel requirements, Cetane number and Octane number

Learning outcomes :

After completion of this unit, students will be able to

- Estimate engine performance. (L4)
- Identify the effects of abnormal combustion in IC engines. (L3)

UNIT III

Nozzles and steam turbines
Nozzles: Type of nozzles, Compressible flow through nozzle- condition for maximum discharge - nozzleefficiency.
Steam Turbines: Impulse and reaction principles, compounding of steam turbines, velocity diagrams Work doneand efficiency
Learning outcomes:
After completion of this unit, students will be able to
- Explain concepts of vapour power cycle used in steam power plant. (L2)
- compare the performance of nozzles, used in turbines. (L2)

UNIT IV
Air compressors
Reciprocating Compressors: Principle of operation, work required
Rotary Compressor (Positive displacement type): Roots Blower, vane sealed compressor, mechanical detailsand principle of working
Dynamic Compressors: Centrifugal compressors: Mechanical details and principle of operation – velocityand pressure variation.
Axial Flow Compressors: Mechanical details and principle of operation
Learning outcomes:
After completion of this unit, students will be able to
- Explain concepts, selection and design of compressors used in industries. (L2)
- compare the performance of differtn types of compressors. (L2)

UNIT V
Gas Turbines, Rockets and Jet propulsions
Gas turbines: Brayton cycle, Simple gas turbine plant, closed cycle and open cycle for gas turbines, Regeneration, Intercooling and Reheating, condition for maximum pressure ratio and optimum pressure ratio, actual cycle

Jet Propulsion: Criteria of performance, gas turbine engines - working, Ramjet engines, pulsejet engines, simpleturbojet engine, simple turbofan engine, simple turboprop engine.
Rocket Propulsion: Rocket engines - rocket engine performance, solid and liquid propellant rockets, comparisonof various propulsion systems.
Learning outcomes:
After completion of this unit, students will be able to
- Evaluate the cycles used in gas turbines. (L4)
- outline the jet propulsion system and rocket propulsion systems (L2)

Text Books

1. Ganesan V, Internal Combustion Engines, Tata McGraw Hill, 2017
2. M.L.Mathur and F.S.Mehta, Thermal Engineering, Jain brothers,2014
3. R K Rajput, Thermal Engineering, lakshmi publications
4. P.L.Ballaney, Thermal Engineering, 2/e, Khanna, 2005.

Reference Books

1. Cengal Y.A and Boles M.A, Thermodynamics: An Engineering Approach, 5/e,
2. Yahya, S. M., Turbines, Compressors and Fans, 4/e, Tata McGraw Hill, 2010
3. Nag P.K, Engineering Thermodynamics, 4/e, Tata McGraw-Hill, 2008
4. Onkar Singh, Thermal Turbomachines, 3/e, Wiley India, 2014

Evaluation Procedure					
Continuous Evaluation	Total 70 Marks				
	Quiz 1	Quiz 2	Quiz 3	Assignment CAT 1	CAT 2
Sem End Examination	Total 30 Marks				

Course Outcome - Programe Outcome Mapping															
Course Outcomes :	**Programme Outcomes**														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	3	3	3	3		3		2	1	2	2	1	3	3	2
2	3	3	3	3		3		2		2	2		3	3	2
3	3	3	3	3		3		2		1	2		3	3	2
4	3	3	3	2		3		2	1	3	2		3	3	2
5	3	3	3	2	2	3		2	1	1	2		3	3	2
Date of Approval													21.05.2021		

	Course Code	Course Title	L	T	P	J	S	C
		Applied thermodynamics (Laboratory)	3	0	2	0	0	4
	Course Owner	Department of MechanicalEngineering	**Syllabus version**				1.0	
	Course Pre-requisite(s)	Knowledge of strength of materials and engineeringmechanics .	**Contact hours**				30	
	Course Co-requisite(s)	None	**Date Approved**					
	Alternate Exposure							

Practical Experiment

Topic	Type
To determine the flash and fire point of any Fuel	Experiment
To Prepare Valve timing diagram 4-stroke diesel engine and Port timing diagram of 2-stroke petrol engine	Experiment
To find the cetane index of diesel oil	Experiment
To prepare Heat balance sheet of 4-stroke multi-cylinder diesel engine and estimate the emissions using gasanalyser and smoke meter	Experiment
To conduct Morse test on multi cylinder petrol engine	Experiment
To conduct Performance Test of Refrigeration system	Experiment
To conduct Performance of Air conditioning system	Experiment
To conduct Performance of heat pipe	Experiment
To conduct Performance Test of 4-stroke multi-cylinder diesel engine	Experiment
To conduct a test to find the viscosity of any liquid	Experiment
to study and Determinations of nozzle characteristics	Experiment
To conduct Performance of heat pump	Experiment

SEMESTER – V

	Course Code	Course Title	L	T	P	J	S	C
	PC7	PC 7: MECHANICS OF MACHINERY	3	0	10	0	0	8
	Course Owner	Department of Mechanical Engineering	**Syllabus version**				1.0	
	Course Pre-requisite(s)	None	**Contact hours**				30	
	Course Co-requisite(s)	None	**Date Approved**					
	Alternate Exposure							

Course Description

Course Objectives:
This course provides adequate knowledge on simple mechanisms along with the kinematic analysis. This course also introduces the concepts of gears, vibrations and balancing of rotating and reciprocating masses. These conceptswill help the students to analyze and design various mechanisms for different applications

1. To introduce various mechanisms and their applications
2. To explain the importance of degree of freedom
3. To familiarize the evaluation of velocity and acceleration in mechanisms
4. To explain gear terminology and the analysis of gears and gear trains
5. To explain the concept of balancing of rotating and reciprocating masses
6. To explain the concept of natural frequency

Course Outcomes:

1. Understand different mechanisms and their inversions
2. Calculate the velocity and acceleration of different links in a mechanism
3. Analyze different gears and gear trains and design the gears for various applications
4. Determine the position and magnitude ofmasses required for balancing of roatating and reciprocatingmachines
5. Calculate the natural frequency of vibrating systems

UNIT I

Simple Mechanisms **8 Hrs**
Classification of mechanisms – Basic kinematic concepts and definitions – Degrees of freedom, Grashof's law, kinematic inversions of four bar chain, single slider, and double slider crank chains - Mechanical advantage- Transmission angle–steering gear mechanisms- Universal Joint – Simple problems.
Learning outcomes:
After completion of this unit, students will be able to

- contrast between machine and structure (L2)
- find degrees of freedom for different mechanisms (L1)
- identify the inversions of four bar mechanism (L3)
- explain the difference between Davis and Ackerman steering gear mechanisms (L2)
- explain Universal joint mechanisms (L2)

UNIT II **12 Hrs**
Velocity and acceleration in Mechanisms
Velocity analysis of simple mechanisms by Instantaneous center method, relative velocity method (graphicalmethod), Kennedy's theorem. Acceleration analysis of simple mechanisms- Slider crank mechanism, Corioliscomponent of acceleration, crank and slotted lever mechanism.
Learning outcomes:

After completion of this unit, students will be able to

- calculate the velocities and acceleration of various links in a mechanism (L4)
- determine instantaneous centers for a given mechanism (L4)
- determine Coriolis component of acceleration (L4)

UNIT III **8 Hrs**

Gears and Gear trains

Classification of Gears, gear terminology, fundamental law of gearing, Involute and cycloidal gear profiles, spurgear contact ratio and interference/undercutting-helical, bevel, worm, rack & pinion gears, Simple, compound,reverted and epicyclic gear train, Analysis of epicyclic gear train, sun and planet gear train, differentials **Learning outcomes:**

After completion of this unit, students will be able to

- explain the different gear profiles and parameters (L2)
- identify different types of gears and application (L3)
- analyze gear trains(L4)

UNIT IV **8 Hrs**

Balancing of rotating and reciprocating masses

Need for balancing, static and dynamic balancing, balancing of single mass and several masses in different planes,using graphical methods. Balancing of reciprocating mass, Balancing of locomotives, effects of partial balancing of locomotives.

Learning outcomes:

After completion of this unit, students will be able to

- explain the importance and need for balancing (L2)
- analyze balancing problems in rotating and reciprocating engines (L4)

UNIT V **10 Hrs**

Vibrations

Introduction, degree of freedom, types of vibrations, free natural vibrations, degree of freedom, Damped vibrations- under damped, critically damped; and over damped systems, logarithmic decrement, forced vibrations with and without damping in single degree of freedom; Vibration isolation and transmissibility, torsional vibrations-two and three rotor systems.

Learning outcomes:

After completion of this unit, students will be able to

- formulate equations of motion and solve for single degree of freedom system with damping. (L5)
- estimate natural frequency of vibratory systems. (L5)
- explain concept of vibration isolation and transmissibility. (L2)

Text Books

1. S.S.Rattan,Theory of Machines, 4/e, Tata Mc-Graw Hill, 2014
2. G.K.Groover, Mechanical Vibrations, 8/e,Nemchand Bros, 2009

Reference Books

1. F. Haidery, Dynamics of Machines, 5/e,NiraliPrakashan, Pune, 2003
2. J.E.Shigley, Theory of Machines and Mechanisms, 4/e, Oxford, 2014
3. P.L.Ballaney, Theory of Machines & Mechanisms, 25/e, Khanna Publishers, Delhi, 2003.

1. Norton, R.L.,Design of Machinery - An introduction to Synthesis and Analysis of Mechanisms and Machines,2/e, McGraw Hill, New York, 2000.

Evaluation Procedure	
	Total 70 Marks

s Evaluation	Quiz 1	Quiz 2	Quiz 3	Assignment CAT 1	CAT 2
Sem End Examination	Total 30 Marks				

Course Outcome - Programe Outcome Mapping															
Course Outcomes :	Programme Outcomes														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	2	1	0	0	0	0	0	0	0	0	0	0	0	1	0
2	1	2	0	0	0	0	0	0	0	0	0	0	0	1	0
3	2	3	1	0	0	0	0	0	0	2	1	0	1	1	0
4	3	3	0	0	0	0	0	0	0	2	1	0	1	1	0
5	3	3	0	0	0	0	0	0	0	2	1	0	1	1	0
6															

Date of Approval	

	Course Code	Course Title	L	T	P	J	S	C
	PC8	**PC 8 FLUID MECHANICS AND MACHINERY**	4	0	2	0	0	5
	Course Owner	Department of MechanicalEngineering	**Syllabus version**				1.0	
	Course Pre-requisite(s)	Students are expected to know the fundamentals of engineeringmechanics, resolving of forces, Statics, Dynamics and flow kinematics.	**Contact hours**				30	
	Course Co-requisite(s)	None	**Date Approved**					
	Alternate Exposure							

Course Description

Mechanics of Fluid is a fundamental subject dealt for Mechanical, Electrical, Chemical, Civil and Aeronautical Engineering branches in an interdisciplinary manner. Machineries associated with fluid handling are of utmost importance for the aforesaid Engineers. The characteristic performances of these machines are studied to ascertain the suitability of the same for the specific purpose. The dynamics of fluid deals with all kinds of understanding theintricacies of the subject. The subject deals with various elements that are used in Hydro Electric power plant and ocean power plant. Various equipment's are studied with their performance like Pelton turbine, Francis Turbine and various other pumps.The purpose of studying this course is to imbibe the basic knowledge on fluid mechanics.This will be useful for Mechanical, civil and electrical engineering students for designing and applying to flow systems. Flow systems are applied for turbines, pumps, pipes etc.

Course Objectives:

1. To impart the knowledge of fluid properties and their behavior in static and dynamic states
2. To acquaint mathematical techniques to fluid flow problems.
3. To introduce the concepts of boundary layer
4. To evaluate the performance of hydraulic turbines
5. To understand the functioning and characteristic curves of pumps

Course Outcomes:

1. Interpret the behavior under static and dynamic conditions. (L3)
2. Analyze one dimensional viscous flows using conservation laws for compressible and incompressible flows.(L4)
3. Apply boundary layer flows for laminar and turbulent regimes. (L5)
4. To select and analyze an appropriate turbine with reference to given situation in powerplants. (L4)
5. To estimate performance parameters of a given Centrifugal and Reciprocating pump. (L5)

UNIT I **9 Hrs**

Fluid Properties and Fluid Statics:

Definition of fluid. Properties of fluid, compressibility, surface tension, vapour pressure, Newton's law of viscosity, Newtonian and Non-Newtonian fluids. Pressure and its measurement, basic principles of hydrostatic forces on surfaces. Fluid kinematics: Classification of flows-steady and unsteady, uniform and non-uniform, laminar and turbulent, rotational and irrational, viscous and inviscid, internal and external flows, continuity equation,stream line, stream tube, stream function, potential function, vorticity and circulation, vortex motion, free and forced vortices.

Learning outcomes:

After completion of this unit, students will be able to

- interpret the properties of fluid and their application (L2)

- select appropriate method for analyzing fluid flow problems (L1)
- understand principles of continuity in fluid motions (L2)

UNIT II **9 Hrs**

Fluid Dynamics and Flow through pipes
Fluid Dynamics: Conservation of momentum, conservation of energy, Euler's equation, Bernoulli's equation Measurement of flow- Venturimeter, Orificemeter and Pitot tube. Flow through pipes: Loss of head due to friction in pipes, Darcy-Weisbach equation - friction factor, minor losses. Laminar and turbulent flow through pipes, Hagen-Poiseuille flow.
Learning outcomes:
After completion of this unit, students will be able to
- convert conservation laws into flow governing equations (L3)
- apply Bernoulli's principle for determining flow in measuring devices (L3)
- solve governing equations for solutions of simple fluid flow problems (L3)
- compute major and minor losses in pipe flows (L4)

UNIT III **9 Hrs**

Boundary layer theory and Impact of jets
Concept of boundary layer, boundary layer thicknesses, von-Karman momentum integral method, effect of pressuregradient, Boundary layer separation, Methods to prevent separation. Hydrodynamic force of jets on stationary and moving flat, inclined, and curved vanes, jet striking centrally and at tip, velocity diagrams, work done and efficiency, flow over radial vanes.
Learning outcomes:
After completion of this unit, students will be able to
- identify importance of boundary layer theory (L3)
- evaluate factors influencing laminar and turbulent flow (L4)
- employ suitable method to control flow separation(L4)

UNIT IV **9 Hrs**

Hydraulic Turbines
Classification of turbines, Heads and efficiencies, impulse and reaction turbines, Pelton wheel, Francis turbine andKaplan turbine-working proportions, work done, efficiencies, hydraulic design –draft tube theory- functions and efficiency. Performance of hydraulic turbines: Geometric similarity, **UNIT** and specific quantities, characteristiccurves, governing of turbines, selection of type of turbine, cavitation, surge tank, water hammer.
Learning outcomes:
After completion of this unit, students will be able to
- identify and design different types of turbines (L3)
- evaluate factors influencing performance of turbines (L4)
- employ suitable method to control cavitation (L4)

UNIT V **9 Hrs**

Centrifugal pumps and Reciprocating pumps
Centrifugal pumps: Classification, working, work done – barometric head- losses and efficiencies specific speed-performance characteristic curves, NPSH. Reciprocating pumps: Working, Discharge, slip, indicator diagrams.
Learning outcomes:
After completion of this unit, students will be able to

- identify and design different types of pumps (L3)
- evaluate factors influencing performance of pumps(L4)

Text Books

1 S K Som, Gautam Biswas, S. Chakraborty, Introduction to Fluid Mechanics and FluidMachines, McGraw Hill Education, 2017
2 Y.A. Cengel and J.M. Cimbala, Fluid Mechanics - Fundamentals and Applications, 3/e, TataMcGraw Hill, 2013.

Reference Books

1 Hydraulics, Fluid mechanics and Hydraulic Machinery - MODI and SETH
2 Fluid Mechanics and Hydraulic Machines by Rajput.
3 A.K.Mohanty, Fluid Mechanics, 2/e, Prentice Hall of India, 2004.

Evaluation Procedure					
Continuous Evaluation	Total 70 Marks				
	Quiz 1	Quiz 2	Quiz 3	Assignment CAT 1	CAT 2
Sem End Examination	Total 30 Marks				

Course Outcome - Programe Outcome Mapping															
Course Outcomes :	Programme Outcomes														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	2	1	0	0	0	0	0	0	0	0	0	0	0	1	0
2	1	2	0	0	0	0	0	0	0	0	0	0	0	1	0
3	2	3	1	0	0	0	0	0	0	2	1	0	1	1	0
4	3	3	0	0	0	0	0	0	0	2	1	0	1	1	0
5	3	3	0	0	0	0	0	0	0	2	1	0	1	1	0
6															

Course Code	Course Title	L	T	P	J	S	C
PC8	**PC 8 FLUID MECHANICS AND MACHINERY (Laboratory)**	4	0	2	0	0	5
Course Owner	Department of MechanicalEngineering	**Syllabus version**				1.0	
Course Pre-requisite(s)	Students are expected to know the fundamentals of engineeringmechanics, resolving of forces, Statics, Dynamics and flow kinematics.	**Contact hours**				30	
Course Co-requisite(s)	None	**Date Approved**					
Alternate Exposure							

Practical Experiment

Topic	Type
measurement of coefficient of discharge using venturi and orifice meter	Experiment
measurement of friction factor	Experiment
measurement of force exerted by the jet on flat, inclined and curved plate	Experiment
performance characteristics of Pelton wheel	Experiment
performance characteristics of Francis turbine	Experiment
performance characteristics of centrifugal pump	Experiment
Estimation of drag and lift coeffcient of an aerofoil using wind tunnel	Experiment

Course Code	Course Title	L	T	P	J	S	C
PC	PC: MEASUREMENTS AND METROLOGY	3	0	2	0	0	4
Course Owner	Department of Mechanical Engineering	Syllabus version				1.0	
Course Pre-requisite(s)	None	Contact hours				30	
Course Co-requisite(s)	None	Date Approved					
Alternate Exposure							

Course Description

The objective is to make the students to have knowledge on the various measuring and inspection devices and to provide tolerances during design. This is useful for every engineer who is working in any industry as every industryproducing any good should be inspected and then only will be sent out for the release in the market for customers.Course intends to introduce the technological and engineering concepts and study the applications of measuring quantities like force, torque and temperature.

Course Objectives

• To introduce the basic concepts of metrology and measurement methods.
• To demonstrate the importance of metrology in manufacturing.
• To explain the concepts of transducers and its practical applications.
• To expose with various measuring instruments
• To familiarize calibration methods of various measuring instruments.

UNIT I 8 hrs

Concept of Measurement: General concept-generalized measurement system, units and standards, measuring instruments, sensitivity, readability, range of accuracy, precision, static and dynamic response, repeatability, systematic and random errors, correction, calibration, terminology and limits fits and tolerances, hole basis and shaft basis system, interchangeability.

Learning Outcomes:

At the end of this unit the student will be able to

- Identify important parameters in metrology. (L3).
- Differentiate interchangeability and selective assembly. (L4).
- Select limits and tolerances for different assemblies. (L1)

UNIT II 8 hrs

Linear measuring instruments: Vernier instruments, micrometers, slip gauges, tool makers microscope. Comparators: Mechanical-Johansson mikrokator, sigma and reed type, pneumatic-solex and differential type and electrical- visual gauging and multi gauging.

Angular measurements: Sine bar, bevel protractor and angle dekkor.Learning Outcomes:

At the end of this unit the student will be able to

- Explain the principles of measurement of various comparators. (L2).
- Discuss about the principles of slip gauges, micrometers and vernier height gauges. (L2)

UNIT III 8 hrs

Screw thread measurements: Elements of threads, errors in screw threads, various methods of measuring externaland internal screw threads, screw thread gauges and errors in screw threads.

Gear Measurement: Gear tooth terminology, measurement of gear elements-runout, lead, pitch backlash, profileand tooth thickness by chordal thickness method, constant chord and base tangent method.

Learning Outcomes:

At the end of this unit, the student will be able to

- Identify the errors in screw threads. (L3)
- Explain the principles of gear measuring instruments. (L2)
- Select the tools and methods for measuring screw thread, gear profiles. (L1)

UNIT IV 10 hrs

Surface Roughness:Terminology, differences between surface roughness and surface waviness-Numerical assessment of surface finish - CLA, RMS and ten point height average Value. Methods of measurement of surfacefinish-Profilometer, Tomlinson surface meter, Taylor Hobson talysurf.

Inspections systems: Classification of automatic inspections systems, co-ordinate- measuring machines, non- contact inspection techniques-machine vision, laser scanning systems.
Learning Outcomes:
At the end of this unit, the student will be able to

- Recall the terms used in surface roughness measurement. (L1)
- Explain the factors affecting the surface finish in machining. (L2)
- Demonstrate the application of different surface measuring instruments. (L2)

UNIT V 8 hrs
Measurement of Force: Direct method - analytical balance, platform balance; elastic members – load cells,cantilever beams and proving rings.
Measurement of Torque: Torsion bar dynomometer, servo controlled dynamometer and absorption dynamometer.Measurement of Temperature: Pressure thermometers and bimetallic strip thermometers.

Learning Outcomes:
At the end of this unit, the student will be able to

- Identify various types of transducers used for the measurement of force, torque, and temperature. (L3)
- Explain methods of measurement of force, torque and temperature. (L2)
- Develop the techniques for calibration of force, torque and temperature measuring

devices. (L3)Course Outcomes:
1. have knowledge on basic concepts and apply the concepts of limits, fits, tolerances to engineering drawing &design (L4)
2. Demonstrate the concepts of linear and angular measurements to practical applications (L3)
3. Examine geometry of screw threads and gear profiles. (L4)
4. evaluate surface finish and also to inspect various components using non-contact and contact techniques. (L5)
5. Select suitable techniques to measure and evaluate force torque and temperature. (L5)

Textbooks:

1. Beckwith, Marangoni, Linehard, Mechanical Measurements, 6/e, PHI, 2013.
2. R.K. Jain, Engineering Metrology, 20/e, Khanna Publishers, 2013.

Reference Books:

1. Mahajan, Engineering Metrology, 2/e, DhanpatRai, 2013.
2. S.Bhaskar, Basic Principles - Measurments and Control Systems, Anuradha Publications, 2014.
3. Anand K Bewoor&Vinay A Kulkarni, Metrology & Measurement, 15/e, McGrawHill, 2015

Course Code	Course Title	L	T	P	J	S	C
	MEASUREMENTS AND METROLOGY (Laboratory)	0	0	2	0	0	1
Course Owner	Department of MechanicalEngineering	**Syllabus version**					
Course Pre-requisite(s)	Engineering Mechanics:Statics	**Contact hours**					
Course Co-requisite(s)	Strength of Materials (Theory)	**Date Approved**					
Alternate Exposure	Programming and Plotting software						

Course Description

The practical methods of material testing and analysis would be taught with the use of standard numerical andsoftware tools

Course Objectives:

1 To conduct uni-axial tension test on Steel, Aluminium, Copper and Brass.
2 To perform compression test on spring and wood.
3 To determine elastic constants of materials using flexural and torsion tests.
4 To find hardness of given metals.
5 To demonstrate behavior of non-elastic materials

Course Outcomes:

On completion of this lab student will be able to

1 identify the standards of sample preparation and testing (L1).
2 understand the difference between compression and tension testing(L2).
3 test the hardness of different materials (L3).
4 analyse stress-strain data and calculate material properties (L4).
5 evaluate the type of testing required for various materials (L5).

Specific Instructional Objectives

1 Demonstration of experiments using relevant equipment
2 Demonstartion of data analysis using relevant software
3 Validation of results using theoretical concepts

List of exercises:

1. Preparation of tensile testing samples using ASTM or ASME standards.
2. Metallographic sample preparation (Mounting and Polishing)
3. Study the Stress Strain Characteristics of Metals by using UTM (analysis of Tensile Stress-Strain Data).
4. Compression test using UTM – Applications & comparison with Tensile results
5. Determination of hardness using different hardness testing Machines- Brinnels, MicroVickers, andRockwells.
6. Impact Test by using Izod and Charpy Methods.
7. Deflection test on Beams using UTM.
8. Torsion Test on Circular Shafts.
9. Creep and Stress Relaxation tests
10. Fatigue Test – Analysis of results

Text Books

1. F. P. Beer, E. R. Johnston Jr., J. T. DeWolf, D. F. Mazurek & S. Sanghi, Mechanics of Materials, 8/e,McGraw Hill Education (India) , 2020.
2. S. S. Rattan, Strength of materials, 3/e, Tata McGraw-Hill, 2016.

Reference Books

1. R. C. Hibbeler, Mechanics of Materials (SI Edition), 9/e, Pearson Education, 2018.B. C. Punmia, Ashok K. Jain, Arun K. Jain, Mechanics of Materials, R/e, Laxmi Publications, 2017.
2. B. C. Punmia, Ashok K. Jain, Arun K. Jain, Mechanics of Materials, R/e, Laxmi Publications, 2017.

Evaluation Procedure														
Continuous Evaluation	**Total XX Marks**													
	Exp1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8	Exp 9	Exp10	Exp11	Exp12	Exp13	Exp14
	10	10	10	10	10	10	10	10	10	10				
	Exp15													
Term End Examination	Total XX Marks													

Course Outcome - Program Outcome Mapping															
Course Outcomes :	**Programme Outcomes**														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	3	1	1	1	0	1	0	0	0	0	1	1	3	2	1
2	3	1	3	1	0	1	0	0	0	0	1	1	3	2	1
3	3	1	3	1	0	1	0	0	0	0	1	1	3	2	1
4	3	1	2	1	0	1	0	0	0	0	1	1	3	2	1
5	3	1	3	1	0	1	0	0	0	1	1	1	3	2	1

Semester - VI

	Course Code	Course Title	L	T	P	J	S	C
	PC 10	DESIGN OF MACHINE ELEMENTS	4	0	0	0	0	4
	Course Owner	Department of MechanicalEngineering	Syllabus version				1.0	
	Course Pre-requisite(s)	1. Concepts of stress, strainand their relationships 2. Axial, bending, torsion, shear loads and theircombinations	Contact hours				30	
	Course Co-requisite(s)	1. PC7 Mechanics ofMachinery 2. PC5 Strength of Materials	Date Approved					
	Alternate Exposure							

Course Description:
This course introduces the design procedures for various mechanical elements. Concepts applied in this course arefrom previous courses such as Strength of materials and Dynamics of Machinery. The course aims to throw knowledge on design against static and fatigue loadings. The course addresses designing of fasteners, couplings, shafts and other machine components and limited to strength and rigidity based designs.

Course Objectives:
1 To provides an introduction to design of machine elements.
2 To familiarize with fundamental approaches to failure prevention for static and dynamic loading.
3 To explain design procedures for different types of joints.
4 To explain the working principle of clutches and brakes and their design procedures.
5 To instruct different types of bearings and design procedures.

Course Outcomes:
1 Apply the knowledge in designing of fasteners. [L3]
2 Use the principles to estimate safety factors of machine members subjected to static and dynamic loads.(L3)
3 Apply basic design procedures of gears [L2]
4 Understand different types of Bearings and designing procedures [L3]
5 Analyze and design different machine components and optimize the design decisions according to therequisites.
6 Design different fasteners subjected to various loads. (L5)

UNIT I **12 Hrs**

Mechanical Engineering Design
Design process, design considerations, codes and standards of designation of materials, selection of materials. Design for Static Loads: Modes of failure, design of components subjected to axial, bending, torsional and impact loads, Static theories of failures. Design for Dynamic Loads: Endurance limit, fatigue strength under axial, bending and torsion, stress concentration, notch sensitivity. Types of fluctuating loads, fatigue design for infinite life. Fatigue theories of failure.Soderberg, Goodman and modified Goodman criterion for fatigue failure. Fatigue designunder combined stresses.

Bolted Joints: Threaded fasteners, preload of bolts, various stresses induced in the bolts. Torque requirement for bolt tightening, eccentrically loaded bolted joints, and gasketed joints. Riveted Joints: Design of lap, butt and eccentrically loaded joints, failure and efficiency of riveted joints. Welded Joints: Strength of lap and butt welds, eccentrically loaded welded joints. Joints subjected to bending andtorsion.

UNIT II **12 Hrs**

Bolted, Welded And Riveted Joints

Bolted Joints: Threaded fasteners, preload of bolts, various stresses induced in the bolts. Torque requirement for bolt tightening, eccentrically loaded bolted joints, and gasketed joints. Riveted Joints: Design of lap, butt and eccentrically loaded joints, failure and efficiency of riveted joints. Welded Joints: Strength of lap and butt welds, eccentrically loaded welded joints. Joints subjected to bending andtorsion.

UNIT III **12 Hrs**

Shafts, Keys, And Shaft Couplings

Power Transmission Shafts: Design of shafts subjected to bending, torsion and axial loading. Shafts subjected tofluctuating loads using shock factors.

Keys: Function, types, design of sunk, saddle, Kennedy and Woodruff keys.

Couplings: Design of flange and bushed pin couplings, universal coupling.

UNIT IV **12 Hrs**

Clutches And Brakes

Friction Clutches: Torque transmitting capacity of disc and centrifugal clutches. Uniform wear theory anduniform pressure theory.

Brakes: Different types of brakes. Concept of self-energizing and self-locking of brake. Band brake, block brakesand disc brakes.

UNIT V **12 Hrs**

Bearings And Gears

Design of Sliding Contact Bearings: Lubrication modes, bearing modulus, McKee's equations, design of journal bearing. Bearing Failures.

Design of Rolling Contact Bearings: Static and dynamic load capacity, Stribeck's Equation, equivalent bearing load, load-life relationships, load factor, selection of bearings from manufacturer's catalogue. Design of Gears: Spur gears, beam strength, Lewis equation, design for dynamic and wear loads.

Text Books

1 J.E. Shigley, Mechanical Engineering Design, 2/e, Tata McGraw Hill, 1986.

2 V. B. Bhandari, Design of Machine Elements, 3/e, Tata McGraw Hill, 2010.

Reference Books

1 R.L. Norton, Machine Design an Integrated approach, 5/e, Pearson Education, 2018.

2 R. K. Jain, Machine Design, Khanna Publications, 1988.

3 M. F. Spotts and T. E. Shoup, Design of Machine Elements, 8/e, Prentice Hall (Pearson Education),2019.

Evaluation Procedure						
Continuous Evaluation	Total 70 Marks					
	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2
	10	10	10	10	15	15
Sem End Examination	Total 30 Marks					

Course Outcome - Programe Outcome Mapping															
Course Outcomes :	Programme Outcomes														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	3	0	2	0	0	1	0	0	0	0	0	0	3	0	1
2	3	0	3	0	0	0	0	0	0	0	0	0	2	0	1
3	3	1	3	0	0	0	0	0	1	0	0	0	3	0	0
4	3	1	2	0	0	1	0	0	1	0	0	0	3	0	0
5	3	1	2	1	1	1	1	1	2	1	1	1	2	1	1
6															

Course Code	Course Title	L	T	P	J	S	C
PC11	**PC11: HEAT AND MASS TRANSFER**	3	0	2	0	0	4
Course Owner	Department of MechanicalEngineering	Syllabus version					
Course Pre-requisite(s)	Thermodynamics	Contact hours					
Course Co-requisite(s)	None	Date Approved					
Alternate Exposure							

Course Description

This course focuses on the fundamental concepts and techniques of heat and mass transfer and emphasizes application of mathematical principles in heat transfer. The knowledge of Thermodynamics and Fluid mechanics are prerequisite in understanding the concepts fluid kinematics & boundary layer concepts with respect to heat and mass transfer. Further, this course gives good understanding of industrial related problems as phase change heat transfer and heat exchangers.

Course Objectives:

1 To impart the basic laws of conduction, convection and radiation heat transfer and their applications
2 To familiarize the convective heat transfer concepts
3 To explain basics of radiation heat transfer
4 To make conversant with the heat transfer analysis related to thermal systems like heat exchangers,evaporator, and condenser.
5 To explain basics of boiling condensation and mass transfer

Course Outcomes:

1 Apply the concepts of different modes of heat transfer. (L2)
2 Apply knowledge of conduction heat transfer in the design of insulation of furnaces and pipes. (L3)
3 Analyse free and forced convection phenomena in external and internal flows. (L2)
4 Design of thermal shields using the concepts of black body and non-black body radiation. (L4)
5 Apply the basics of mass transfer for applications in diffusion of gases. (L3)

UNIT I **10 Hrs**

Introduction

Introduction: Basic modes of heat transfer- rate equations- generalized heat conduction equation - steady state heatconduction solution for plain and composite slabs – cylinders. Fins: Heat conduction through fins of uniform cross section- fin effectiveness and efficiency. Unsteady State Heat Transfer - Transient heat conduction- lumped system analysis and use of Heisler charts.

Learning Outcomes:

•identify the phenomenon related to different modes of heat transfer [L2]
•compare different types of conduction heat transfer[L2]
•apply concept of thermal resistance and its importance in practical problems[L3]
•compare different types of Fins[L2]
•apply concept transient heat conduction in practical problems[L3]

UNIT II **9 Hrs**

Convection

Convection: Basic concepts of convection–heat transfer coefficient - types of convection –forced convection and free convection. Dimensional analysis in convection External Flow: Concepts of hydrodynamic and thermal boundary layer- use of empirical correlations for flow over plates and cylinders. Fluid friction – heat transfer analogy Internal Flow: Use of empirical relations for convective heat transfer in horizontal pipe flow. Free Convection -development of hydrodynamic and thermal boundary layer along a vertical plate – use of empirical relations for convective heat transfer on plates and cylinders in horizontal and vertical orientation.

Learning Outcomes: Upon completion of **UNIT** 2, the student will be able to
•Apply the physical phenomenon of convective heat transfer[L3]
•Calculate convective heat transfer using empirical relations for different cases[L4]
•Use analogy between fluid friction and heat transfer to solve engineering problems.[L4]

UNIT III **8 Hrs**

Radiation
Radiation: Radiation heat transfer – thermal radiation – laws of radiation - Black and Gray bodies – shape factor-radiation exchange between surfaces - Radiation shields - Greenhouse effect.

Learning Outcomes:
Upon completion of **UNIT** 3, the student will be able to
•Apply the principles of radiation heat transfer[L3]
•Design a radiation shield for given conditions[L5]
•Examine the effect of greenhouse gases on atmosphere[L2]

UNIT IV **9 Hrs**

Heat Exchangers
Heat Exchangers: Types of heat exchangers- parallel flow- counter flow- cross flow heat exchangers- overall heattransfer coefficient- LMTD and NTU methods- fouling in heat exchangers.

Learning Outcomes:
Upon completion of **UNIT** 4, the student will be able to
● Explain the working of different types of heat exchangers[L1]
•Calculate the heat transfer in heat exchangers[L5]
•Design a heat exchanger for a given application[L5]

UNIT V **9 Hrs**

Boiling and Condensation/Mass Transfer
Boiling and Condensation: Different regimes of boiling- nucleate, transition and film boiling – condensation - filmwise and dropwise condensation.
Mass Transfer: Conservation laws and constitutive equations - Fick's law of diffusion, isothermal equi-mass -Equimolar diffusion- - diffusion of gases and liquids- mass transfer coefficient.

Learning Outcomes:
After completion of this **UNIT** , the student will be able to
•identify different regimes of boiling in design of boilers[L1]
•interpret the basic modes of condensation heat transfer[L2]
•Explain the basic mechanism of mass transfer[L2]
•Differentiate between mass transfer due to convection and diffusion[L2]

Text Books
1 P.K. Nag, Heat Transfer, 3/e, Tata McGraw-Hill, 2011.
2 F. P. Incropera and D.P. Dewitt, Fundamentals of Heat and Mass Transfer, 6/e, John Wiley, 2007.

Reference Books
1 J.P. Holman, Heat Transfer, 9/e, Tata McGraw-Hill,2008.
2 Cengel. A.Yunus, Heat Transfer- A Practical Approach, 4/e, Tata McGraw-Hill, 2007.
3 S.P. Sukhatme, A Textbook of Heat Transfer, Universities Press, 2005
4 Lienhard and Lienhard, A Heat and Mass Transfer, Cambridge Press, 2011.

5 C.P. Kothandaraman and S. Subramanyan, Heat and Mass Transfer databook, New Age Publications,2014

Evaluation Procedure						
Continuous Evaluation	**Total 70 Marks**					
	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2
	5	5	5	15	20	20
Sem End Examination	Total 30 Marks					

Course Outcome - Programe Outcome Mapping															
Course Outcomes :	**Programme Outcomes**														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	3	3	1	1	0	1	0	1	2	0	1	0	0	0	2
2	3	3	1	1	0	1	0	1	2	0	1	0	0	3	0
3	3	3	1	1	0	1	0	1	2	0	1	0	3	0	0
4	3	3	1	0	0	1	0	1	2	0	1	0	0	0	2
5	3	3	1	0	0	1	0	1	2	0	1	0	2	0	0

<table>
<tr><td>Course Code</td><td>Course Title</td><td>L</td><td>T</td><td>P</td><td>J</td><td>S</td><td>C</td></tr>
<tr><td>PC11</td><td>PC11: HEAT AND MASS TRANSFER (Laboratory)</td><td>3</td><td>0</td><td>2</td><td>0</td><td>0</td><td>4</td></tr>
<tr><td>Course Owner</td><td>Department of MechanicalEngineering</td><td colspan="4">Syllabus version</td><td colspan="2"></td></tr>
<tr><td>Course Pre-requisite(s)</td><td>Thermodynamics</td><td colspan="4">Contact hours</td><td colspan="2"></td></tr>
<tr><td>Course Co-requisite(s)</td><td>None</td><td colspan="4">Date Approved</td><td colspan="2"></td></tr>
<tr><td>Alternate Exposure</td><td colspan="7"></td></tr>
</table>

Practical Experiment

Topic	**Type**
Determine the thermal conductivity of a metal rod	Experiment
Determine the heat transfer coefficient for a vertical cylinder in natural convection	Experiment
Determine the heat transfer coefficient in forced convection of air in a horizontal tube.	Experiment
Determine the heat transfer coefficients on film and drop wise condensation apparatus.	Experiment
Determine the effectiveness of a parallel and counter flow heat exchanger	Experiment
Determine the thermal conductivity by guarded hot plate method	Experiment
Determine the thermal conductivity of a given liquid sample	Experiment
Determine the effectiveness of compact heat exchanger	Experiment
Determine the emissivity of the test plate surface	Experiment
Study the pool boiling phenomenon and different regimes of pool boiling.	Experiment

	Course Code	Course Title	L	T	P	J	S	C
	PC12	PC12: INTRODUCTION TO CAD, CAM, AND PRACTICAL CNC MACHINING	3	0	2	0	0	4
	Course Owner	Department of MechanicalEngineering	**Syllabus version**					
	Course Pre-requisite(s)	Concepts of Machine Designand Machining processes	**Contact hours**					
	Course Co-requisite(s)	None	**Date Approved**					
	Alternate Exposure							

Course Description

This course familiarizes you to the foundational knowledge in computer-aided design, manufacture, and the practical use of CNC machines. In this course, we begin with the basics in CAD by learning how to properly sketch and model 3D parts. Before we program any toolpaths, we will explore CNC machining basics to ensure we have the ground level foundational knowledge needed to effectively define toolpaths. Finally, we explore the basics of setting up a CAM program and defining toolpaths to cut simple geometry. This same basic process gets repeated for the design and manufacture of any part and is a critical step in learning and understanding the process

Course Objectives:

1 Explain the CAD design process as applied to prismatic parts.
2 Summarize the workflow of digital manufacturing.
3 Demonstrate knowledge and skills in basic CAM software.
4 Recall foundational knowledge of practical CNC machining.
5 Familiarize the various computer aided tools that can be implemented in various industrial applications.
6 Introduce the standard terminologies, conventions, processes, operations, programming techniques, designand operational characteristics of key hardware components of CNC machines.

Course Outcomes:

1 Students will describe basic concepts of CAD and CAM application and understand CIM wheel
2 Students will prepare CNC programs for manufacturing of different geometries on milling, drilling andlathe machines.
3 Students will classify different components using different techniques of group technology
4 Students will prepare Process planning for different components
5 Students will select layouts of FMS for industrial applications
6 Students will describe computer vision and Robot for preliminary industrial applications like pick andplace.

UNIT I **9 Hrs**

Introduction to CAD

Introduction – Role of Computers in design and manufacture. Fundamentals of CAD: Definition of CAD Tools, Graphics standards, Graphics software: requirements of graphics software, Functional areas of CAD, Efficient useof CAD software. Introduction, Design process, Application of computer for design, creating the manufacturing database, Benefits of CAD, Design work station, CAD hardware. Introduction to Geometric Modelling: Requirement of geometric modelling, Classification of geometric modeling techniques, comparison and advantagesof Geometric models.

Learning Outcomes:

Understand the significance of CAD **[L1]**
Comprehend the concept of graphic standards **[L2]**
Understand the significance of Geometric modelling **[L1]**

UNIT II **9 Hrs**

Introduction to CAM

Introduction to CAM Concepts, Objectives & scope, Nature & Type of manufacturing system, Evolution, Benefits of CAM. Overview on the concepts of Computer Integrated Manufacturing, FMS, and their Impact on manufacturing. Outlines on the concept and component of FMS, FMS: need, objectives, types of FMS lay outs, limitations, and advantages.

Learning Outcomes:

At the end of this unit, the student will
be able to Understand the need of CAM. **[L1]**
Comprehend the concepts of FMS and CAPP systems. **[L2]**
Understand the different models and algorithms of Group Technology.**[L1]**

UNIT III **9 Hrs**

Introduction group technology

Introduction group technology, part families, part classification and coding systems. Benefits of group technology. Concept of CAPP, Different approaches to CAPP systems, application, limitations, and benefits. Basic concepts ofComputer Vision and its applications to manufacturing.

UNIT IV **9 Hrs**

Introduction to NC and CNC Technology

Introduction to NC and CNC Technology: Types, Classification, Specification, components and construction details. NC machine tools: Nomenclature of NC machine axes, Types of NC machine tools, Machining centers, Automatic tool changes (ATC), Turning centers. Machine control **UNIT** & tooling: Functions of MCU, NC actuation systems. Axis designation, NC/CNC tooling. Fundamentals of Part programming, Types of format, Part Programming for drilling, lathe and milling machine operations, subroutines, do loops, canned Cycles, parametricsub routines.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand the concept of NC and CNC systems. [L1]
- Prepare part programs for machining operations using codes. [L2]
- Operate the CNC machines to manufacture the parts. [L6]

UNIT V **9 Hrs**

APT programming

APT programming: APT language structure, APT geometry: Definition of point, time, vector, circle, plane, patterns and matrices. APT motion commands: setup commands, point-to-point motion commands, continuous path motion commands. Post processor commands, complication control commands, Macro subroutines, Part programming preparation for typical examples. Extension of Numerical Control such as concepts of direct numerical control (DNC), adaptive control and their advantages.

Learning Outcomes:

At the end of this unit, the student will be able to

- Understand the concept of APT programming language. [L1]
- Develop the APT part programs for typical examples. [L3]
- Acquaint the knowledge of DNC and adaptive control machining [L2]

Pedagogy Tools	3 hrs	1 hrs	1 hrs	1 hrs	1 hrs	1 hrs	1 hrs
	Teacher centred approach	Collaborative	Inquiry-based	E-learning	Reflective	Blended Learning	Open Educational Resources

Text Books

1. M.M.M. Sarcar, K. Mallikarjuna Rao, K. Lalit Narayan, Computer Aided Design and Manufacturing,Kindle Edition, Printice Hall of India, 2008.
2. P.N.Rao, CAD/CAM: Principles and Applications, 3rd edition, McGraw Hill Education, 2017.
3. S.R. Deb, Robotics Technology and Flexible Automation, 2nd edition, Tata McGraw-Hill, 1994.
4. Smith Peter, CNC programming handbook, 2nd edition, 2003, Industrial Press Inc.

Reference Books

1. Mikell, P. Groover, Mitchell Weis, Roger, N. Nagel, Nicholas G. Odrey,Industrial Robotics Technology,Programming and Applications, 1st edition,McGraw-Hill, Int. 1986.
2. Richard. D, Klafter, Thomas, A, Chmielewski, Michael Negin, Robotics Engineering – An IntegratedApproach, 1st edition, Prentice-Hall of India Pvt. Ltd., 2009
3. K.S.Fu, R.C. Gonzalez and C.S.G. Lee, Robotics Control, Sensing, Vision and Intelligence, McGraw Hill,July, 1987
4. David D. Bedworth, Mark R. Henderson, Philp M. Wolfe, “Computer Integrated Design andmanufacturing”, Mc Graw Hill International series, 1991

Evaluation Procedure						
Continuous Evaluation	**Total 70 Marks**					
	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2
	5	5	5	15	20	20
Sem End Examination	Total 30 Marks					

	Course Code	Course Title	L	T	P	J	S	C
	PC12	**PC12: INTRODUCTION TO CAD, CAM, AND PRACTICAL CNC MACHINING (Laboratory)**	3	0	2	0	0	4
	Course Owner	Department of MechanicalEngineering	**Syllabus version**					
	Course Pre-requisite(s)	Concepts of Machine Designand Machining processes	**Contact hours**					
	Course Co-requisite(s)	None	**Date Approved**					
	Alternate Exposure							

Practical Experiment

Topic	Type
1. Demonstrate constructional features of CNC and its operation	Exercise
2. Prepare a part program for simple turning with steps.	Exercise
3. Prepare a part program for simple turning with tapers.	Exercise
4. Prepare a part program for turning with with circular (concave / convex shape) interpolation codes.	Exercise
5. Prepare a part program for simple contour milling operation.	Exercise
6. Prepare a part program for simple contour milling operation.	Exercise
7. Prepare a part program for simple contour milling operation with (convex / concave) circularinterpolation	Exercise
8. Prepare a part program for drilling holes with same diameter of the hole on a given plate.	Exercise
9. Prepare a part program for drilling holes with varying diameter of the holes on a given plate.	Exercise
10. Prepare a part program for drilling holes with varying depth of the holes on a given plate.	Exercise

Course Outcome - Programe Outcome Mapping															
Course Outcomes :	**Programme Outcomes**														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	2				2	3	2	1		2			1	1	
2	2	1		1		3	2			2			1	1	
3	2				2	2				2				1	
4	2	1			2	3	2	1		2				1	
5	2	1			2	3	2			2				1	
6	3	2	2		3	3	2	1	2	2	2	3	2	2	2

Semester- VII

Course Code	Course Title	L	T	P	J	S	C
PC 13	**PC 13 INDUSTRIAL ENGINEERING AND MANAGEMENT**	3	0	0	0	0	3
Course Owner	Department of MechanicalEngineering	**Syllabus version**					
Course Pre-requisite(s)	Basic Mathematics	**Contact hours**					
Course Co-requisite(s)	None	**Date Approved**					
Alternate Exposure							

Course Description

The course is suitable to fit into all functional areas of business in different sections of the economy from manufacturing to the service sector and the process industry and fit into managerial positions in all organizations like Manufacturing, service, IT, Logistics & Apparels. It is helpful to train students to rigorously make use of quantitative techniques in analyzing and designing service operations and also to train students who will have the passion to engage in improving the service and its delivery. The individual should be creative, inquisitive, analytical, and detail-oriented, and able to work in a team and communicate well, both orally and in writing

Course Objectives:

1 Understand the basic concepts of management, planning, organizing and staffing
2 Understand the concepts of materials management and quality control
3 Understand the concepts of production planning control
4 Understand the principles of management
5 Learn the acts related to industries

Course Outcomes:

1 Explain the basic concepts of management, planning, organizing and staffing
2 Explain the concepts of materials management and quality control and implement in the industry
3 Explain the concepts of production planning control
4 Explain the principles of management.
5 Explain and utilize various acts related to industries

UNIT I **8 Hrs**

Definition of Industrial Engineering: Objectives, work study, method study, method study procedure - various charts, THERBLIGS, work measurement – various methods of work measurements. Factors affecting productivity,strategies for improving productivity.

Learning Outcomes:

• An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering,science, and mathematics (L3).
• An ability to communicate effectively with a range of audiences (L5).

UNIT II **8 Hrs**

Materials Management:

Strategic importance of materials in manufacturing industries, inventory control models, inventory control systems, safety stock, selective Inventory control – ABC, FSN, and VED analysis. Quality Management: Definition of quality, various approaches, concepts of quality assurance systems, statistical quality control, variables & attributes, charts, acceptance sampling, OC curve, introduction to TQM & ISO-9000.

Learning Outcomes
- An ability to acquire and apply new knowledge as needed, using appropriate learning strategies (L4).
- Able to learn the difference between quality management and types (L2)

UNIT III **8 Hrs**

Production Planning and Control: Objectives, types of productions, production cycle, product design and development, process planning, forecasting, functions of production control. Plant Layout and Material Handling: Plant layout and location, types of layouts, principles, concept of **UNIT** load, selection of material handling equipment.

Learning Outcomes:
- Professional Responsibility - an understanding of professional and ethical responsibility by using the conceptproduction planning and control (L3).
- Multidisciplinary Teamwork- an ability to function on multidisciplinary teams and learn the plant layout design(L2).

UNIT IV **8 Hrs**

Industrial Management:
Concepts, principles of management, growth of management thought, functions of management, principles oforganization, types of organizations.

Learning Outcomes:
- An understanding of the need for and an ability to engage in self-directed continuing professional developmentin managing the organization (L2).
- An ability to function effectively as a member of a technical team (L2).

UNIT V **8 Hrs**

Industrial Relations:
Industrial disputes, settlement of industrial disputes, trade unions, industrial dispute act 1947 and factories act 1948.Conflict management in organizations.

Learning Outcomes:
- Describe and critique the concept of employee engagement (L4).
- Identify problems associated with both over-engagement and disengagement (L3).

Text Books:
1. ILO, Introduction to Work Study, 3/e, Oxford and IBH Publishing, 2008
2. O.P. Khanna, Industrial Engineering and Management, 14/e, Dhanpat Rai Publications, 2011

Reference Books:
1. Chary, S. N., Production and Operations Management, 4/e, Tata McGraw Hill Publications, 2009
2. M.T. Telsang, Industrial Engineering and Production Management, 2/e, S Chand and Co., 1999.

Evaluation Procedure						
Continuous Evaluation	**Total 70 Marks**					
	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2
	10	10	10	10	15	15

Sem End Examination	Total 30Marks

	Course Code	Course Title	L	T	P	J	S	C
	PC 13	**PC 13 INDUSTRIAL ENGINEERING AND MANAGEMENT**	3	0	0	0	0	3
	Course Owner	Department of MechanicalEngineering	**Syllabus version**					
	Course Pre-requisite(s)	Basic Mathematics	**Contact hours**					
	Course Co-requisite(s)	None	**Date Approved**					
	Alternate Exposure							

Practical Experiment

Topic	Type
Method Study for the assembly of a Bolt, a nut and a washer.	Exercise
Time study of electric plug assembly	Exercise
Estimation of standard time using PMTS.	Exercise
Determination of standard time of pin board assembly using centi minute stop watch	Exercise
Drawing Man-multi machine Multiple activity chart	Exercise
Physiological evaluation of performance testing of individual on Tread Mill/bicycle ergometer	Exercise
Drawing & analyzing Mean and Range Chart for given process.	Exercise
Drawing & analyzing P-chart for given process.	Exercise
Drawing & analyzing C-chart for given process.	Exercise
Showing that sample means from normal universe follow normal distribution	Exercise
Drawing Operation characteristic curve for single sampling attributes plan.	Exercise
Stop watch time study on drilling machine, lathe machine and CNC machine	Exercise

Course Outcome - Programe Outcome Mapping

Course Outcomes :	Programme Outcomes														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	0	0	1	0	2	1	2	2	1	3	2	2	1	0	1
2	0	0	1	0	2	1	2	2	1	3	2	2	1	0	1
3	0	0	1	0	2	1	2	2	1	3	2	2	1	0	1
4	0	0	1	0	2	1	2	2	1	3	2	2	1	0	1
5	0	0	1	0	2	1	2	2	1	3	2	2	1	0	1
6															

	Course Code	**Course Title**	L	T	P	J	S	C	
	EME473	**MANUFACTURING OF AUTOMOBILE COMPONENTS**	3	0	0	0	0	3	
	Course Owner	Department of Mechanical Engineering	**Syllabus version**				1.0		
	Course Pre-requisite(s)	Basic Automobile Engineering and Manufacturing Processes	**Contact hours**						
	Course Co-requisite(s)	None	**Date Approved**						

	Alternate Exposure	Production technology

Course Description

Course Objectives:

1 To introduce the concepts of casting, forging, welding and coatings processes.
2 To understand the Material selection and Manufacturing methods for transmission system.
3 To explain the concepts of Surface Treatments and welding processes for automobile body components
4 To describe the Material and manufacturing selection methods for chassis components.
5 To understand the various prototype selection of materials and manufacturing methods

Course Outcomes:

1 illustrate the concepts of casting, forging, welding and coatings processes.[L3]
2 explain the various material and suitable manufacturing methods for transmission components. [L4]
3 understand various surface treatments and welding processes for automobile body components.[L2]
4 understand the material and manufacturing selection methods for chassis components [L2]
5 understand the various selection of materials and manufacturing methods prototype of various automobilecomponents [L2]

UNIT I **9 Hrs**

ENGINE COMPONENTS:

Overview - Material selection and Manufacturing methods for the Engine Components. Engine block – Casting –Conventional and expendable pattern. Cylinder head – Casting, machining and thermal barrier coating. Crank shaft,connecting rod, camshaft – Forging, machining and heat treatment. Piston - Gravity, squeeze, die casting, machining and finishing. Gudgeon Pin - Machining and Finishing, Valve forging, friction welding, machining, thermal barrier coating, heat treatment and surface improvement. Cylinder Liners, Piston ring - Centrifugal, HPDC,LPDC, machining and finishing. Castings Processes for Oil pan and Carburetors. Push Rods, Rocker Arm, Tappets,Spark Plug – Forging, Machining, Finishing and Heat treatment.

UNIT II **9 Hrs**

Drilling Jigs: design principles, drill bushes, Types of drilling jigs-template, plate type, swinging leaf, channel, box, angle plate, angular post, turnover, pot, universal jigs, Design and development of Jigs for given components.

UNIT III **9 Hrs**

Fixtures: General principles, lathe, milling, boring, broaching, grinding, planning and shaping fixtures, simple welding fixtures, design and development of fixtures for given components.

UNIT IV **9 Hrs**

Press Working Terminologies- Die block, die shoe. Bolster plate, punch holder, guide pins, bushes, strippers, knockouts, presses and press accessories, Computation of capacities and tonnage requirements. Types of dies-progressive, combination and compound dies, clearance, cutting forces, strip layout and strip layout calculations.

UNIT V **9 Hrs**

Design and Development of Dies: Design and development of progressive and compound dies for blanking and piercing operations, development of bending, forming, and drawing dies, design considerations in forging, extrusion, casting and plastic dies.

Text Books
P.C.Sharma, A Text Book of Production Engineering, S.Chand & company, 3/e, 1982

Reference Books
1 Joshi, P.H., Jigs and Fixtures, 2/e, Tata McGraw-Hill, 2004.
2 Donaldson. C, Tool Design, 3/e, Tata McGraw-Hill, 1986.
3 Kempster, Jigs and Fixtures Design, The English Language Book Society, 1978.

Evaluation Procedure						
	Total 70 Marks					
Continuous Evaluation	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT2
	5	5	5	15	20	20
Sem End Examination	Total 30 Marks					

Course Outcome - Programe Outcome Mapping															
	Programme Outcomes														
Course Outcomes:	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	2	2	1												
2	2	2													
3	1					1									
4	2	1											1		
5															
6															

Course Code	**Course Title**	L	T	P	J	S	C
19EME447	**ADDITIVE MANUFACTURING**	3	0	10	0	0	8
Course Owner	Department of Mechanical Engineering	**Syllabus version**					
Course Pre-requisite(s)	Concepts of manufacturing technology and Computer aided design	**Contact hours**					
Course Co-requisite(s)	NIL	**Date Approved**					
Alternate Exposure	NIL						

Course Description

Additive manufacturing (AM), broadly known as 3D printing, is transforming how products are designed, produced, and serviced. AM enables on-demand production, without dedicated equipment or tooling, and unlocks digital design tools, giving breakthrough performance and unparalleled flexibility. Across industries, knowledge remains one of the greatest barriers to AM's wider adoption.

Course Objectives:

1 Additive Manufacturing (AM) is an economically viable alternative to conventional manufacturingtechnologies for producing highly complex parts.
2 Select and use the correct CAD formats in the manufacture of a 3D printed parts.
3 Understand the operating principles, capabilities and limitations of Additive Manufacturing processes.
4 Appreciate the differences and capabilities among liquid, sold and powder based Additive Manufacturingprocesses.
5 Describe the important process parameters for bio-manufacturing and determine the suitable additabletechnique for bio- manufacturing.
6 Impart fundamentals of additive manufacturing processes along with the various file formats, softwaretools, processes, techniques and applications.

Course Outcomes:

1 Understand the fundamentals of Additive Manufacturing Technologies for engineering applications.
2 Understand the methodology to manufacture the products using SLA and SGC technologies and study theirapplications , advantages and case studies.
3 Understand the methodology to manufacture the products using LOM and FDM technologies and studytheir applications , advantages and case studies.
4 Understand the methodology to manufacture the products using SLS and 3D Printing technologies andstudy their applications , advantages and case studies.
5 Apply professional, ethical, legal, security and social issues in the design of AM processes.
6 Decide between the various trade-offs when selecting AM processes, devices and materials to suitparticular engineering requirements.

UNIT I **9 Hrs**

Introduction to Additive Manufacturing (AM)

Introduction to Additive Manufacturing (AM): Overview – History - Need-Classification -Additive Manufacturing Technology in product development- Materials for Additive Manufacturing Technology, Tooling - Applications. Classification of AM processes: Liquid polymer system, discrete particle system - molten material systems - solidsheet system.

Learning Outcomes:

At the end of this unit, the student will be able to

demonstrate the knowledge of Additive Manufacturing technologies. [**L-1**]
describe additive manufacturing and explain its advantages and disadvantages. **[L2]**
explain the processes used in additive manufacturing for a range of materials and

applications **[L3]UNIT II** **9**

Hrs

CAD and Reverse Engineering

CAD and Reverse Engineering: Basic Conceptualization, CAD model preparation – conversion to STL - STL filemanipulation - Part Orientation and support generation – Model Slicing –Tool path Generation – Transfer to AM - Machine setup, build , removal and clean up, post processing. Data Processing for Additive Manufacturing Technology - Softwares for Additive Manufacturing Technology: MIMICS, MAGICS.

Learning Outcomes:

At the end of this unit, the student will be able to

1. Apply engineering knowledge, techniques, skills and modern tools to analyze problems in AM. [**L-3**]
2. Able to apply technique of CAD and reverse engineering for geometry transformation in Additive Manufacturing. [**L-3**]

UNIT III **9 Hrs**

Liquid Based and Solid Based Additive Manufacturing Systems

Liquid Based and Solid Based Additive Manufacturing Systems: Classification – Liquid based system – Stereolithography Apparatus (SLA)- Principle, process, advantages and applications - Solid based system – Fused Deposition Modeling - Principle, process, advantages and applications, Laminated Object Manufacturing.

Learning Outcomes:

At the end of this unit, the student will be able to
identify the significance of Liquid based systems in 3D design. [**L-1**]calculate the material required for making of an actual part. [**L-3**] differentiate the object manufacturing to utilize the concepts [**L-3**]

UNIT IV **9 Hrs**

Powder Based Additive Manufacturing Systems

Powder Based Additive Manufacturing Systems: Selective Laser Sintering – Principles of SLS process - Process, advantages and applications, Three Dimensional Printing - Principle, process, advantages and applications - LaserEngineered Net Shaping (LENS), Electron Beam Melting.

Learning Outcomes:

Upon successful completion of the course, the students will be
able todifferentiate the SLS process
select between a subtractive and an AM process for a particular application. [**L-1**]select a particular AM process. [**L-3**]
take a career in research or in advanced manufacturing, the AM being a rapidly evolving area and with wideapplications. [**L-4**]

UNIT V **9 Hrs**

Medical And Bio-Additive Manufacturing

Medical And Bio-Additive Manufacturing: Customized implants and prosthesis: Design and production. Bio-Additive Manufacturing- Computer Aided Tissue Engineering (CATE) – Case studies.

Learning Outcomes:

Upon successful completion of the course, the students will be able to
select between a subtractive and an cage process for a particular application. [**L-1**]select the ability of to make CATE a activity . [**L-3**]
take a career in research or in advanced manufacturing, the AM being a rapidly evolving area and with wideapplications. [**L-4**]

Text Books

1. Chua C.K., Leong K.F., and Lim C.S., “Rapid prototyping: Principles and applications”, Third Edition, WorldScientific Publishers, 2010.
2. Gibson, Rosen, Stucker, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing. Springer, 2009.
3. Frank W. Liou, Rapid Prototyping and Engineering Applications: A Toolbox for Prototype Development, CRCPress, Taylor and Francis Group, 2007.
4. Duc Pham, S.S. Dimov, “Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping andRapid Tooling”, Springer-Verlag London, 2001.

Reference Books

1. Gebhardt A., “Rapid prototyping”, Hanser Gardener Publications, 2003.
2. Liou L.W. and Liou F.W., “Rapid Prototyping and Engineering applications : A tool box for prototypedevelopment”, CRC Press, 2007.
3. Hopkinson, Hague, Dickens, Rapid Manufacturing: An Industrial Revolution for the Digital Age. Wiley, 2005.

4. Kamrani A.K. and Nasr E.A., “Rapid Prototyping: Theory and practice”, Springer, 2006.

Evaluation Procedure						
	Total 70 Marks					
Continuous Evaluation	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2
	5	5	5	15	20	20
Sem End Examination	Total 30 Marks					

Course Outcome - Programe Outcome Mapping															
Course Outcomes:	**Programme Outcomes**														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	2				2	3	2	1		2			1	1	
2	2	1		1		3	2			2			1	1	
3	2				2	2				2				1	
4	2	1			2	2	1	1		2				1	
5	2	1			2	2	1			2				1	
6	3	2	2		3	2	2	1	2	2	2	3	2	2	2

	Course Code	**Course Title**	L	T	P	J	S	C

19EME447	**COMPUTER INTEGRATED MANUFACTURING**	3	0	10	0		0	8
Course Owner	Department of Mechanical Engineering	**Syllabus version**						
Course Pre-requisite(s)	Introduction to CAD,CAM and Automation knowledge.	**Contact hours**						
Course Co-requisite(s)	Manual Part Programming codes and Misselaneous codes	**Date Approved**						
Alternate Exposure	Coding of NC program							

Course Description

This course provides basic knowledge about computer integrated manufacturing and it deals with grouping technology which is one of the most important technology followed in leading industries. It provides the basic knowledge of Computer aided process planning, Artificial Intelligence, Integrative Manufacturing Planning and Control. CIM combines various technologies like computer-aided design (CAD) and computer-aided manufacturing (CAM) to provide an error-free manufacturing process that reduces manual labourand automates repetitive tasks

Course Objectives:

1 To introduce the concepts of automation, group technology integrated to Computer aided design andmanufacturing.
2 To obtain an overview on computer aided process planning
3 To impart the knowledge of forecasting, scheduling capacity planning, shop-floor control in manufacturingsystems and the concept of JIT manufacturing.
4 To impart the basic knowledge of quality control, inspection methods and computer-aided testing
5 To classify and summarise the manufacturing systems, and integration of CAQC with CAD/CAM

Course Outcomes:

1 To understand the concepts of Production Automation, Process Planning & Quality control in ComputerIntegrated Manufacturing Systems
2 To acquire the knowledge on quality control; computer aided testing and inspection methods
3 To analyse the Computer Aided Process Planning &Control, Material handling, and Artificial intelligencein FMS
4 To design and solve the problems of Forecasting, Scheduling, and capacity planning in manufacturing andassembling
5 To integrate computer aided design and computer aided manufacturing protocols to manufacture products

Specific Instructional Objectives

1 importance and scope of CIM in fabrication/ manufacturing industry.
2 identify the stages of the product life cycle and related challenges
3 application of industrial engineering theory and practice to the area of operations management andproduction planning/control

UNIT I **10 Hrs**

Introduction

Scope of computer integrated manufacturing, product life cycle, production automation. Group technology: Role of group technology in CAD/CAM integration, methods for developing part families, classification and coding, examples of coding systems, facility design using group technology, economics of group technology.

Learning outcomes:

At the end of this unit, the student will be able to know the

- understand importance and scope of CIM in fabrication/ manufacturing industry. [L1]
- demonstrate automated production and assembly lines. [L2]
- identify the stages of the product life cycle and related challenges. [L2]
- learn the importance of group technology. [L1]

UNIT II **10 Hrs**

Computer Aided Process Planning

Role of Process Planning, Approaches to process planning- manual, variant, generative approach, Implementation techniques, process planning systems – CAM-I'S CAPP system, MI Plan system, criteria for selecting a CAPP system, benefits and advantages of CAPP

Learning outcomes:

At the end of this unit, the student will be able to know the

- demonstrate automated storage/retrieval system. [L1]
- understand the computer aided process planning. [L1]
- acquiring the knowledge of different forms of learning. [L3]

UNIT III **9 Hrs**

Integrative Manufacturing Planning and Control

Role of integrative manufacturing in CAD /CAM integration, over view of production control, forecasting, master production schedule, capacity planning, MRP, order release, shop-floor control, quality assurance, planning and control systems, cellular manufacturing, JIT manufacturing philosophy.

Learning outcomes:

At the end of this unit, the student will be able to know the

- application of industrial engineering theory and practice to the area of operations management and production planning/control. [L3]
- analysis and understanding of forecasting, aggregate planning, capacity planning, materials requirement planning, inventory management, short-term scheduling and sequencing. [L2]
- ability to use and compare various statistical forecasting models [L2]
- knowledge of lean manufacturing, tools, techniques and implementation outcomes. [L1]
- understanding of just-in-time systems. [L1]

UNIT IV **8 Hrs**

Computer Aided Quality Control

Terminology in quality control, Automated inspection principles and methods, computer aided inspection, computer aided testing, contact inspection methods, noncontact inspection methods, integration of CAQC with CAD/CAM.

Learning outcomes:

At the end of this unit, the student will be able to

- demonstrate automated inspection system. [L2]
- apply the knowledge of inspection techniques. [L3]
- understand the concept of integration of CAQC with CAD/CAM. [L2]
- apply knowledge about computer aided quality control and process planning. [L3]

Text Books

1. Mikell P. Groover, Automation, Production Systems, and Computer Aided Manufacturing, 2/e., Prentice Hall,2001
2. Mikell P. Groover, and Zimmers, CAD/CAM: Principles and Applications, 3/e, Tata-McGraw hill, 2010.
3. Dr.Sadhu Singh, Computer Aided Design and Manufacturing, Khanna Publishers

Reference Books

1. M.M.M. Sarcar, K. Mallikarjuna Rao, K. Lalit Narayan, Computer Aided Design and Manufacturing, 2/e, Prentice Hall of India, 2008.

Evaluation Procedure						
	Total 70 Marks					
	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2

Continuous Evaluation						
Sem End Examination	Total 30 Marks					

Course Outcome - Programme Outcome Mapping															
Course Outcomes:	**Programme Outcomes**														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1						2								2	
2		2				1							2		
3		3											1		
4			2										1		
5		2											1		
6															

	Course Code	Course Title	L	T	P	J	S	C
	EME-	**AUTOMATION IN MANUFACTURING**	3	0	0	0	0	3
	Course Owner	Department of Mechanical Engineering	**Syllabus version**					
	Course Pre-requisite(s)	Manufacturing Processes, Introduction to CAD,CAM and Practical CNC Machining, Measurements and Metrology	**Contact hours**					
	Course Co-requisite(s)	NIL	**Date Approved**					
	Alternate Exposure	Not Required						

Course Description

Automated manufacturing systems operate in the factory on the physical product. They perform operations such as processing, assembly, inspection and material handling. Manufacturing automation is the use of control systems, such as computers and information technologies for handling different processes and machines in an industry to replace a human being. Students will get exposure to automated manufacturing systems and their importance in themodern automated factory.

Course Objectives:

1 To learn various concepts of automation and work part transport mechanisms
2 To study the assembly systems and their applications.
3 To understand the importance of handling systems and identification systems.
4 To apply the concepts of part families and machine cells into various production systems
5 To recognize the importance of automated inspection and to distinguish the various control systems

Course Outcomes:

1 After the successful completion of this course, the student will be able to understand various concepts ofautomation and work part transport mechanisms
2 recognize the importance of handling systems and identification systems.
3 understand various production systems and transfer lines and their applications
4 differentiate various quality control aspects and automatic inspection techniques in automation

Unit-I **10 hours**

Manufacturing and Automation-Over View: Production systems, Automation in production systems, Automation principles and strategies, Reasons for Automation, Manufacturing operations, Functions in Manufacturing, Information processing in Manufacturing plant layout, production facilities. Basic elements of an automated system, levels of automation; Hardware components for automation and process control, programmablelogic controllers and personal computers. Automation for machining operations.

Learning outcomes:

At the end of this unit, the student will be able to

- recognize the significance of automation in production[L2]
- examine the various configurations of transfer lines, features and how they work[L2]

Unit-II **10 hours**

Assembly Systems and Line Balancing- Assembly Process-Assembly lines-manual single stations assembly, Manual assembly line, automated assembly system-Line balancing. Automated Assembly Systems – Design for automated assembly-Types of automated assembly systems-Parts feeding devices.

Learning outcomes:

At the end of this unit, the student will be able to

- explain the basic concepts of assembly process and the systems[L2]
- solve the line balancing problems[L3]

Unit-III **9 hours**

Automated Material Handling and storage system: Material Handling and Identification Technologies: Material handling, equipment, Storage systems, performance and location strategies, Automated storage systems, AS/RS, types. Functions, material handling equipment-Conveyors, AGVS, Industrial Robots-Anatomy, Robot configurations, work volume-AS/RS. Automatic identification methods, Barcode technology, RFID.

Learning outcomes:

At the end of this unit, the student will be able to

- recognize the importance of various automated material storage and handling systems(AS/RS)[L2]
- understand the role of identification systems in AS/RS[L2]

Unit-IV **8 hours**

Manufacturing Systems and Automated Production Lines: Manufacturing systems: components of a manufacturing system, Single station manufacturing cells,Automated production lines, Applications, Transfer lines.

Learning outcomes:

At the end of this unit, the student will be able to

- understand the fundamentals of automated production lines[L2]
- recognize the applications of transfer lines[L2]

Unit-V **8hours**

Control Systems-Process Industries Versus Discrete Manufacturing Industries, Continuous Versus Discrete Control: Continuous Control Systems, Discrete Control Systems, Computer Process Control: Control Requirements, Capabilities of Computer Control, Forms of Computer Process Control

Quality Control and Support Systems-Quality in Design and manufacturing, inspection principles and strategies, Automated inspection, contact and non-contact, CMM and machine vision techniques.

Learning outcomes:

At the end of this unit, the student will be able to

- examine the principles of automated inspection and sensor technologies[L2]
- recognize various control systems used in automation[L2]

Text Books

1. Milkell P. Groover, Automation, Production Systems and Computer Integrated Manufacturing, Kindle Edition, Prentice Hall of India, 2016.

Reference Books

1. C. Roy, “Robots and Manufacturing Automation”, Asfahl John Wiley & Sons.
2. Krishna Kant, “Computer Based Industrial Control”, EEE-PHI, 2nd edition, 2010.

<table>
<tr><th colspan="7">Evaluation Procedure</th></tr>
<tr><th rowspan="3">Continuous Evaluation</th><th colspan="6">Total 70 Marks</th></tr>
<tr><td>Quiz 1</td><td>Quiz 2</td><td>Quiz 3</td><td>Assignment</td><td>CAT 1</td><td>CAT 2</td></tr>
<tr><td>5</td><td>5</td><td>5</td><td>15</td><td>20</td><td>20</td></tr>
<tr><th>Sem End Examination</th><td colspan="6">Total 30 Marks</td></tr>
</table>

Course Outcome - Programe Outcome Mapping															
Course Outcomes:	**Programme Outcomes**														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	0	3	0	0	0	2	0	0	0	1	1	0	0	1	1
2	2	3	0	0	0	2	0	0	0	1	1	0	0	1	1
3	0	3	0	0	0	2	0	0	0	1	1	0	0	1	1
4	0	3	0	0	0	2	0	0	0	1	1	0	0	1	1
5	0	3	2	0	0	2	0	0	0	1	1	0	0	1	1

Course Code	Course Title	L	T	P	J	S	C
	IT IN MANUFACTURING	3	0	0	0	0	3
Course Owner	Department of Mechanical Engineering	**Syllabus version**				1	
Course Pre-requisite(s)	NIL	**Contact hours**					
Course Co-requisite(s)	NIL	**Date Approved**					
Alternate Exposure	NIL						

Course Description

This course exposes the students on diversity of digital controlled manufacturing processes and information systems developments. It also focuses on use of information technology in manufacturing applications in the organizations.

Course Objectives:

1 To understand the concepts of digital manufacturing system
2 To study the importance of organization and management information systems
3 To understand the concepts of Information Technology Infrastructure
4 To understand the techniques of product life cycle management
5 To illustrate the application of digital manufacturing using information technology

Course Outcomes:

1 Understand the concepts of Digital manufacturing information system [L1].
2 Understand the information systems in manufacturing functions [L1].
3 Apply knowledge on IT Infrastructure and Emerging Technologies [L3].
4 Analyze the functionality of the PLM Systems [L4].
5 Understand the application of Digital and Smart Manufacturing [L1].

UNIT I **10 Hrs**

Introduction to manufacturing systems and digital manufacturing

Introduction to manufacturing systems and approach: Manufacturing organizations, management, and the networked enterprises, Globalization challenges and opportunities, Dimensions of Information systems, Approaches to study information system, Technical and Behavioural approach. Introduction to Digital Manufacturing: Definition of digital manufacturing, Operation Mode and Architecture of Digital Manufacturing System.

Learning outcomes:

At the end of this unit, the student will be able to

- *Understand the manufacturing information systems [L1]*
- *Comprehend the concept of digital manufacturing [L2]*

UNIT II **9 Hrs**

Organizations, management, and the networked enterprise

Information systems in global business today, Global e-business: Use of information systems in manufacturing functions, information system, organizations, and strategy, ethical and social issue in information systems.

Learning outcomes:

At the end of this unit, the student will be able to

- *Understand the organizational information system [L1]*
- *Understand the e-business concepts using information system [L1]*

UNIT III **9 Hrs**

Information Technology Infrastructure

IT Infrastructure and Emerging Technologies, Foundations of Business Intelligence: Databases and Information Management, Telecommunications, the Internet, and Wireless Technology, Securing Information Systems, Shop floor communications.

Learning outcomes:

At the end of this unit, the student will be able to

- *Comprehend the concept of Information technology infrastructure [L2]*
- *understand the IT Infrastructure and Emerging Technologies [L1]*

UNIT IV **8 Hrs**

Product Life Cycle Management

Introduction, Types of Product Data, PLM systems, Features of PLM System, System architecture, Product information models, Functionality of the PLM Systems.

Learning outcomes:

At the end of this unit, the student will be able to

- *Understand the concepts of Product life cycle [L1]*
- *analyze the functionality of the PLM Systems. [L4]*

UNIT V **9 Hrs**

Key System Applications

Achieving Operational Excellence and Customer Intimacy: Enterprise Applications, E-Commerce: Digital Markets, Digital Goods, Managing Knowledge and Collaboration, Enhancing Decision Making.

Learning outcomes:

At the end of this unit, the student will be able to

- *identify different areas of Digital and Smart Manufacturing and its applications [L4]*

Text Books

1. K. Laudon and J. Laudon, Management Information Systems, 14th edition, Pearson Higher Education, 2016, ISBN: 9780136093688.
2. F. Cecelja, Manufacturing Information and Data Systems, 1st edition, Butterworth - Heinemann, 2002, ISBN: 97 81857180312.

Reference Books

1. T. O. Boucher and A. Yalçin, Design of Industrial Information Systems, 1st edition, Elsevier, 2006, ISBN: 9780123704924.
2. K. E. Kurbel, Enterprise Resource Planning and Supply Chain Management: Functions, Business Processes and Software for Manufacturing Companies, 1st edition, Springer, 2013, ISBN: 9783662509869.
3. Antti Saaksvuori and Anselmi Immonen, "Product Life cycle Management", Springer, 2004.
4. M. P. Groover, Automation, Production systems and Computer Integrated manufacturing. 3rd edition, Pearson Education, 2015. ISBN: 978-9332549814.
5. M. Kuniavsky, Smart Things: Ubiquitous Computing User Experience Design, 1st edition, Morgan Kaufmann, 2010, ISBN-10: 0123748992

Evaluation Procedure						
Continuous Evaluation	**Total 70 Marks**					
	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2
	20	20	20	10	40	30
Sem End Examination	Total 30 Marks					

Course Outcome - Programe Outcome Mapping															
Course Outcomes:	**Programme Outcomes**														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1		2		2	3	2					2	1	2	3	2
2		2		1	3	3						2	2	1	2
3		1		2	2	3						2	2	1	2
4		1		2	2	2					1	2	2	1	2
5		1		1	2	2				2	1	2	2	2	2

Course Code	Course Title	L	T	P	J	S	C
EME467	CONTROL SYSTEMS ENGINEERING	3	0	0	0	0	3
Course Owner	Department of Mechanical Engineering	Syllabus version					
Course Pre-requisite(s)	Basics of Physics and Mathematics, Mechanics of Machinery	Contact hours					
Course Co-requisite(s)	None	Date Approved					
Alternate Exposure							

Course Description

This course is designed with the fundamentals of control system for advanced courses. It lays foundation for designing a control system, finding out its transfer function using different techniques, conversion from time domain to either s-domain or frequency domain, identifying the stability condition of the control system. It also aids in studying about sampled data control system, ways to identify stability of the system along with sampling process for sampled data control system.

Course Objectives:

1 To provide adequate knowledge about open and closed loop control systems.
2 To analyze the transfer function of physical systems and introduce the control system components.
3 To evaluate the response of the different order systems and analyze steady state error.
4 To analyze the stability of the control systems and to study about sampling process.
5 To understand sample data control system.

Course Outcomes:

1 design solutions for complex control system using different models.
2 formulate a model and apply the basic principles to analyse it.
3 apply the knowledge to solve complex control systems.
4 select and apply appropriate techniques for analyzing stability of the control systems.
5 analyze the response of different order systems for various inputs.

UNIT I **8 Hrs**

Introduction to Control Systems

Basic elements of control systems. Examples of control systems: Simple pneumatic, hydraulic and thermal systems, open loop and closed loop control systems, series and parallel electrical systems, analogies, mechanical and electrical components.

UNIT II **8 Hrs**

Techniques to Find Transfer Function

Feedback characteristics and effects of feedback, transfer function, Block diagram reduction technique, reduction of block diagrams, output to input rations. signal flow graph (SFG) technique, Mason's gain formula, block diagram to SFG, representation of linear equations in SFG form.

UNIT III **8 Hrs**

Transient and Steady-State Response Analyses

Laplace transformation, response of systems to different inputs viz. Step, impulse, pulse, parabolic and sinusoidal inputs, time response of first and second order systems, Time domain specifications, steady state errors and error constants of **UNIT** y feedback circuit.

UNIT IV **8 Hrs**

Stability Analysis
Stability definitions, characteristic equation, location of roots in the s-plane for stability, Routh - Hurwitz criteria of stability, frequency response, basic concepts of Nyquist stability criteria

UNIT V **8 Hrs**

Sampled Data Control Systems
Sampled data control systems - functional elements, sampling process, z-transforms, properties, inverse z-transforms, response between samples-modified z-transforms, ZOH and first order hold process, mapping between s and z planes, pulse transfer functions, step response, stability analysis - Jury's stability test.

Text Books

1 Katsuhiko Ogata., Modern Control Engineering, 4/e, Prentice Hall of India, 2004.
2 I J Nagrath and GopalM., Control Systems Engineering, 4/e, New Age International, 2006.

Reference Books

1 Benjamin, C Kuo, Automatic Control System, 7/e, Prentice Hall of India, 1993.
2 Richard, C. Dorf and Robert H. Bishop., Modern Control System Engineering, Addison Wesley, 1999.

Evaluation Procedure					
Continuous Evaluation	Total 70 Marks				
	Quiz 1	Quiz 2	Quiz 3	Assignment CAT 1	CAT 2
Sem End Examination	Total 30 Marks				

Course Outcome - Programe Outcome Mapping															
Course Outcomes:	**Programme Outcomes**														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	3	1	3			1							2	2	1
2	3	2	2										2	2	1
3	3												3	2	1
4	2	1		3		1							3	2	1
5		3		2		1							2	2	1

<table>
<tr><td>Course Code</td><td>Course Title</td><td>L</td><td>T</td><td>P</td><td>J</td><td>S</td><td>C</td></tr>
<tr><td></td><td>INTRODUCTION TO ROBOTICS</td><td>3</td><td>0</td><td>0</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Course Owner</td><td>Department of Mechanical Engineering</td><td colspan="4">Syllabus version</td><td colspan="2"></td></tr>
<tr><td>Course Pre-requisite(s)</td><td>Engineering Mechanics, Higher Engineering Mathematics, Basic electrical and Electronics Engineering</td><td colspan="4">Contact hours</td><td colspan="2"></td></tr>
<tr><td>Course Co-requisite(s)</td><td>Kinematics and Dynamics of Machinery</td><td colspan="4">Date Approved</td><td colspan="2"></td></tr>
<tr><td>Alternate Exposure</td><td colspan="7"></td></tr>
</table>

Course Description

This course helps in understanding the basics of robotics such as origin of robotics, types of robotics and various generation of robots. This course teaches the fundamentals of robotics required to design the robot anatomy, kinematics of robots, robot dynamics, robot drive systems, robot programming and its applications. The Knowledge gained from this course is to apply the concepts in handling the automated systems like assembly systems, material handling systems, storage, and retrieval systems

Course Objectives:

1. To familiarize the history and automation of robot, robot anatomy and its applications.
2. To enhance the knowledge about robot end effectors, sensors, and their design as well as their applications.
3. To illustrate the working of sensors and robotic vision system in robot operations/environment.
4. To impart computational skills related to kinematic model of robots and acquire knowledge about Robot Programming methods & Languages of robot.
5. To develop the ability of designing the robotic work cell systems and to maintain safety rules in integration of collaborative robots.

Course Outcomes:

1. Illustrate different types of robots as per their configuration and workspace
2. Understand the basic components of robots drive systems, robot grippers and the control mechanism of robot manipulators
3. Comprehend and interpret various aspects relating to the sensors of robots and robot vision system
4. Compute and analyse the Forward and inverse kinematic models of robots, robot programming languages
5. Design of robot work cells and their operational work-space characteristics, interpret basic safety guidelines for robotic applications

UNIT I **8 Hrs**

Fundamentals of Robotics

Introduction to robot, definition need and scope of robots, laws of robotics, robot anatomy, co-ordinate system, work envelop, robot classification, robot parts and functions, need of robot and its applications

UNIT II **10 Hrs**

Robot Drive systems and Control

Design of drive systems, Mechanical, hydraulic, and pneumatic drives, electric drives, motors, designing of end effectors, mechanical, hydraulic, vacuum, and magnetic grippers, Open and close loop control, linear control and PID control schemes of robotic manipulators.

UNIT III **8 Hrs**

Robot Sensors and Machine vision

Sensors in robotics, need of sensors, position sensor, tactile sensor, proximity and range sensors, wrist-force sensing, frame grabbers, robotic vision system, components of vision systems, image representation, image processing industrial applications of vision-controlled robotic systems

UNIT IV **10 Hrs**

Robot Kinematics and Robot Programming
Forward and inverse kinematics of manipulators, Homogeneous transformations, D-H parameter notation, Jacobian notation, Joint space techniques, Cartesian space techniques, trajectory planning. Robot Programming Methods, and programming languages for robotics.

UNIT V **8 Hrs**

Robot Cell Design and Application
Robot work cell design and control, safety in robotics, robot cell layouts, multiple robots and machine interference, robot cycle time analysis. Industrial application of robots.

Text Books

1. Robotics and Control / Mittal R K & Nagrath I J / TMH
2. Robotics: Control, sensing, vision and intelligence, Fu, K., Gonzalez, R. and Lee, C. S. G McGraw Hill.

Reference Books

1. Robotics: Fundamental concepts and analysis, A. Ghosal, Oxford university press
2. Mikell P. Groover, Mitchell Weiss, Roger N. Nagel, Nicholas G. Odrey, Industrial Robotics, Technology programming and Applications, McGraw Hill International Edition, 2014
3. K.S. Fu, R.C. Gonzalez, C.S.G. Lee, Robotics Control, Sensing Vision and Intelligence, McGraw Hill Book Company, 2008

Evaluation Procedure						
	Total 70 Marks					
	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2
Continuous Evaluation						
Sem End Examination	Total 30 Marks					

Course Outcome - Programe Outcome Mapping															
	Programme Outcomes														
Course Outcomes:	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	3	3	3	2	1	3	0	0	1	1	2	1			2
2	3	3	3	2	1	2	0	0	1	1	2	1		3	
3	3	2	3	2	1	3	0	0	1	1	2	1	3		
4	3	3	3	2	1	1	0	0	1	1	2	1			2
5	3	3	3	2	1	2	0	0	1	1	2	1	2		

PROGRAM ELECTIVES

Course Code	Course Title	L	T	P	J	S	C
PE	ADVANCED STRENGTH OF MATERIALS	3	0	0	0	0	3
Course Owner	Department of Mechanical Engineering	Syllabus version					
Course Pre-requisite(s)	Strength of Materials	Contact hours					
Course Co-requisite(s)	None	Date Approved					
Alternate Exposure	Mathematics						

Course Description

This course introduces advanced topics in solid mechanics such as columns, thick cylinders and curved beams. It explains the failure phenomenon to be considered for the design of structures as well as techniques to solve statically indeterminate structures.

Course Objectives:

1 To introduce the concept of columns and struts
2 To demonstrate the calculation of bending moments and deflections of fixed and continuous beams.
3 To explain the concept of shear center and curved beams
4 To calculate stresses in thick & compound cylinders
5 To analyze fracture in solids

Course Outcomes:

After successful completion of this course student will be able to
1 Design and analyze a column/strut for different loading conditions [L3]
2 Evaluate the moments, deflections in fixed and continuous beams [L4]
3 Locate shear center and calculate stresses in curved beams [L4]
4 Analyze stresses due to shrink fits in cylindrical pressure vessels [L4]
5 Analyze the modes of failure due to various types of loading [L4]

Specific Instructional Objectives

1 Review of mathematics and numerical methods for understanding of equations
2 Review of statically indeterminate structures
3 Solving of problems modelled on GATE/IES and other competitive exams

UNIT I **10 Hrs**

Columns and Struts

Euler's theory, equivalent length, limitations of Euler's theory, Rankine formula, strut with eccentric loading, strut with initial curvature- Simple problems.

Learning Outcomes:

After completing this **UNIT**, the student will be able to
• contrast between a column and strut [L2]
• differentiate between short and long columns [L2]
• analyze columns at different loading conditions [L4]

UNIT II **10 Hrs**

Fixed and continuous beams

Moment-area method, Macaulay's method, Clapeyron's three-moment equation, moment distribution method.

Learning Outcomes:

After completing this **UNIT** , the student will be able to
• recognize statically indeterminate beams [L2]
• analyze fixed and continuous beams [L4]

UNIT III **8 Hrs**

Shear Center & Curved Beams
Shear centre: Shear flow in thin-walled sections, shear center for axi-symmetric and unsymmetrical sections. Curved Beams: Winkler-Bach formula, Neutral axis of rectangular, circular and trapezoidal cross-sections, problems related to stresses in curved beams.

Learning Outcomes:
After completing this **UNIT** , the student will be able to
• find the shear center [L4]
• determine the stresses in beams due to nonsymmetrical bending [L4]

UNIT IV **8 Hrs**

Thick Cylinders
Lame's equation for stresses in thick cylinders, Stress distribution in Compound Cylinders – Shrink fits.Learning Outcomes::
After completing this **UNIT** , the student will be able to
• calculate different types of stresses in thick cylindrical pressure vessels [L2]
• analyze compound cylinders [L4]

UNIT V **9 Hrs**

Fracture Mechanics
Brittle Fracture, Stress Intensity Factor, Fracture Toughness, Fracture Conditions, Fracture Modes

Learning Outcomes::
After completing this **UNIT** , the student will be able to
• understand the mechanism of fracture [L2]
• analyze the modes of fracture [L4]

Text Books
1. S. S. Rattan, Strength of materials, 3/e, Tata McGraw-Hill, 2016.
2. L. S. Srinath, Advanced mechanics of solids, 3rd Edition, McGraw-Hill, 2009.

Reference Books
1. R. G. Budynas, Advanced Strength and Applied Stress Analysis, 2nd Edition, McGraw Hill, 1999.
2. P. Boresi, R. J. Schmidt, Advanced Mechanics of Materials, 6th Edition, John Willey and Sons, 2009.
3. M. H. Sadd, Elasticity: theory, applications, and numeric, 3rd edition, Academic Press, 2014.

Evaluation Procedure						
Continuous Evaluation	**Total 70 Marks**					
	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2
	10	10	10	10	15	15
Sem End Examination	Total 30 Marks					

Course Outcome - Programe Outcome Mapping															
Course Outcomes:	**Programme Outcomes**														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	3	1	1	1	0	1	0	0	0	0	1	1	3	2	1
2	3	1	3	1	0	1	0	0	0	0	1	1	3	2	1
3	3	1	3	1	0	1	0	0	0	0	1	1	3	2	1
4	3	1	2	1	0	1	0	0	0	0	1	1	3	2	1
5	3	1	3	1	0	1	0	0	0	1	1	1	3	2	1
6															

	Course Code	Course Title	L	T	P	J	S	C
	19EME352	FINITE ELEMENT ANALYSIS	3	0	0	0	0	3
	Course Owner	Department of Mechanical Engineering	Syllabus version					
	Course Pre-requisite(s)	Engineering Mathematics, Strength of Materials	Contact hours					
	Course Co-requisite(s)	None	Date Approved					
	Alternate Exposure							

Course Description

Finite Element Analysis is an approximate technique to solove the complex domain problems for which no closed form solutions are available. This course exposes the students to deal with various modeling techniques and uses different numerical methods for solving a system of governing equations over the domain of a continuous physical system, which is discredited into simple geometric shapes called finite element. This course also capitalizes on knowledge of mechanics and solves problems that can only be tackled numerically on the computer.

Course Objectives:

1 Introduce the basic principles of finite element analysis.
2 Teach procedure to develop FEA model that represent a physical structure.
3 Discuss the finite element solutions to static and dynamic structural problems.
4 Demonstrate the methodology to model and to solve complex problems in engineering applications
5 Familiarize the students with the knowledge and skills needed to effectively use commercial finite element software.

Course Outcomes:

1 Understand the capability of FEA in mechanical engineering problems
2 Comprehend the solution path to engineering problems.
3 Apply the theoretical FEA concepts in solving simple to complex multi-physics FEA problems using advanced software's.
4 Infer and analyze the results obtained from finite element analysis software
5 Make transparent judgments` with regards to the design or issues related to engineering problems

UNIT I **8 Hrs**

Introduction

Introduction: Historical Perspective of FEM and applicability to mechanical engineering problems. **Fundamental Concepts:** Stresses and Equilibrium, Boundary conditions, Strain-Displacement relations, Stress-Strain relations, Plane stress, Plane strain, Temperature effects, Potential energy and Equilibrium. Raleigh-Ritz method, Galerkin's method, Saint Venant‟s principle.

UNIT II **8 Hrs**

One Dimensional Problems

One-dimensional Problems: Finite element modeling coordinates and Shape functions. Potential energy approach. Galerkin approach, Assembly of the global stiffness matrix- mass matrix and load vector, Treatment of boundary conditions, Quadratic shape functions, Temperature effects. **Trusses:** Plane trusses, Three-dimensional trusses.

UNIT III **8 Hrs**

Two Dimensional Problems

Two-dimensional Problems Using Constant Strain Triangles: Finite element modeling, Constant strain triangle, in plane and Bending, problem modeling and boundary conditions.
Axisymmetric Solids subjected to Axisymmetric Loading: Axisymmetric formulation, Finite element modeling -triangular element, Problem modeling and boundary conditions.

UNIT IV **8 Hrs**

Isoparametric Elements and Beams
Two-dimensional Isoparametric Elements and Numerical Integration: Four-node quadrilateral, Numerical integration, Higher-order elements.
Beams: Finite element formulation, Load vector, Boundary considerations, Shear force and bending moment.

UNIT V **8 Hrs**

Dynamic considerations and Scalar field problems
Dynamic considerations: formulation, element mass matrices, evaluation of Eigen values and Eigen vectors.
Scalar field problems: Steady state heat transfer condution and convection.

Text Books

1 Tirupathi.R.Chandrupatla, Ashok.D.Belegundu "Introduction to Finite Elements in Engineering", Pearson Education Limited, fourth edition ,2015

2 S.S.Rao, "Finite element method in engineering", Elsevier Butterworth-Heinmenn publications, fourth edition, 2011.

Reference Books

1 Oc Zienkiewicz, Rl Taylor, Jz Zhu," Finite Element Method Its Basis & Fundamentals" Reed Elsevier India Pvt.Ltd, 2015 edition.

2 JN Reddy, "An Introduction to the Finite Element Method" McGraw-Hill, 3rd edition, 2006.
3 P.Seshu ,"Finite element Analysis", PHI Learning Pvt. Ltd, first edition, 2003.

Evaluation Procedure						
Continuous Evaluation	**Total 70 Marks**					
	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2
	10	10	10	10	15	15
Sem End Examination	Total 30 Marks					

Course Outcome - Programe Outcome Mapping															
Course Outcomes:	**Programme Outcomes**														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1					2	3									
2	1	3	3	3				2	1		3		2		3
3	3	3	3	3		3		2			3		3	1	1
4			3	3		1		2			1		3	2	1
5			1	1		2	3	3	2		2	1	3	1	

Course Code	Course Title	L	T	P	J	S	C
	MECHANICAL VIBRATIONS	3	0	10	0	0	8
Course Owner	Department of Mechanical Engineering	**Syllabus version**					
Course Pre-requisite(s)	None	**Contact hours**					
Course Co-requisite(s)	None	**Date Approved**					
Alternate Exposure							

Course Description

The primary objective of this course is to enable to build and solve mathematical models of vibrating systems. The response of single and two degree of freedom systems and continuous system under free and forced vibrations will also be covered. This course also introduces various vibrating instruments.

Course Objectives:

1 To introduce the concept of vibration and its classifications.
2 To explain the response of a vibratory system under harmonic force.
3 To explain the analysis of two degree of freedom systems.
4 To evaluate the natural frequencies and mode shapes of vibrating systems.
5 To explain different vibration measuring instruments.

Course Outcomes:

1 Develop the differential equation of motion of vibratory systems and analyze spring constants, masses, damping constants, natural frequency of single degree of freedom systems
2 Analyse harmonically excited single-degree-of-freedom vibration systems.
3 Formulate the equations of motion of two-degree-of-freedom systems
4 Determine the natural frequencies of vibration and the modal vectors by using Dunkerley's formula, Rayleigh's method, Holzers' method, Matrix iteration method, Jacobi's method
5 Design and conduct experiments to predict the vibrations.

UNIT I **8 Hrs**

Fundamentals of Vibration

Brief history of vibration, Importance of the study of vibration, basic concepts of vibration, classification of vibrations

Free Vibration of Single Degree of Freedom Systems: Introduction, Free vibration of an undamped translational system, free vibration of an undamped torsional system, Raleigh's energy method, free vibration with viscous damping

UNIT II **8 Hrs**

Harmonically Excited Vibrations

Introduction, Equation of motion, response of an undamped system under harmonic force, Response of a damped system under harmonic force, Response of a damped system under harmonic motion of the base.

UNIT III **8 Hrs**

Two Degree of Freedom Systems

Introduction, Equation of motion for forced vibration, free vibration analysis of an undamped system, Torsional system

UNIT IV **8 Hrs**

Determination of Natural Frequencies and Mode Shapes
Introduction, Dunkerley's formula, Rayleigh's method, Holzers' method, Matrix iteration method, Jacobi's method.

UNIT V **8 Hrs**

Vibration Measurement
Variable Resistance Transducers, Piezoelectric Transducers, Electrodynamic Transducers, Linear Variable Differential Transformer Transducer, Vibration Pickups – Vibrometer, Accelerometer, Velometer, Phase Distortion Frequency-Measuring Instruments, Vibration Exciters-Mechanical Exciters, Electrodynamic Shaker.

Text Books
1 S.S.Rao, Mechanical Vibrations, 5/e, Pearson publications, 2010.

Reference Books
1 G.K. Grover, Mechanical Vibrations, 8/e, S. Chand & Co.
2 W.T. Thomson, Mechanical Vibrations, 2/e, Prentice Hill India.
3 S. Graham Kelly, Fundamentals of mechanical vibrations, 2/e McGraw-Hill.

Evaluation Procedure					
Continuous Evaluation	**Total 70 Marks**				
	Quiz 1	Quiz 2	Quiz 3	Assignment CAT 1	CAT 2
Sem End Examination	Total 30 Marks				

Course Outcome - Programe Outcome Mapping															
Course Outcomes:	**Programme Outcomes**														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	3	2	2	1	0	0	0	0	0	1	2	0	2	2	1
2	3	2	2	1	0	0	0	0	0	1	2	0	2	2	1
3	3	2	2	1	0	0	0	0	0	1	2	0	2	2	1
4	3	3	3	1	0	0	0	0	0	1	2	0	2	2	1
5	3	3	3	1	0	0	0	0	0	3	2	0	2	2	1
6															
Date of Approval															

	Course Code	Course Title	L	T	P	J	S	C
	EME…	TURBO MACHINERY	3	0	0	0	0	3
	Course Owner	Department of MechanicalEngineering	Syllabus version				1	
	Course Pre-requisite(s)	Fluid Mechanics, Thermodynamics.	Contact hours					
	Course Co-requisite(s)	NIL	Date Approved					
	Alternate Exposure	NIL						

Course Description

Turbo machines are basically rotodynamic machines which work on the principles of dynamic action. This coursedeals with the definition of a turbo machines, main parts, classification and its comparison with positive displacement machines. The first and second laws of thermodynamics, adiabatic efficiency, drawing of velocity triangles diagram, dimensionless parameters are the common factors for the calculation of power of the turbo machines.

Course Objectives:

1 Evaluate which turbine to be used in a Hydro Power Plant or a Gas Power Plant.
2 Calculate the main dimensions of hydro- and steam-turbines.
3 Evaluate which pump or compressor to be used in a process-, gas- or a fluid-system.
4 To have knowledge about Hydro turbines, Gas turbines, Pump turbines, Centrifugal pumps andCompressors.
5 Use this knowledge in projects where these turbo machinery is a part of for example a process system or apower plant

Course Outcomes:

1 Understand the basics of turbo machines including dimensional analysis (L1)
2 To understand the principles and energy transfer process in turbo machines. (L2)
3 To understand the structural and functional aspects of major components of turbo machines. (L3)
4 Develop the application of fuel cell in automobiles [L3]
5 Analyse the turbo machines to improve and optimize its performance (L4)
6 To understand control and maintenance aspects of turbo machines (L4)

UNIT I

Introduction: Definition of turbo machine, parts of turbo machines, Comparison with positive displacement machines, Classification of turbo machines, Dimensionless parameters and their significance, UNIT and specific quantities, model studies and its numerical.

Thermodynamics of fluid flow: Application of first and second law of thermodynamics to turbo machines, Efficiencies of turbo machines, Static and Stagnation states, overall isentropic efficiency, stage efficiency and polytropic efficiency for both compression and expansion processes. Reheat factor for expansion process.

Learning Outcomes:

- Able to identify the main parts of turbo machines, Classify turbo machines. and compare it with positivedisplacement machines (L1)
- Understand the effect of Reynolds number, specific speed & dimensionless parameters and their physicalsignificance on turbo machines (L2)
- Know Compression process – Overall isentropic efficiency of compression; Stage efficiency, Polytropicefficiency and preheat factor (L3)
- Explore the principles of model studies and apply same to design of turbo machines (L3)

UNIT II

Energy transfer in Turbo machines: Euler's turbine equation, Alternate form of Euler's turbine equation, Velocity triangles for different values of degree of reaction, Components of energy transfer, Degree of Reaction, utilization factor, Relation between degree of reaction and Utilization factor.
General Analysis of Turbo machines: Radial flow compressors and pumps – general analysis, Expression for degree of reaction, velocity triangles, Effect of blade discharge angle on energy transfer and degree of reaction, Effect of blade discharge angle on performance. General analysis of axial flow pumps and compressors, degree ofreaction, velocity triangles

Learning Outcomes:

- Derive the Euler's turbine equation and explain the significance of components of energy transfer(L3)
- Define and discuss the significance of degree of reaction & derive an expression between utilization factorand degree of reaction. (L2)
- Learn how to draw velocity triangles diagram for axial flow compressors and pumps for different valuesof degree of reaction. (L2)
- Explain the general analysis of a turbo machine – effect of blade discharge angle on energy transfer anddegree of reaction. (L3)

UNIT III

Steam Turbines: Classification, Single stage impulse turbine, condition for maximum blade efficiency, stage efficiency, Need and methods of compounding, Multi-stage impulse turbine, expression for maximum utilization factor
Reaction turbine – Parsons's turbine, condition for maximum utilization factor, reaction staging.

Learning Outcomes:

- Explain the construction, working, types and classification of a steam turbine.(L2)
- Explain the condition for maximum blade efficiency, stage efficiency. (L2)
- Explain compounding - Need for compounding, Method of compounding.(L2)
- Explain impulse staging – Condition for maximum utilization factor for multi stage turbine withequiangular blades. L2)
- Explain Reaction turbine and Parson's reaction turbine, Discuss Condition for maximum blade efficiency,reaction staging.(L3)

UNIT IV

Hydraulic Turbines: Classification, various efficiencies.
Pelton Wheel – Principle of working, velocity triangles, design parameters, maximum efficiency
Francis turbine – Principle of working, velocity triangles, design parameters
Kaplan and Propeller turbines - Principle of working, velocity triangles and design parameters. Theory and typesof Draft tubes.
Learning Outcomes:

- Explain the construction, working and classification of water turbine. (L2)
- Explain design parameters of Pelton wheel. (L3)
- Explain Francis turbine, its velocity triangles, runner shapes for different blade speed and its design. (L3)
- Explain draft tubes and its types.(L2)
- Explain Kaplan and propeller turbines, its design parameters and velocity triangles.(L3)

UNIT V

Centrifugal Pumps: Classification and parts of centrifugal pump, different heads and efficiencies of centrifugal pump, Theoretical head – capacity relationship, Minimum speed for starting the flow, Maximum suction lift, Net positive suction head, Cavitation, Need for priming, Pumps in series and parallel.
Centrifugal Compressors: Stage velocity triangles, slip factor, power input factor, Stage work, Pressure developed, stage efficiency and surging
Axial Flow Compressors: Expression for pressure ratio developed in a stage – work done factor, efficiencies andstalling.

Learning Outcomes:

- Explain the construction, working and classification of Centrifugal pump. (L3)
- Explain suction, delivery and manometric heads, pressure rise in the impeller, and various efficiency termslike manometric efficiency, hydraulic efficiency, volumetric efficiency and overall efficiency.(L3)
- Explain multistage centrifugal pumps, minimum starting speed, slip, priming, cavitations (L3)
- Explain the construction and working of Centrifugal and an axial flow compressors.(L2)
- Analyze blade angles at impeller eye root and eye tip; slip factor and power input factor, width of theimpeller channel.(L4)

Text Books
1. Turbo Machines B.U.Pai Wiley India Pvt, Ltd 1st Edition Universities Press, Hyderabad, 2006.Machines,McGraw Hill Education, 2017
2. An Introduction to Energy Conversion, Volume III, Turbo machinery V. Kadambi and Manohar Prasad NewAge International Publishers reprint 2008 Applications, 3/e, Tata McGraw Hill, 2013.
3. Turbo machines M. S. Govindegowda and A. M. Nagaraj M. M. Publications 7Th Ed, 2012
4. Fundamentals of Turbo Machinery B.K Venkanna PHI Publishers

Reference Books
1. Fluid Mechanics & Thermodynamics of Turbo machines S. L. Dixon Elsevier 2005
2. Turbines, Compressors & Fans S. M. Yahya Tata McGraw Hill Co. Ltd 2nd edition, 2002 3. Principals ofTurbo machines D. G. Shepherd The Macmillan Company 1964

<table>
<tr><th colspan="7">Evaluation Procedure</th></tr>
<tr><td rowspan="3">Continuous Evaluation</td><td colspan="6">Total 70 Marks</td></tr>
<tr><td>Quiz 1</td><td>Quiz 2</td><td>Quiz 3</td><td>Assignment</td><td>CAT 1</td><td>CAT 2</td></tr>
<tr><td>5</td><td>5</td><td>5</td><td>15</td><td>20</td><td>20</td></tr>
<tr><td>Sem End Examination</td><td colspan="6">Total 30 Marks</td></tr>
</table>

Course Outcome - Programe Outcome Mapping															
Course Outcomes :	**Programme Outcomes**														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	2	1	0	0	0	0	0	0	0	0	0	0	0	1	0
2	1	2	0	0	0	0	0	0	0	0	0	0	0	1	0
3	2	3	1	0	0	0	0	0	0	2	1	0	1	1	0
4	3	3	0	0	0	0	0	0	0	2	1	0	1	1	0
5	3	3	0	0	0	0	0	0	0	2	1	0	1	1	0

	Course Code	**Course Title**	L	T	P	J	S	C
	19EME441	**COMPUTATIONAL FLUID DYNAMICS**	3	0	0	0	0	3
	Course Owner	Department of Mechanical Engineering	**Syllabus version**				1	
	Course Pre-requisite(s)	NIL	**Contact hours**					
	Course Co-requisite(s)	NIL	**Date Approved**					
	Alternate Exposure	NIL						

Course Description

This course helps to understanding the importance of governing equations while solving fluid flow problems. It explains the importance of Navier-Stokes equation, boundary conditions and various types of boundary conditions. Also, it explains essence of boundary conditions while solving the realistic physics involved in the engineering problems. The course helps to acquire the knowledge on formulation of mathematical model and its solution usingfinite difference and finite volume method. In addition to, various errors come across during simulation and importance of convergence, consistency of the solution. Moreover, it provides various grid generation and FVM methods to solve fluid flow problems. It explains the introduction to turbulence modelling and various models usedin fluid flow.

Course Objectives:

1 To provide the students with essential background to understand the mathematical representation of thegoverning equations for fluid flow problems.
2 To equip the students to formulate fluid flow problems by approximating the governing differentialequations with boundary conditions through Finite difference and finite volume discretization methods.
3 To acquire the knowledge of various grid generation methods and approximation of errors while solvingproblems subsequently suitability for different engineering applications.
4 To introduce various turbulence for solving engineering problems.

Course Outcomes:

1 Apply mathematics and engineering fundamentals to formulate mathematical problem by imposingappropriate boundary conditions and governing equations
2 Solve 1D and 2D governing equations using FDM schemes
3 Adopt appropriate grid generation methods for solving engineering problems accurately.
4 Solve fluid flow and heat transfer problems using commercial CFD tools.
5 Comprehend the application of turbulence models used in incompressible fluid flow analysis.

UNIT I 7 Hrs

Introduction

CFD overview, importance of CFD in modelling the engineering problems, application of CFD in variousengineering field. Conservative and Non-conservative form, Governing equations- Mass, Momentum and Energy.

Learning Outcomes:

After the completion of this UNIT, the student will be able to

- Understand the importance of CFD in various engineering applications (L1)
- Derive governing equations and deduce them according to physics involved in the problem. (L3)
- Comprehendthe difference between conservative and non-conservative forms

UNIT II **8 Hrs**

Biomass Pyrolysis

Numerical solution of PDE: Classification of PDEs- elliptic, parabolic and hyperbolic Boundary conditions: Classification of boundary conditions, explain with suitable example, definition of BVP and IVP; Finite difference method (FDM): Basic aspects of Discretization- Comparison of finite difference, finite volume, and finite element techniques

Learning Outcomes:

After the completion of this UNIT , the student will be able to

- Classify PDEs and identify them through examples(L1)
- Acquire the knowledge of boundary conditions used in CFD and implementation in governing equations (L2)
- Understand the discretization aspects of computational domain (L2)

UNIT III **8 Hrs**

Biomass Gasification

Finite difference method (FDM): Forward, Backward and Central difference schemes, Transient 1D and 2D conduction - Explicit, implicit. Stability analysis and error estimation

Learning Outcomes:

After the completion of this UNIT , the student will be able to

- Understand various FDM schemes(L2)
- Apply FDM schemes to both 1D and 2D problems (L2)
- Acquire the knowledge of stability analysis and estimation of error(L3)

UNIT IV **8 Hrs**

Biomass Combustion

Finite volume method (FVM): Concept of discretization, methods of deriving discretization equations, finite volume method for one dimensional steady state diffusion, conservativeness, boundedness, transportiveness, four basic rules for FV discretization, assessment of central and upwind differencing schemes

Learning Outcomes:

After the completion of this UNIT , the student will be able to

- Understand the basic rules of finite volume method and FVM discretization methods (L2)
- Analyze 1D steady state diffusive problems using FVM method(L3)
- Understand and learn various FVM schemes to discretize the pressure velocity coupling terms (L2)

UNIT V **9 Hrs**

Biogas

Incompressible Fluid Flow: Discretization of the momentum equation. Primitive variable approach, staggered gridand collocated grid, SIMPLE algorithm, SIMPLER algorithm. Introduction to turbulence models

Learning Outcomes:

After the completion of this UNIT, the student will be able to

- Understand the SIMPLE and SIMPLER algorithms. (L1)
- Apply and analyze both SIMPLE and SIMPLER algorithms to 1D steady diffusive problems.(L2)
- Learn elementary treatment of turbulence models(L3)

Text Books

1 J.D.Anderson Jr., Computational Fluid Dynamics, 2/e, McGraw Hill, 2012.
2 H.K.Versteeg and W. Malalasekera, An Introduction to Computational Fluid Dynamics: The FiniteVolume Method, Pearson, 2007

Reference Books

1 Gautam Biswas, Somenath Mukherjee, Computational Fluid Dynamics, Narosa, 2013
2 T.J.Chung, Introduction to Computational Fluid Dynamics, Cambridge University Press, 2010
3 J.H.Ferziger, M.Peric, Computational Methods for Fluid Dynamics, Springer, 2002

Evaluation Procedure						
Continuous Evaluation	**Total 70 Marks**					
	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2
	5	5	5	15	20	20
Sem End Examination	Total 30 Marks					

Course Outcome - Programe Outcome Mapping															
Course Outcomes :	**Programme Outcomes**														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	3	0	0	2	0	0	0	0	0	0	0	0	3	0	0
2	0	3	0	0	0	0	0	0	0	0	0	0	2	0	0
3	0	0	0	2	0	0	0	1	0	0	0	0	2	0	0
4	0	0	0	0	0	2	0	0	0	0	0	0	2	0	0
5	0	3	0	0	0	0	0	0	0	0	0	0	3	0	0
6															

Course Code	Course Title	L	T	P	J	S	C
	REFRIGERATION AND AIR CONDITIONING	3	0	0	0	0	3
Course Owner	Department of MechanicalEngineering	**Syllabus version**					
Course Pre-requisite(s)	NIL	**Contact hours**					
Course Co-requisite(s)	NIL	**Date Approved**					
Alternate Exposure	NIL						

Course Description

This course helpful to understand the working of various refrigeration systems and their applications. It helps to explore desired properties of refrigerants and selection of refrigerant for ecofriendly environment. The course provides fundamental understanding the concept of thermal comfort, prediction of thermal comfort and indices. Itprovides importance of infiltration and IAQ in assessing the thermal comfort of inhabitants. Also, it helps to understand the estimation of thermal load in a building and discussion of few methods and pertinent parameters

Course Objectives:

1 To provide the students with essential background to understand concept of refrigeration and refrigerationsystems.
2 To understand the importance of refrigerant properties and effect on environment
3 To acquire the knowledge of thermal comfort concept and relevant indices to measure. Also, to explore theimportance of IAQ parameters
4 To introduce various aspects of cooling/heating load estimation.
5 To understand the periodic heat transfer through building wall and roof.

Course Outcomes:

1 classify different types of waste for their usefulness in preparing different fuels(L3)
2 describe the biomass pyrolysis process and its yield issues(L2)
3 outline the different biomass gasification processes and their construction arrangements(L3)
4 explain the types and principles of biomass combustors(L2)
5 analyze the calorific values and composition of biogas resources(L5)

UNIT I **7 Hrs**

Introduction

Definition of Refrigeration and Air Conditioning, History of Refrigeration and Air conditioning History fromconceptual point of view - Ice production by nocturnal cooling in ancient India and application of evaporative

cooling in India. Vapour Compression Refrigeration Systems- working and analysis, efficiency, Vapour AbsorptionRefrigeration Systems- Water- Ammonia Systems, Practical problems, Lithium- Bromide System.

Learning Outcomes:

After the completion of this **UNIT**, the student will be able to

• Understand the conceptual idea of refrigeration and design of refrigeration cycle. (L1)
•Comprehend the working of various refrigeration systems. (L3)

UNIT II **8 Hrs**

Biomass Pyrolysis

Refrigerants – Early refrigerants (SO_2, CO_2, CH_3Cl, CH_4, C_2H_6 etc.), Thermodynamic properties and desired properties of refrigerants, Introduction of CFCs and HCFCs, Ozone layer depletion, Comparison between differentrefrigerants, Special issues and practical implications.

Learning Outcomes:

After the completion of this **UNIT** , the student will be able to

- Classify the various types of refrigerants(L1)
- Acquire the knowledge of desired refrigerant properties in thermodynamic aspect (L2)
- Understand the practical implications of refrigerants and protecting the environment (L2)

UNIT III **8 Hrs**

Biomass Gasification

Air conditioning systems for comfort - Thermal comfort. Heat transfer from human body by sensible and latent heat transfer. Metabolic heat generation, steady state and unsteady state model for heat transfer, effect of clothing and definition of effective temperatures. PMV and PPD. ASHRAE comfort chart. Inside and Outside design conditions, Summer air conditioning systems, Winter air conditioning systems, All year air conditioning systems

Learning Outcomes: After the completion of this **UNIT** , the student will be able to

- Understand concept of thermal comfort and indices to measure(L2)
- Acquire the knowledge of ASHRAE comfort chart(L2)
- Understand various air conditioning systems(L3)

UNIT IV **8 Hrs**

Biomass Combustion

Infiltration- Infiltration and ventilation, Infiltration due to stack effect, temperature difference and wind velocity, Infiltration due to door openings. Indoor Air Quality (IAQ)-Sources of indoor air pollution, Methods of control ofIAQ, Fresh air requirements for ventilatio

Learning Outcomes:

After the completion of this **UNIT** , the student will be able to

- Understand the importance of infiltration and IAQ parameters to design air conditioning system for a room(L2)
- Analyze infiltration losses due to door openings etc(L3)
- Understand the requirements for ventilation and IAQ (L2)

UNIT V **9 Hrs**

Biogas

Heating and Cooling load calculations- Differences between winter and summer load calculations, Solar radiation-Distribution of solar radiation, Direct and diffuse solar radiation, Earth sun angles and their relationship. Thermal resistance of various building materials, Periodic heat transfer through walls and roof-Governing equations, Methods of solution, Decrement factor and Time lag method, Equivalent Temperature difference Method and CLTD Method.

Learning Outcomes:

After the completion of this **UNIT** , the student will be able to

- Understand the fundamentals of solar radiation and pertinent parameters in the aspect of thermal load calculation.(L1)
- Analyze the periodic heat transfer through building (wall and roof)(L2)
- Understand heating load estimation using TETD(L3)

Text Books

1 Air conditioning principles and systems by Edward G. Pita, PHI (Prentice Hall of India).

2 Arora, C. P., "Refrigeration and Air Conditioning", Tata McGraw-Hill

Reference Books

1 Refrigeration and Air Conditioning by W.F. Stocker and J. W. Jones, McGraw-Hill
2 Refrigeration and Air Conditioning by Ameen Ahmadul, PHI India
3 Refrigeration and Air Conditioning by Manohar Prasad, New Age International Publisher

Evaluation Procedure						
Continuous Evaluation	**Total 70 Marks**					
	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2
	5	5	5	15	20	20
Sem End Examination	Total 30 Marks					

Course Outcome - Programe Outcome Mapping															
Course Outcomes :	**Programme Outcomes**														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	2	1	0	0	0	0	0	0	0	0	0	0	3	0	0
2	0	0	0	0	0	2	0	0	0	0	0	0	2	0	0
3	2	0	0	2	0	0	0	2	0	0	0	0	2	0	0
4	0	0	0	2	0	2	0	0	0	0	0	0	2	0	0
5	2	1	0	0	0	0	0	2	0	0	0	0	3	0	0
6															

Course Code	Course Title	L	T	P	J	S	C
Elective	**CRYOGENICS**	3	0	10	0	0	8
Course Owner	Department of Mechanical Engineering	**Syllabus version**					
Course Pre-requisite(s)	NIL	**Contact hours**					
Course Co-requisite(s)	NIL	**Date Approved**					
Alternate Exposure	NIL						

Course Description

This course focuses mainly on the on the basics of cryogenic Engineering, different cryogenic fluids and their properties such as Thermal, chemical, mechanical, and electrical conductive propeties, Applications, Gas separation and Purification, design of system, safety , components of cryogenic system, and Intstruments.

Course Objectives:

1 To encourage the dissemination of information concerning low temperature processes and techniques.
2 To understand the basic principles of cryogenic processes.
3 To bring together those in all disciplines concerned with the applications of low temperature technology.
4 To unders stand the basic design of a cryocooler
5 To increase public awareness of the usefulness of cryogenic technology.

Course Outcomes:

1 Possess basic knowledge of cryogenics.
2 Design cryogenic systems.
3 Find applications of cryogenics
4 Demonstrate the knowledge of cryogenic instrumentation
5 Demonstrate the instruments of cryogenic systems

UNIT I **7 Hrs**

Introduction to Cryogenics

Introduction: Cryogenic engineering, properties of cryogenic fluids like Oxygen, Nitrogen, Argon, Neon, Florin, Helium, Hydrogen, Properties of material at cryogenic temperature- mechanical, thermal, and electrical-Super conductivity, application of cryogenic systems.

UNIT II **8 Hrs**

Cryogenic Refrigeration

Cryogenic refrigeration: Principle and Methods of production of low temperature and their analysis: Joule Thomson Expansion, Cascade processes, Ortho and para hydrogen conversion, cold gas refrigerators, Linde -Hampson cycles, Claude and cascaded systems, magnetic cooling, Stirling Cycle Cryocoolers, Philips refrigerators, Gifford single volume refrigerator, Pulse tube refrigerators

UNIT III **8 Hrs**

Cryogenic Components

Cryogenic requirements: Cryogenics Heat Exchangers, Compressors, Expanders, Effect of various parameters in performance and system optimization. Various insulations (expanded foams, gas filled, fibrous, vacuum, multi- layer etc.) and Storage equipment for cryogenic fluids, industrial storage and transfer of cryogenic fluids

UNIT IV **8 Hrs**

Gas separation and Purification
Gas separation and purification systems – Properties of mixtures, Principles of mixtures, Principles of gas separation – Air separation systems- Cryogenic Refrigeration Systems, Working media- Cryostat – Cryo Coolers-Applications – Space technology.

UNIT V **8 Hrs**

Safety and Applications of Cryogenics
Cryogenic instrumentation and safety: Properties and characteristics of instrumentation, strain displacement, pressure, flow, liquid level, density and temperature measurement in cryogenic range. Safety in cryogenic fluid handling, storage and use. Applications: Super conductive devices such as bearings, motors, cryotrons, magnets,
D.C. transformers, tunnel diodes, space technology, space simulation, cryogenics in biology and medicine, food preservation and industrial applications, nuclear propulsions, chemical propulsions

Text Books
1 Cryogenic Systems – R.F. Barron, Oxford University.

2 Cryogenics Engineering – R. B. Scott, Von Nostrand Inc, New Jersey, 19593 T.M Flynn, Cryogenic Engineering, Maxwell Dekker, 1997.
4 R W Yance and WM Duke, Applied Cryogenic Engineering, John Willey.

Reference Books
1 Cryogenic Engineering – Thomas M.
2 Hand Book of Cryogenic Engineering – J.G.Weisend –II, Taylor and Francis, 19983 Cryogenic mixed Refrigerant processes by G. Venkataratnam, IIT Madras.

Evaluation Procedure						
Continuous Evaluation	**Total 70 Marks**					
	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2
Sem End Examination	Total 30 Marks					

Course Outcome - Programe Outcome Mapping															
Course Outcomes :	**Programme Outcomes**														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1															
2															
3															
4															
5															
6															

Course Code	Course Title	L	T	P	J	S	C
	VEHICLE TECHNOLOGY	3	0	10	0	0	8
Course Owner	Department of MechanicalEngineering	**Syllabus version**					
Course Pre-requisite(s)	Thermal Engineering	**Contact hours**					
Course Co-requisite(s)	NIL	**Date Approved**					
Alternate Exposure	NIL						

Course Description

To acquire knowledge of Vehicle and to make the student understand the working of different Sub systems ofvehicle, and emphasize the need for maintenance of automotive equipment.

Course Objectives:

1 To familiarize concepts of transmission system for power transfer from Prime mover to wheels.
2 To explain different mechanisms and working of transmission system.
3 To teach the concepts of clutches and gears
4 To introduce the concept of Steering and suspension system
5 To introduce the concept of Steering and suspension system

Course Outcomes:

1 To understand the different transmission systems and steering system in an automobile. (L2)
2 select proper transmission system for a vehicle, and to identify and solve problems related to transmissionsystem. L3
3 To understand the vehicle structure and the suspension system (L3)
4 Choose a particular drive line for an application L4
5 To understand and develop the braking systems in vehicles (L4)

UNIT I **8 Hrs**

Chassis and Clutches

Introduction: Classification of Vehicles.

Chassis: Introduction of chassis, classification, conventional construction - frameless construction, - transmission and arrangements.

Clutches: Necessity of clutch in an automobile, different types of clutches, friction clutches namely Single plate clutch, multi plate clutch, cone clutch, centrifugal clutch, electromagnetic clutch, hydraulic clutches, Clutch - adjustment, Clutch troubles and their causes, requirements of a clutch, Clutch materials, clutch lining Vacuum operated clutch. Fluid coupling

UNIT II **8 Hrs**

Transmission System

The need for transmissions, Necessity of gear box, Desirable ratios of 3-speed & 4-speed gear boxes, Constructional details of sliding-mesh gear box, constant-mesh gear box, synchromesh gear box,, Automatic transmission: relative merits and demerits when compared to conventional transmission epicyclic, continuously variable transmission, torque converter, constructional and operational details of typical hydraulic transmission drives.

UNIT III **8 Hrs**

Drive line

Drive line: Effects of driving thrust and torque reaction. Hotchkiss drive. Torque tube drive, radius rods. Propeller shaft.Universal joints. Final drives – different types, double reaction final drive. Two speed rear axle. Rear axle construction – full floating, three quarter floating and semi-floating arrangements. Differential conventional type, no-slip type. Differential locks.

UNIT IV **8 Hrs**

Steering System and suspension systems

Steering System: Types of steering systems, different steering mechanisms, power steering. suspension systems: The need for suspension systems,Types of springs, shock absorbers, types of suspension systems

UNIT V **8 Hrs**

Brakes, Rims and tires

Types of brakes and brake actuation mechanisms, regenerative brakes. types of rims and tyres, tyre rating.

Text Books

1. Kirpal Singh, Automobile Engineering, Vol.-1 & 2, 12/e, Standard Publisher, 2011.
2. Joseph Heitner, Automotive Mechanics, 2/e, Affiliated East-west Press, 2013

Reference Books

1. Crouse. W.H. and Angling. D.L., Automobile Mechanics,10/e, Tata McGraw-Hill, 2007.
2. Judge A.W, Modern Electrical Equipment of Automobiles, Chapman and Hall, 1992

Evaluation Procedure						
Continuous Evaluation	**Total 70 Marks**					
	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2
Sem End Examination	Total 30 Marks					

Course Outcome - Programe Outcome Mapping															
Course Outcomes :	**Programme Outcomes**														
	1	2	3	4	5	6		8	9	10	11	12	PSO1	PSO2	PSO3
1															
2															
3															
4															
5															
6															

Course Code	Course Title	L	T	P	J	S	C
	POWER PLANT ENGINEERING	3	0	0	0	0	3
Course Owner	Department of MechanicalEngineering	**Syllabus version**				1	
Course Pre-requisite(s)	Thermodynamics and Applied Thermodynamics	**Contact hours**					
Course Co-requisite(s)	NIL	**Date Approved**					
Alternate Exposure	NIL						

Course Description

This course provides an introduction to the various layouts and working mechanisms of steam power plant, gas power plant, nuclear power plant, and hydroelectric power plant. Power Plant Economics concepts will also be dealt in this course. This course introduces the working concepts of power generating devices like turbines and their components. This course is having integrity with industrial problems as prime movers are main components of power plants.

Course Objectives:

1 Understand the basic knowledge of different types of thermal power plants states.
2 Design of chimney, cooling tower operation in thermal power plants
3 Perform basic analyses associated with each subsystem
4 Improving skills to adopt modern methods in mechanical engineering as continuous improvement.
5 Understand about the site selection of setting up a hydroelectric plant

Course Outcomes:

1 Study the working of typical systems subsystems of a steam power plants(L1)
2 Acquaint with the knowledge about recent advances in gas turbine power plants and apply the knowledgein industries for enhancing productivity (L2)
3 Choose appropriate site for plantand layout of hydroelectric power plant (L3)
4 Experiment with multi-disciplinary goals in the power plants [L3]
5 Analyse the turbo machines to improve and optimize its performance (L4)
6 Utilize the concepts of power plant economics and understand costs involved in power plants (L4)

UNIT I **9 L**

Steam Power Plants: General layout, power plant cycles, coal-handling, storing, preparation and supply. Boiler Mountings and accessories, Draft systems, Flue gas testing and indicators (mechanical, electrical and chemical).Condensers and cooling towers,

Learning outcomes:

After completion of this UNIT, students will be able to

- Study the general layout of the steam power plants. (L_1)
- Acquaint with boiler mountings and accessories. (L_2)
- Utilize the knowledge of condensers and cooling towers. (L_3)

UNIT II **8 L**

Gas Turbine Power Plants: Introduction, gas turbine plant- classification and comparison of different types of gas turbine power plants, components and different arrangements of the gas turbine plants, Indian gas turbine powerplants, governing system of gas turbine plant.

Learning outcomes:
After completion of this UNIT, students will be able to

- Study the general layout of the gas turbine power plants. (L_1)
- Summarize about different types of gas turbines. (L_2)
- Design a gas turbine for Indian scenario. (L_4)

UNIT III **9 L**

Nuclear Power Plants: Classification of reactors, thermal utilisation, fuels, fuel moderator and coolant, control and safety rods, special properties of structural materials required, induced radio-activity, gas cooled reactors, radiation hazards and shielding, radioactive waste disposal.

Learning outcomes:
After completion of this UNIT, students will be able to

- Acquaint with various nuclear reactors. (L_2)
- Summarize about the special properties of structural materials used. (L_4)
- Train about radiation hazards and shielding. (L_3)

UNIT IV **8 L**

Hydro Electric Plants: Selection of site, hydrology, hydrometric survey rainfall, catchment, reservoir, run-off flow and fall, storage and pondage. Mass- duration and flood discharge. Losses due to percolation, evaporation and transpiration. General layout of the plant. Different types of plants: Low, medium and high head plants and pump storage plants. Head works, spillways, canals, tunnels, governing, lubrication, penstock, anchorages and relief valves. Different types of surge tanks, intakes, gates and valves.

Learning outcomes:
After completion of this UNIT, students will be able to

- Study about the site selection of setting up a hydro electric plant. (L_1)
- Outline about the losses due to percolation, evaporation and transpiration. (L_2)
- Acquaint with the layout of the plant. (L_1)
- Study about gates, valves, intakes and surge tanks which are necessary for a hydro electric plant. (L_1)

UNIT V **8 L**

Power Plant Economics: Capacity factor, Load factor, Diversity factor, Peak load consideration, Factors governing capacity of plants. Cost of power plant, Cost of erection. Operating and maintenance expenses, Cost ofproduction, distribution of power and determination of rates.

Learning outcomes:
After completion of this UNIT, students will be able to

- Study about different factors associated with power plant economics. (L_1)
- Acquaint with factors governing plant capacity. (L_2)
- Summarize about cost associated with plant erection, operating and maintenance. (L_4)

Text Books

1. P.K.Nag, Power plant engineering, Tata McGraw-Hill publishing Co., 2014Universities Press, Hyderabad, 2006.
2. Machines, McGraw Hill Education, 2017
3. S.C. Arora and Domkundwar, A course in power plant engineering, DhanpatRai and Co, 2001
4. R.K. Rajput, A Text Book of Power Plant Engineering, 4/e, Laxmi Pub., 2007.

Reference Books

1. B.S.Magal, Solar Power Engineering, 1/e, Tata McGraw-Hill publishing Co., 1999.
2. Joel Weisman, Roy Eckart, Modern Power Plant Engineering, Prentice Hall of India, 1985.
3. D.K. Singhai, Fundamentals of Nuclear Power Engineering, 4/e, Khanna Publishers, 2001.
4. G.R.Nagpal, Power Plant Engineering, 14/e, Khanna Publishers, 1996.

Evaluation Procedure						
Continuous Evaluation	**Total 70 Marks**					
	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2
	5	5	5	15	20	20
Sem End Examination	Total 30 Marks					

Course Outcome - Programe Outcome Mapping															
Course Outcomes :	**Programme Outcomes**														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	2	1	0	0	0	0	0	0	0	0	0	0	0	1	0
2	1	2	0	0	0	0	0	0	0	0	0	0	0	1	0
3	2	3	1	0	0	0	0	0	0	2	1	0	1	1	0
4	3	3	0	0	0	0	0	0	0	2	1	0	1	1	0
5	3	3	0	0	0	0	0	0	0	2	1	0	1	1	0
6															

	Course Code	Course Title	L	T	P	J	S	C
		RENEWABLE ENERGY TECHNOLOGY	3	0	0	0	0	3
	Course Owner	Department of MechanicalEngineering	**Syllabus version**					
	Course Pre-requisite(s)	NIL	**Contact hours**					
	Course Co-requisite(s)	NIL	**Date Approved**					
	Alternate Exposure	NIL						

Course Description

The course provides an introduction to energy systems and renewable energy resources, with a scientific examination of the energy field and an emphasis on alternate energy sources and their technology and application. It helps in exploring society's present need and future energy demands, examine conventional energy sources and systems. The course will also help in assessing the procedures in terms of technical, financial and social, in the context of training as an Mechanical Engineer

Course Objectives:

1 To understand the basic knowledge of conventional and non-conventional energy sources.
2 To design and optimization of solar, wind, OTEC and Geo Thermal power plants,
3 To perform basic analyses associated with each subsystem
4 To apply the same in their project works as well as higher studies or in their job.

Course Outcomes:

1 understand the different types of conventional and non-conventional energy sources, theirparts, working, and will be able to sort out realistic application to society. (L2)
2 analyse different set of operational parameters and constraints of solar energy systems fordirect and indirect methods of usage, (L4)
3 improve the efficiency of the wind and bio gas l energy systems. (L4)
4 understand concepts of fuel cells. (L2)
5 understand and analyze geothermal, tidal and wave energy conversion systems (L4)

UNIT I **7 Hrs**

Introduction

Introduction: Role and potential of new and renewable sources. Solar Energy: Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors. Solar energy storage- Different methods, sensible, latent heat and stratified storage, solar ponds. Solar applications, solar heating/ cooling techniques, solar distillation and drying, nano materials used in solar photovoltaic cells. Next generation photovoltaic systems- SolarInk, photovoltaic energy conversion.

Learning Outcomes:
At the end of this UNIT , the student will be able to

- acquaint basic knowledge of renewable sources. [L1]
- understand of different solar energy storage. [L2]
- acquire fundamental concepts of photovoltaic systems. [L1]

UNIT II **8 Hrs**

Biomass Pyrolysis
Wind Energy: Sources and potentials, classification of wind mills, horizontal and vertical axis wind mills, effect ofwind speed on power generation, site evaluation, wind turbine subsystems-rotors, drive trains, yaw control systems, electrical systems. Bio Gas: Properties, principles of production, classification- fixed dome-floating type, comparison, site selection, water removing device, environmental effect. Plant models in India: floating gas holder-KVIC, fixed dome - janata type, pragati model, deenbandhu model, constraints for implementation

Learning Outcomes:
At the end of this UNIT , the student will be able to

- acquaint with sources and potentials of wind energy. [L1]
- understand the effect of wing speed on power generation. [L2]
- study the properties of bio gas. [L2]
- design the structure of Bio gas in India. [L4]

UNIT III **8 Hrs**

Biomass Gasification
Fuel cells: Principle of fuel cells, Faradays laws, thermodynamic aspects. Performance limiting factors of fuel cells- reactivity-invariance, electrode losses-chemical polarization-concentration polarization-resistance polarization, types of fuel cells-hydrogen-oxygen fuel cells-biochemical cellsregenerative cells

Learning Outcomes:
At the end of this UNIT , the student will be able to

- study the principle of fuel cell and laws governing it. [L1]
- acquaint with losses i fuel cells. [L1]
- summarize different fuel cells available. [L2]

UNIT IV **8 Hrs**

Biomass Combustion
Geothermal Energy: Resources, types of wells, methods of harnessing the energy, potential in India. OTEC: Principles, utilization, setting of OTEC plants, thermodynamic cycles. Tidal and Wave Energy: Potential and conversion techniques, tidal barrage, modes of operationebb generation- flood generation-two way generation. Latest techniques used in TIDAL energy generation.

Learning Outcomes:
At the end of this UNIT , the student will be able to

- understand the resources of geothermal energy. [L1]
- acquaint with the principles and utilization of otec. [L2]
- study about tidal and wave energy. [L2]
- outline modes of operation of ebb generation. [L2]

- choose the latest techniques in tidal energy generation. [L3]

UNIT V **9 Hrs**

Biogas

Direct Energy Conversion: Need for DEC, limitations, principles of DEC. Thermoelectric generators, seebeck, Peltier and Joule Thompson effects, figure of merit, materials, applications, MHD generators, principles, dissociation and ionization, hall effect, magnetic flux, MHD accelerator, MHD engine, power generation systems,electron gas dynamic conversion, economic aspects

Learning Outcomes:

At the end of this UNIT , the student will be able to

- understand and acquire the need for DEC.[L1]
- acquaint basic knowledge of thermoelectric generators. [L1]
- understand the performance of MHD generators. [L2]

Text Books

1. G.D. Rai, Non-conventional Energy Sources, 6/e, Khanna Publishers, 2004.
2. R.K.Rajput, Non-Conventional Energy Sources and Utilization, 2/e, S. Chand Publishing,2014.

Reference Books

1. G.Boyle, Renewable Energy: Power for a Sustainable Future, 3/e, Oxford University PressIndia, 2012
2 D.P.Kothari, K.C.Singal, Ranjan Rakesh, Renewable Energy Sources and EmergingTechnologies, 2/e, Prentice Hall India, 2011
3 B.H.Khan, Non-Conventional Energy Resources, 2/e, McGraw Hill India, 2009.

Evaluation Procedure						
Continuous Evaluation	**Total 70 Marks**					
	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2
	5	5	5	15	20	20
Sem End Examination	Total 30 Marks					

Course Outcome - Programe Outcome Mapping															
Course Outcomes :	**Programme Outcomes**														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	3	1	1	1	0	0	0	0	0	0	0	0	3	0	0
2	2	0	0	0	2	2	0	1	0	0	0	0	1	0	0
3	2	0	1	2	0	0	0	2	0	0	0	0	2	0	0
4	1	0	0	2	1	2	0	0	0	0	0	0	2	0	0
5	2	1	0	0	0	0	0	2	0	0	0	0	3	0	0
6															

Course Code	Course Title	L	T	P	J	S	C
	ALTERNATIVE FUELS AND POLLUTION CONTROL METHODS	3	0	10	0	0	8
Course Owner	Department of MechanicalEngineering	**Syllabus version**					
Course Pre-requisite(s)	Applied thermodynamics	**Contact hours**					
Course Co-requisite(s)	NIL	**Date Approved**					
Alternate Exposure	NIL						

Course Description

Course Objectives:

1 Different fuels and their properties
2 Different Testing methods of fuels
3 Factors responsible for the emissions
4 the methods to measure and control

Course Outcomes:

1 understand the various kinds of fuels, their characteristics
2 Acquire knowledge about testing of fuels.
3 student will be enriched with enough knowledge to understand the formation of pollution
4 learn the concept to control pollution

UNIT I

Solid and liquid Fuels

Solid Fuels: classification of fuels – Conventional and Unconventional Solid, Liquid, gaseous fuels, and nuclear fuels. Coal – Carburisation, Gasification and liquification – properties of coal, efficient use of solid fuels, solid fuelhandling and storage. Liquid Fuels : Alcohols as fuels, Bio-diesel production from Vegetable oils and waste cooking oil, Blends, Fuel modifications to suit SI and CI engines, Ignition accelerators and other additives-Storageand Safety

UNIT II

Gaseous Fuels

Natural Gas, LPG, Hydrogen, CNG and Biogas: Availability, properties, modification required to use in engines, admission of gaseous fuels like Hydrogen, CNG, LPG, Natural Gas, Producer gas and Bio gas in engines– Safety Precautions, storage and handling, performance and emissions

UNIT III

Properties and testing of fuels

Properties and testing of fuels: Required properties of fuels-biofuels and their importance in the context of IC Engines. Testing of fuels for their properties -Acid number- base number, Sulphur content, Flash point -fire point,cloud -pour point, corrosion resistance, Oxidation stability- viscosity - viscosity index, carbon residue – cetane number-cetane index

UNIT IV

Emission formation

Pollution formation in SI and CI engines - Factors affecting emissions -Formation of NO and NO2 in Engines, Formation of CO, Flame quenching in SI engines. Unburned HC formation in SI engines, crevice HC, oil film HC and other sources, soot formation, Instrumentation to measure pollutants, Trends in vehicle emission standards, emission limits,

UNIT V

Pollution control methods

Control of emissions inside the engine: EGR, crankcase evaporative emission control. Control of emissions outside the engine- Exhaust gas after treatment, Thermal and catalytic reactors, Elements of catalytic reactors, catalysts, and substrates. Oxidation, reduction and 3-waycatalytic reactors, catalyst deactivationmechanism, cold start HC control, Lean de-nox catalysts, nox traps and SCR.

Text Books

1. B. P. Pundir, Engine Emissions: Pollutant Formation and Advances in Control Technology, Narosa PublishingHouse, New Delhi, 2007.
2. Alternate Fuels – Dr. S. S. Thipse – Jaico Publications
3. Osamu Hi rao and Richard K.Pefley, Present and Future Automotive Fuels,John Wiley and Sons, 1988
4. Keith Owen and Trevor Eoley, Automotive Fuels Handbook, SAE Publications, 1990

Reference Books

1. Handbook of Air Pollution from Internal Combustion Engines: Pollutant Formation and Control, Ed. Eran Sher,Academic Press, 1998
2. Richard L.Bechtold, Automotive Fuels Guide Book, SAE Publications, 1997.

Evaluation Procedure						
Continuous Evaluation	**Total 70 Marks**					
	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2
Sem End Examination	Total 30 Marks					

Course Outcome - Programe Outcome Mapping															
Course Outcomes :	**Programme Outcomes**														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1															
2															
3															
4															
5															
6															

Course Code	Course Title	L	T	P	J	S	C
19EME362	SOLAR ENERGY	3	0	0	0	0	3
Course Owner	Department of MechanicalEngineering	Syllabu s version					
Course Pre-requisite(s)	NIL	Contact hours					
Course Co-requisite(s)	NIL	Date Approved					
Alternate Exposure	NIL						

Course Description

To understand the fundamentals of solar energy and its conversion techniques for both thermal and electrical energy applications. Solar energy is the most secure of all energy sources. It is abundantly available. Renewable Power generation including Solar Photovoltaic (PV) and Solar Thermal (ST) power / steam / hot water generation offer an environmentally safe and sustainable alternative.

Course Objectives:

1 Summarize the basic fundamental concepts of the solar radiation and analyze the future scopeof solar energy and their utilization
2 Explain the working principle of solar cells and their modern manufacturing techniques
3 Elaborate the students with various solar Thermal systems and their utilization
4 Demonstrate the workings of various solar photovoltaic systems
5 Appraise the knowledge related to latest life cycle analysis of solar Energy Systems

Course Outcomes:

1 summarize the basic concept of solar radiation calculations. [L2]
2 demonstrate the working principle solar cells and their importance[L2]
3 analyze the solar collectors and their limitations [L4]
4 explain the function of solar photovoltaic and modern techniques of using solar energy in differentapplication. [L2]
5 analyze economic analysis and life cycle of solar thermal systems.[L4]

UNIT I **8 Hrs**

Introduction

Introduction: Basic Heat Transfer Principles- Availability of Solar Energy- Nature of Solar Energy Solar Energy & Environment- Sun as the source of radiation- Solar radiation- Measurement of solar radiation Irradiance- Solar constant- Insolation- Radiosity- Emissive power- Earth‟s equator Meridian Longitude- Sun earth angles- Sunrise, sun set and day length- Solar time- Equation of time Various Methods of using solar energy- Photo thermal, Photovoltaic, Photosynthesis, Present & Future Scope of Solar energy.

Learning Outcomes:

At the end of this **UNIT** , the student will be able to

- summarize the availability of Solar Energy and nature of Solar Energy [L2]
- demonstrate the basic measurement of solar radiation [L2]
- illustrate the different methods of using solar energy [L2]

UNIT II **9 Hrs**

Solar cells

Solar cells :Various generations- Semiconductor materials- Doping- Fermi level- PN junction and characteristics- Photovoltaic effect- Photovoltaic material- Parameters of solar cells- Effects of cell temperature on cell efficiency-Types of solar cells- Solar **UNIT** s and arrays- Advantages and limitations of solar energy system- Solar cell power plant- Silicon, thin film and polymer processingSilicon waferbased solar cells.

Learning Outcomes:
At the end of this **UNIT**, the student will be able to

- summarize various solar cell characteristics and their materials.[L2]
- analyze different types of solar cells and their units and arrays.[L4]
- assess solar power plant with silicon, thin film and polymer processing. [L4]

UNIT III **9 Hrs**

Solar Thermal Energy
Solar Thermal Energy: Stationary collectors- FPC- CPC- ETC- Sun tracking concentrating collectors- PTC- PDR- HFC Fresnel collectors- Solar thermal power plants- Solar chimney power plant- Solar pond- Solar water heater- Solar cooker- Types- SODIS- Thermal energy storage- Solarcooling- Limitations of solar thermal energy.

Learning Outcomes:
At the end of this **UNIT** , the student will be able to

- summarize the principles underlying in working different types stationary collectors [L2]
- analyze working principle of solar thermal power plants [L4]
- analyze the limitations of thermal energy storage in solar system. [L4]

UNIT IV **8 Hrs**

Solar Photovoltaics
Solar Photovoltaics: Photovoltaic cell function- Types of PV system- Design of PV system- Grid connected PV system Stand alone PV system- Efficiency of PV unit - MPPT- Applications of PV system- SPV lighting system- Solar water pumping system- Solar vehicles- Solar dryer- BIPVFeatures of SPV system Case study- Solar water pumping system in Punjab- Performance study on solar drying system in Nepal.

Learning Outcomes:
At the end of this **UNIT**, the student will be able to

- interpret the photovoltaic cell function.[L2]
- design and study the different types of PV system[L5]
- develop the solar dryer, solar pump and solar vehicle.[L3]

UNIT V **7 Hrs**

Economic analysis
Economic analysis: Life cycle analysis of Solar Energy Systems – Time Value of Money –Evaluation of Carbon Credit of Solar Energy Systems.

Learning Outcomes:
At the end of this **UNIT** , the student will be able to

- infer the need of life cycle analysis of solar energy system.[L1]
- develop economic analysis system for solar energy system.[L3]
- evaluate Carbon Credit of Solar Energy Systems.[L4]

Text Books

1. Soteris A. Kalogirou,Solar Energy Engineering: Processes and Systems, 2/e, Academic Press,2013

2. Tiwari G.N, Solar Energy – Fundamentals Design, Modelling and applications, AlphaScience, 2002

Reference Books

1. John W. Twidell,Anthony D Weir,Renewable Energy Resources,Taylor&Francis,2005
2. John A. Duffie, William A. Beckman, Solar Energy: Thermal Processes, 4/e, John Wiley andSons, 2013
3. S P Sukhatme, J K Nayak,Solar Energy, 4/e,McGraw-Hill Education, 2017

Evaluation Procedure						
Continuous Evaluation	**Total 70 Marks**					
	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2
	5	5	5	15	20	20
Sem End Examination	Total 30 Marks					

Course Outcome - Programe Outcome Mapping															
Course Outcomes :	**Programme Outcomes**														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	3	2	2	2	1	3	0	0	0	1	1	1	2	1	0
2	3	2	1	2	1	3	0	0	0	1	1	1	2	0	0
3	3	2	1	2	1	3	0	0	0	1	1	1	2	1	0
4	3	2	1	2	1	3	0	0	0	1	1	1	2	1	0
5	3	2	1	2	1	3	0	0	0	1	1	1	2	0	0

Course Code	**Course Title**	L	T	P	J	S	C
	WASTE TO ENERGY	3	0	0	0	0	3
Course Owner	Department of MechanicalEngineering	**Syllabus version**					
Course Pre-requisite(s)	NIL	**Contact hours**					
Course Co-requisite(s)	NIL	**Date Approved**					
Alternate Exposure	NIL						

Course Description

This course introduces the basic principles and different technologies of converting waste to energy. Student will be able to appropriately identify the methods and build biomass gasification systems of different capacities depending on application requirements.

Course Objectives:

1 to introduce the classification of waste for its usefulness in preparing different fuels
2 to familiarize the biomass pyrolysis process and its yield issues
3 to acquaint the student with biomass gasification processes and construction arrangements
4 to impart the types and principles of biomass combustors
5 to familiarize the calorific values and composition of biogas resources.

Course Outcomes:

1 classify different types of waste for their usefulness in preparing different fuels(L3)
2 describe the biomass pyrolysis process and its yield issues(L2)
3 outline the different biomass gasification processes and their construction arrangements(L3)
4 explain the types and principles of biomass combustors(L2)
5 analyze the calorific values and composition of biogas resources(L5)

UNIT I **7 Hrs**

Introduction

Introduction to Energy from Waste: Classification of waste asfuel – Agro based, Forest residue, Industrial waste -MSW – Conversion devices – Incinerators, gasifiers, digestors.

Learning Outcomes:

After the completion of this **UNIT** , the student will be able to

- distinguish between different types of waste (L1)
- classify the different types of waste for manufacturing different types of fuel (L3)
- identify the different conversion devices and their applications(L4)

UNIT II **8 Hrs**

Biomass Pyrolysis

Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application –Manufacture of pyrolytic oils and gases, yields and applications.

Learning Outcomes:

After the completion of this **UNIT** , the student will be able to

- classify the different types of pyrolysis methods based on speed(L1)
- describe the different methods of manufacturing charcoal (L2)
- explain the chemical processes involved in the manufacture of pyrolytic oils and gases(L2)

UNIT III **8 Hrs**

Biomass Gasification

Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

Learning Outcomes:

After the completion of this **UNIT** , the student will be able to

- explain the design, construction and operation of different gasifiers(L2)
- describe the burner arrangement for thermal heating(L2)
- elaborate the gasifier engine arrangement for equilibrium and kinetic considerations(L3)

UNIT IV **8 Hrs**

Biomass Combustion

Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of allthe above biomass combustors.

Learning Outcomes:

After the completion of this **UNIT** , the student will be able to

- explain the basic principle of biomass combustors(L2)
- classify different combustors based on their capacity and efficiency(L3)
- describe the construction and operation of fixed bed inclined grate, fluidized bed combustors (L2)

UNIT V **9 Hrs**

Biogas

Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

Learning Outcomes:

After the completion of this **UNIT** , the student will be able to

- list the properties of biogas(L1)
- elaborate the design, construction and operation of biogas plant(L2)
- classify the different biomass resources and their conversion process(L3)
- distinguish between different biogas plants and identify their applications(L4)

Text Books

1. Non-Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGrawHill Publishing Co. Ltd., 1983.

Reference Books

1 Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.

2 Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

Evaluation Procedure						
Continuous Evaluation	**Total 70 Marks**					
	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2
	5	5	5	15	20	20
Sem End Examination	Total 30 Marks					

Course Outcome - Programe Outcome Mapping															
Course Outcomes :	**Programme Outcomes**														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	2	2	1	2	1	2	0	0	0	1	1	1	2	1	0
2	2	2	1	2	1	2	0	0	0	1	1	1	2	1	0
3	2	2	1	2	1	2	0	0	0	1	1	1	2	1	0
4	2	2	1	2	1	2	0	0	0	1	1	1	2	1	0
5	2	2	1	2	1	2	0	0	0	1	1	1	2	1	0

<table>
<tr><td rowspan="6"></td><td>Course Code</td><td>Course Title</td><td>L</td><td>T</td><td>P</td><td>J</td><td>S</td><td>C</td></tr>
<tr><td></td><td>ENERGY CONSERVATION AND MANAGEMENT</td><td>3</td><td>0</td><td>0</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Course Owner</td><td>Department of MechanicalEngineering</td><td colspan="4">Syllabus version</td><td colspan="2"></td></tr>
<tr><td>Course Pre-requisite(s)</td><td>NIL</td><td colspan="4">Contact hours</td><td colspan="2"></td></tr>
<tr><td>Course Co-requisite(s)</td><td>NIL</td><td colspan="4">Date Approved</td><td colspan="2"></td></tr>
<tr><td>Alternate Exposure</td><td colspan="7">NIL</td></tr>
</table>

Course Description

This course helps to understand the energy consumption scenario in India and siginificance of energy conservation. It helps to understand the energy conservation act, various methods of energy audit methods. It provides the importance of BEE star labelling for various utilities, thermal systems, Furnaces etc. It helps to explore energy audit instruments and performance evaluation of various steam systems.

Course Objectives:

1 To understand the basic knowledge of conventional and non-conventional energy sources.
2 To design and optimization of solar, wind, OTEC and Geo Thermal power plants,
3 To perform basic analyses associated with each subsystem
4 To apply the same in their project works as well as higher studies or in their job.

Course Outcomes:

1 understand the different types of conventional and non-conventional energy sources, theirparts, working, and will be able to sort out realistic application to society. (L2)
2 analyse different set of operational parameters and constraints of solar energy systems fordirect and indirect methods of usage, (L4)
3 improve the efficiency of the wind and bio gas l energy systems. (L4)
4 understand concepts of fuel cells. (L2)
5 understand and analyze geothermal, tidal and wave energy conversion systems (L4)

UNIT I **7 Hrs**

Introduction

Introduction: Energy kinds: Indian energy scenario. Energy needs, energy security, energy conservationimportance, energy conservation potential, industries and commercial establishments, energy conservation Act.

Learning Outcomes:

At the end of this **UNIT** , the student will be able to

- Understand the significance of energy conservation and energy conservation Act. [L1]
- Understand the energy consumption scenario in India [L1]

UNIT II **8 Hrs**

Biomass Pyrolysis

Energy Efficiency in Thermal Systems: Boilers: Performances evaluation, analysis of losses, feed water treatment;blow down, energy conservation opport**UNIT** ies. FBC boilers- mechanism and advantages. Steam System: Assessment of steam distribution losses, steam leakages, steam trapping, condensate and flash steam recovery system, energy savings.; Furnaces: Classification, general fuel economy measures in furnaces, excess air,heat distribution, temperature control, draft control, waste heat recovery.

Learning Outcomes:
At the end of this **UNIT** , the student will be able to

- Understand the analysis of various losses in thermal systems [L1]
- Acquire the mechanism and advantages of FBC boilers [L2]
- Estimate the various losses in steam supply systems [L2]

UNIT III **8 Hrs**

Biomass Gasification
Energy Efficiency in Electrical Utilities: Electrical load management and maximum demand control, power factorimprovement and its benefit, transformers, distribution and transformer losses, analysis of electrical power systems; Lighting System: Light source, choice of lighting, luminance requirements, and energy conservation

Learning Outcomes:
At the end of this **UNIT** , the student will be able to

- Understand the energy efficient mechanisms in electrical and lighting systems [L1]
- Acquire the knowledge to chose energy efficient lighting system [L1]
- Comprehend the lighting system luminance requirements for energy conservation. [L2]

UNIT IV **8 Hrs**

Biomass Combustion
Energy Conservation in Utilities: Fans, blowers, pumps, compressed air systems, refrigeration and air conditioningsystems and cooling towers: Performance evaluation, efficient system operation and energy conservation

Learning Outcomes:

At the end of this **UNIT,** the student will be able to

- understand energy star rating for various rotodynamic appliances [L1]
- acquaint with the principles and design of efficient performance system [L2]
- Acquire the knowledge of performance evaluation [L3]

UNIT V **9 Hrs**

Biogas
Energy Conservation and Auditing : Definition, need, and types of energy audit, energy management (audit) approach, understanding energy costs, bench marking, energy performance, optimizing the input energy requirements, energy audit instruments; Preliminary and detailed energy audit, energy conservation act, Duties and responsibilities of energy managers and auditors.

Learning Outcomes:
At the end of this **UNIT,** the student will be able to

- Understand various types of energy audits.[L1]
- Comprehend the energy audit instruments and detailed analysis [L1]
- Apply energy audit procedure and propose strategies to conserve energy. [L2]

Text Books

1 Energy Manager Training Manual (4 Volumes) Bureau of Energy Efficiency:http://www.beeindia.in/energy_managers_auditors/ema.php?id=4
2 Y.P. Abbi, Shashank Jain, Handbook on Energy Audit and Environment Management, The Energy andResources Institute, TERI, 2009

Reference Books

1 Steve Doty, Wayne C. Turner Energy Management Handbook, 7/e, the Fairmont Press, Inc., 2009
2 F Kreith, D. Y Goswami, Energy Management and Conservation handbook, CRC Press, 2008
3 YP Abbi and Shashank Jain. Handbook on Energy Audit and Environment Management, TERI

Publications,2006

Evaluation Procedure						
Continuous Evaluation	**Total 70 Marks**					
	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2
	5	5	5	15	20	20
Sem End Examination	Total 30 Marks					

Course Outcome - Programe Outcome Mapping															
Course Outcomes :	**Programme Outcomes**														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	2	2	2	1	0	0	0	0	0	0	0	0	3	0	0
2	2	0	0	0	3	2	0	1	0	0	0	0	3	0	0
3	0	3	2	2	0	0	0	2	0	0	0	0	3	0	0
4	0	0	0	2	2	2	0	0	0	0	0	0	1	0	0
5	2	2	0	0	0	0	0	2	0	0	0	0	3	0	0
6															

Course Code	Course Title	L	T	P	J	S	C
	ELECTRIC AND HYBRID VEHICLES	3	0	10	0	0	8
Course Owner	Department of Mechanical Engineering	**Syllabus version**					
Course Pre-requisite(s)	Applied Thermodynamics	**Contact hours**					
Course Co-requisite(s)	NIL	**Date Approved**					
Alternate Exposure	NIL						

Course Description

This course introduces the fundamental concepts, principles, analysis and design of hybrid, electric and fuel cell vehicles. This course is an intended for learning the Fundamentals of Automobile Hybrid vehicles. This course is gives the brief ideas of Hybrid vehicles propulsion methods- Hybrid architecture Hybrid power plant specifications-Fuel cell technology - and Non electric Hybrid propulsion systems.

Course Objectives:

1 To introduce different configurations of electric vehicles
2 To familiarize knowledge of hybrid electric vehicles
3 To impart basic analyses associated with batteries and its types
4 To enable hybrid vehicle configuration and its components, performance analysis
5 To explain the concepts learnt for project work, higher studies and industry

Course Outcomes:

1 explain the need and advantages of electric vehicles in present scenario (L2)
2 compare hybrid vehicle with IC engines (L2)
3 analyse the modern trends in identifying energy sources in the form of fuel cells (L4)
4 interpret different types of controllers and drive train systems (L2)
5 define various DC and AC electrical machines for vehicle applications (L2)

UNIT I

Introduction to Electric Vehicles

Introduction to Electric Vehicles: History of Modern Transportation, air pollution-NOx, CO, UHC other pollutants, global warming, Economic and Environmental Impact of Electric Hybrid Vehicle, India Dependence on Foreign Oil EV Market

UNIT II

Architecture of Hybrid and Electric Vehicles

Architecture of Hybrid and Electric Vehicles: Vehicle Power Plant and Transmission Characteristics, Basic Architecture of Hybrid Drive Trains and Analysis of Series and parallel Drive Train, Power Flow in HEVs, Basic Architecture of Electric Drive Trains, Advantages and Disadvantages of Series-Parallel Combination.

UNIT III

Energy Sources

Energy Source: Battery- Battery Basics, Lead-Acid Battery, Nickel-Cadmium Battery, Nickel-Metal-Hydride (NiMH) Battery, Li-Ion Battery, Li-Polymer Battery, Zinc-Air Battery, Battery Parameters, Battery Capacity.

Fuel Cells: Fuel Cell Characteristics, Fuel Cell Types- Alkaline Fuel Cell (AFC) Proton Exchange Membrane (PEM), Direct Methanol Fuel Cell (DMFC), Phosphoric Acid Fuel Cell (PAFC), Molten Carbonate Fuel Cell (MCFC), Solid Oxide Fuel Cell (SOFC, ITSOFC), Fuel Cell EV

UNIT IV

Electric Machines and their Controllers

Electric Machines and their Controllers: DC-DC converters-Classification, DC-AC inverter-classification, Induction motors and Permanent Magnet Motors for HEV/EVs,

UNIT V

Design of Hybrid and Electric Vehicles

Design of Hybrid and Electric Vehicles: Hybridness: parallel hybrid, series, mixed and range extender (plug-in) hybrids, Range extender, Techniques to enhance hybrid performance, Mild or micro hybrid features, Plug-in hybrid, All-wheel drive hybrid, Sizing of Electric machine, Brake System of EVs and HEVs, case study of HEV.

Text Books

1. Mehrdad Ehsani, Yimin Gao, Ali Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, CRC Press, 2010
2. E. Fuhs, Hybrid Vehicles and the Future of Personal Transportation, CRC Press, 2009

Reference Books

1. James Larminie, Electric Vehicle Technology Explained, second editon, John Wiley & Sons, 2012.
2. Sandeep Dhameja, "Electric Vehicle Battery Systems", Newness, 2000
3. Iqbal Hussain, Electric & Hybrid Vehicles – Design Fundamentals, Second Edition, CRC Press, 2011
4. Web references: https://nptel.ac.in/courses/108/103/108103009/

Evaluation Procedure						
Continuous Evaluation	**Total 70 Marks**					
	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2
Sem End Examination	Total 30 Marks					

Course Outcome - Programe Outcome Mapping															
Course Outcomes :	**Programme Outcomes**														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1															
2															
3															
4															
5															
6															

Course Code	Course Title	L	T	P	J	S	C
EME…	**FUEL CELLS AND HYDROGEN STORAGE**	3	0	0	0	0	3
Course Owner	Department of Mechanical Engineering	**Syllabus version**					
Course Pre-requisite(s)	NIL	**Contact hours**					
Course Co-requisite(s)	NIL	**Date Approved**					
Alternate Exposure	NIL						

Course Description

This course introduces the alternative energy source to fossil fuels in the form of Hydrogen, through fuel cell technology. As the global energy consumption increasing year-by-year causing threats like greenhouse effects, global warming there is a need of reducing consumption of fossil fuel. This fuel cell technology using in automobile sector may reduce this grave consequences. Basic concepts of electrochemical energy conversion, technology behind the production and storage of Hydrogen are discussed in this course.

Course Objectives:

1 To introduce the basic concepts of fuel cell, and electrochemical energy conversionstates.
2 Familiarize regarding various cell types and advantages
3 Explain the performance and design characteristics and operating issues for various Fuel cells.
4 Enable the student regarding the working of fuel cell and its economics
5 Create awareness about the applications of fuel cell in automobiles

Course Outcomes:

1 Acquaint knowledge of fuels cells regarding their construction, performance and operational issues [L1]
2 Study the operating characteristics of fuel cell [L2]
3 Train the students to apply fundamental knowledge of thermodynamics, fluid mechanics and heat transferin design, construction of fuel cell [L3]
4 Develop the application of fuel cell in automobiles [L3]plants.(L4)
5 Carryout experiments on metal hydrides for hydrogen storage [L5].

UNIT I **9 Hrs**

Introduction

Fundamentals of electrochemical energy conversion, Basic operation principles and Overview. Advantages and applications, Fuel cell thermodynamics; open circuit voltage; efficiency. Heat released, reasons for losses in voltage, Electrode kinetics, porous electrodes, characteristics, fabrication of electrodes, assembly of fuel cells, testing, Classification of fuel cells based on nature of electrolyte, operating temperature etc.

UNIT II **9 Hrs**

Fuel cell types

Alkaline Fuel cells (AFC), Phosphoric Acid Fuel cells (PAFC), Polymer Electrolyte Membrane Fuel cells (PEMFC), Direct Methanol Fuel cells (DMFC), Molten Carbonate Fuelcells(DMFC), Solid Oxide Fuel cells (SOFC), Regenerative Fuel Cells (RFC), Specificcharacteristics, advantages and applications.

UNIT III **9 Hrs**

Applications

Automotive applications & issues – Micro fuel cells & Portable power – Distributed & Stationary power

UNIT IV **9 Hrs**

Hydrogen production technologies

Hydrogen as a future energy carrier, Properties, Chemical production of hydrogen, steam reforming of methanol, natural gas, coal gas etc, shift conversion and thermal decomposition, purification (removal of CO and CO2), desulphurization, Electrolytic hydrogen production, Electrolyser Configurations.

UNIT V **9 Hrs**

Hydrogen storage technologies

Basic principles, compressed gas storage, Cryogenic liquid storage, Solid state Storage, Adsorption in compoundsand metal hydrides, hydride heat pumps and compressors.

Text Books

1. B.Viswanathan and AuliceScibioh, Fuel Cells Principles and Applications,Universities Press, Hyderabad, 2006. Machines, McGraw Hill Education, 2017
2. J. Larminie& A. Dicks, Fuel Cell Systems Explained, Wiley, ISBN#0-471-49026-1, 2003.
   Applications, 3/e, Tata McGraw Hill, 2013.

Reference Books

1. Fuel Cell Handbook, 7th Edition, US Department of Energy, 2004.
2. M. M. Mench, Fuel Cell Engines, Wiley, (ISBN: 978-0-471 68958-4), 2008
3. X. Li, Principles of Fuel Cells, Taylor & Francis, 2005.
4. S. Srinivasan, Fuel Cells: From Fundamentals and Applications, Springer, 2006.

Evaluation Procedure						
Continuous Evaluation	**Total 70 Marks**					
	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2
	5	5	5	15	20	20
Sem End Examination	Total 30 Marks					

Course Outcome - Programe Outcome Mapping															
Course Outcomes :	**Programme Outcomes**														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	2	1	0	0	0	0	0	0	0	0	0	0	0	1	0
2	1	2	0	0	0	0	0	0	0	0	0	0	0	1	0
3	2	3	1	0	0	0	0	0	0	2	1	0	1	1	0
4	3	3	0	0	0	0	0	0	0	2	1	0	1	1	0
5	3	3	0	0	0	0	0	0	0	2	1	0	1	1	0
6															

Course Code	Course Title	L	T	P	J	S	C
	STATISTICAL QUALITY CONTROL	3	0	0	0	0	3
Course Owner	Department of MechanicalEngineering	**Syllabus version**					
Course Pre-requisite(s)	Engineering Mathematics,Probability & Statistics	**Contact hours**					
Course Co-requisite(s)	Total Quality Management	**Date Approved**					
Alternate Exposure	Industrial Engineering Lab Experiments						

Course Description

This course introduces various statistical tools which aid in the process of quality control. Quality control emphasizes testing of products to uncover defects and reporting to management to enable them to decide to allow or deny the release. Quality assurance attempts to improve and stabilize production, and associated processes, to avoid, or at least minimize, issues that lead to the defects.

Course Objectives:

1 To recognize the purpose of various tools used in quality control.
2 To determine costs associated with quality
3 To familiarize students with various control charts for attributes and variables.
4 To investigate the process capability and methods to improve the capability.
5 To understand the acceptance sampling plans

Course Outcomes:

1 Assess and estimate costs of quality. [L5]
2 Use tools of quality to quantify quality costs. [L3]
3 Plot control charts and control limits and revise the limits. [L3]
4 Estimate the capability of a process. [L2]
5 Select a sampling plan for a given scenario. [L1]

UNIT I **9 Hrs**

Quality Basics and History

Meaning of quality, Factors affecting quality, Quality Principles, Quality function, Quality control, Aims and objectives of quality control, Characteristics, Cost of Quality, Value of quality, Seven QC tools, Need ofmanagement of product quality, Historical perspective of quality control.

Learning Outcomes:

- define quality and comprehend the basic terms [L1]
- list factors effecting quality [L2]
- summarize objective of quality [L1]
- list quality tools [L2]

UNIT II **9 Hrs**

Modelling Process Quality

Variation: Stem-leaf Plot, Frequency distribution Histogram, Box Plot, Discrete Distributions Hyper Geometric Distribution, Binomial distribution, Poison Distribution, Continuous Distributions- Normal, Gamma, Exponentialand Weibull's distribution.

Learning Outcomes:

- Interpret frequency distribution through various plots [L2]
- distinguish continuous and discrete distributions [L3]

- analyse the distributions [L4]

UNIT III **9 Hrs**

Statistical Quality Control
Introduction, Concept of variability, Common vs. Special Causes, Types of Control charts, Measurement of controllimits, Control charts for variables -large sample data, Warning limits, Revised control limits, Group control chart,Control chart with line trend.

Learning Outcomes:
- define variability [L1]
- list common and special causes of variability [L1]
- apply control chart technique to solve problems [L3]
- analyse the causes for variations for variable chart [L4]

UNIT IV **9 Hrs**

Control Charts for Attributes and Capability Analysis

Control Charts for Attributes: Control charts for non-confirming Models, control charts for fraction non- conforming.; Process and Measurement System Capability Analysis: Using Probability plot, process capability ratios, specification limits and Tolerances.

Learning Outcomes:
- apply control Chart technique to solve problem for attributes[L3]
- analyse the causes for variations [L4]
- estimate the process capability ratio[L2]
- calculate limits and tolerances [L3]

UNIT V **9 Hrs**

Acceptance Sampling
Introduction, Advantages and Disadvantages of Sampling methods, Sampling techniques, Sampling Risks and indices, Operating characteristic curves, Average outgoing quality Limit. Sampling plans Single, Double, Multipleand Sequential Sampling Plans Tightened Inspection.

Learning Outcomes:
- List advantages and disadvantages of sampling methods [L1]
- Select sampling plans for given situation [L2]
- Apply sampling plan to different scenarios [L3]

Text Books
1. E. L. Grant Richard, R.S. Leavenworth, Design Statistical Quality Control, 7th Edition, McGraw- Hill Pvt LtdNew Delhi, 2011
2. D. C. Montgomery, Statistical Quality Control,7th Edition, John Wiley Sons

Reference Books
1 M. Mahajan, Statistical Quality Control, Revised Edition, Dhanapat Rai & Co, 2007.
2 W.W.Hines, D. C.Montgomery, Probability and Statistics in Engineering and Management, Science, JohnWiley and Sons, New York, 1990.

Evaluation Procedure						
Continuous Evaluatio	**Total 70 Marks**					
	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2

n						
Sem End Examination	Total 30 Marks					

Course Outcome - Programe Outcome Mapping															
Course Outcomes:	**Programme Outcomes**														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO 1	PSO 2	PSO 3
1	5			2									2		
2				4		3					3		1		
3			4						3						
4	3							3	3		3		1		
5					2					3	5		2		

Course Code	Course Title	L	T	P	J	S	C
	OPERATIONS RESEARCH	3	0	0	0	0	3
Course Owner	Department of MechanicalEngineering	**Syllabus version**					
Course Pre-requisite(s)	Mathematics	**Contact hours**					
Course Co-requisite(s)	Optimization Techniques	**Date Approved**					
Alternate Exposure	NIL						

Course Description

This course is to aid decision making and improving efficiency of the system by applying advanced analytical methods. This course addresses a few quantitative tools and techniques and provides students with knowledge andskills needed to apply these tools and techniques for decision making in organizations.

Course Objectives:

1 To Introduce the basics of Operations research, formulation and solution of Linear Programming Problemsusing different methods
2 To Learn Formulation and solve problems of optimization problems in transportation and assignment ofjobs.
3 To explore different queuing models and sequencing techniques for optimal schedule of jobs on machines
4 To impart knowledge on replacement policies for estimation of economic life of equipment and the conceptof game theory to arrive at the optimal business strategy for a given situation
5 To introduce basic inventory models to optimize inventory costs and Project scheduling techniques – CPM& PERT for optimum time and costs

Course Outcomes:

1 After successful completion of this course, the students will be able to develop the mathematical models and propose the optimal resource allocation [L3&L6]
2 formulate and solve transportation & assignment models for optimum resources [L6&L3]
3 analyze the queue system and to propose the optimal sequence of jobs on machines [L4 & L6]
4 evaluate the optimal replacement policy of the equipment and to analyze the strategic interaction betweenrational decision-makers [L6&L4]
5 design the inventory systems and to plan the project activities [L6]

UNIT- I **10 Hrs**

Basics of Operations Research: History, definition, operations research models, phases of implementingoperations research in practice.
Linear Programming: Introduction, formulation, graphical method, simplex method, Big M and Two-Phasemethods, concept of duality.
Learning Outcome:
After completion of Module-I, the students will be able to:

- **recognize** the significance of Operations Research and mathematical modelling while analysing thepractical problems in industry [**L1**]
- **formulate** the various linear Programming Models [**L6**]
- **evaluate** the optimal solution to simple linear programming problems [**L4**]

UNIT- II **8Hrs**

Transportation Model: Formulation, methods for initial feasible solution, optimal solution – MODI method,unbalanced transportation problems, degeneracy in transportation problems.
Assignment Model: Formulation, optimal solution, Hungarian method, travelling salesman problem.
Learning Outcome:
After completion of Module-II, the students will be able to:
- **formulate** the linear programming problem as a Transportation model [**L6**]
- **formulate** the linear programming problem as an Assignment model [**L6]**
- **evaluate** the optimal solution to Transportation Problems [**L4]**
- **evaluate** the optimal solution to Assignment Problems [**L4]**

UNIT- III **8Hrs**

Queuing Models: Introduction, Kendall's notation, Empirical Queueing Models – (M/M/1): (GD/∞/ ∞), (M/M/C)
:(GD/∞/ ∞), (M/M/1) :(GD/N/ ∞).
Sequencing Models: Introduction, assumptions, processing n-jobs through two machines, n-jobs through three machines, n-jobs through m-machines, graphic solution for processing 2 jobs through n machines with different order of sequence.
Learning Outcome:
After completion of Module-III, the students will be able to:
- **define** the various queuing models(**L1**)
- **calculate** Queue length & waiting time of a given queue system(**L3**)
- **evaluate** the optimal sequence of the jobs on machines for minimum cycle time(**L4**)

UNIT- IV **8Hrs**

Replacement Models: Introduction, replacement of items that deteriorate with time **-** value of money unchangingand changing, simple probabilistic model for replacement of items that fail completely.
Game Theory: Introduction, game with pure strategies, game with mixed strategies, dominance property, graphicalmethod for 2xn and mx2 games.
Learning Outcome:
After completion of Module-IV, the students will be able to:
- **analyze** the replacement and maintenance costs of items under various replacement policies [**L4]**
- **evaluate** the optimal replacement policy of items [**L4]**
- **analyze** the players' strategies and thereby **Evaluate** optimal business strategies for the players [**L4**]

UNIT- V **8Hrs**

Inventory Models: Introduction, inventory costs, purchase and manufacturing models, inventory models with quantity discounts.
Project Management: Introduction, phases of project management, network construction, numbering the events- Fulkerson's rule, Critical Path Method (CPM), Programme Evaluation and Review Technique (PERT)

Learning Outcome:
After completion of Module-V, the students will be able to:
- **recognize** the significance of Inventory models & Project Management in real world industrial scenarios[**L1]**
- **differentiate** between the critical and non-critical activities of a given project [**L4]**
- **propose** the optimal schedule of the activities involved in a project [**L6]**
- **evaluate** the optimal order/batch quantity for minimum inventory cost [**L4]**

Text Books
1 Paneerselvam R., Operations Research, 2/e, Prentice Hall of India, 2010
2 Gupta P K. & Hira D.S., Operation Research, 6/e, S Chand Publishers, 2006

Reference Books

1 Harvey M. Wagner, Principles of Operations Research: With Applications to Managerial Decisions, 2/e,Prentice Hall of India, 1975

2 Kanti Swarup., Man Mohan., and Gupta, P.K., Introduction to Operations Research, 7/e, Sultan Chand &Sons,2005

3 Hillier, F.S., and Lieberman G.J., Introduction to Operations Research, 7/e, Tata McGraw Hill, 2009

Evaluation Procedure						
Continuous Evaluation	**Total 70 Marks**					
	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2
	5	5	5	15	20	20
Sem End Examination	Total 30 Marks					

Course Outcome - Programe Outcome Mapping															
Course Outcomes :	**Programme Outcomes**														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	3	1			2								3		
2	3	1	1	1	2								3		
3	2	2	1	2	3	2		1	1				3	1	
4	2	2			3			1					3	1	
5	1	2	2	3	3	2	1	1	1	1	1	1	3	1	1

	Course Code	Course Title	L	T	P	J	S	C
	19EME378	**PLANT LAYOUT AND FACILITIES PLANNING**	3	0	0	0	0	3
	Course Owner	Department of Mechanical Engineering	**Syllabus version**					
	Course Pre-requisite(s)	Production systems	**Contact hours**					
	Course Co-requisite(s)	NIL	**Date Approved**					
	Alternate Exposure	NIL						

Course Description

The workspace is one of the main resources to deliver products/services with the expected level of quality with minimum cost. To achieve the organizational effectiveness and efficiency proper utilization of the workspace must be ensured. This course has been designed to highlight the basic issues, concepts, and the techniques related to Plant layout and assembly lines.

Course Objectives:

1 To impart knowledge on plant layout and plant location Theories.
2 To understand and introduce SLP procedure for plant layout preparation.
3 To learn the basics of material handling techniques.
4 To understand the line balancing techniques and labour optimization in industry.

Course Outcomes:

1 Learn about plant location factors for rural and urban places.
2 Effectively design and analyze facility layouts.
3 Apply and evaluate appropriate facility location models.
4 Apply algorithms for layout Preparation.
5 Apply algorithms for line balancing.

UNIT –I **8 L**

Plant Engineering: Plant Layout, Introduction, Types of Plant Layout, Phases of Layout Planning, Plant Location, Urban v/s Rural Location, Single facility location problems, Multi facility location Problems.

Learning Outcomes:

After completing this UNIT, the student will be able to

- familiarize the characteristics of product, process layouts. **[L1]**
- expose various factors those influence the location of a plant in urban vs rural area. **[L3]**
- know different phases of layout planning. **[L2]**
- study a facility location problem for single and multiple facilities. **[L2]**

UNIT-II **10 L**

Systematic Layout Planning: P-Q Analysis, Flow of Materials Analysis, Activity Relationship Analysis, Space Requirements & Availability, Modifying Considerations, Practical Limitations, Selection of Layout, Installation of Layout, CORELAP, CRAFT, ALDEP Algorithms Procedure and application, Problems.

Learning Outcomes:

After completing this UNIT, the student will be able to

- study the material flows in a manufacturing industry. **[L2]**
- adapt the knowledge in REL chart. **[L4]**
- employ various computer algorithms in designing a layout. **[L3]**
- teach the students for selecting a layout process**. [L3]**

UNIT–III **8 L**

Material Handling: Functions, Principles of Material Handling, MH Equipment-Conveyors, MH Equipment-Cranes, MH Equipment-Trucks, Systematic Handling Analysis, Classification of Materials.

Learning Outcomes:

After completing this UNIT, the student will be able to

- familiarize various functions and principles of material handling systems. **[L1]**
- introduce various MH equipment used in the manufacturing industry. **[L1]**
- expose various materials used in a manufacturing industry. **[L3]**
- enumerate some numerical problems for selection of MH equipment for a given

material. **[L1]UNIT–IV** **8 L**

Mass Production Management (Line Balancing): Basic idea of assembly line balancing, Optimization of numberof stations with given production rate, Minimization of cycle time with fixed number of stations.

Learning Outcomes:

After completing this UNIT, the student will be able to

- learn the concept of line balancing in an assembling a product. **[L1]**
- acquaint knowledge in minimum number of work stations in a production line. **[L1]**
- solve numerical problems in calculating the minimum cycle time of an assembly line**.[L3]**
- Recognize the importance of assembly line balancing through a case study.

[L1] UNIT –V **8 L**

Line Balancing Algorithms: Kilbridge and Wester, Rank Positional Weight method, COMSOAL, Moodie andYoung method.

Learning Outcomes:

After completing this UNIT, the student will be able to

- evaluate algorithmic approach to balance the assembly line. **[L5]**
- explain various methods for assembly line balancing in the mass production. **[L2]**
- examine existing software methods for solving assembly line problems. **[L4]**
- solve a practical line balancing problems through research papers. **[L3]**

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Text Books

1. R.L Francis and J.A White, Facilities layout and location-An analytical approach, Prentice Hall, 1992.

Reference Books

1. R. Panneerselvam, Production and operations management,3rd Edition, Prentice Hall Inc, 2012.
2. J.M. Apple, Plant Layout and Material Handling, McGraw Hill, 1972.

3. P. Rama Murthy, Production and operations management, 2nd Edition, New Age International,2006.

Evaluation Procedure						
Continuous Evaluation	**Total 70 Marks**					
	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2
	5	5	5	15	20	20
Sem End Examination	Total 30 Marks					

Course Outcome - Programe Outcome Mapping															
Course Outcomes :	**Programme Outcomes**														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	2														
2		2													
3			1												
4				2											
5				2											

Course Code	Course Title	L	T	P	J	S	C
EME-----	PRODUCTION PLANNING AND CONTROL	3	0	0	0	0	3
Course Owner	Department of MechanicalEngineering	Syllabus version					
Course Pre-requisite(s)	NIL	Contact hours					
Course Co-requisite(s)	NIL	Date Approved					
Alternate Exposure	NIL						

Course Description

Production Planning and Control helps manufacturers in allocating resources such as people, materials, machinesand money for their efficient and optimum utilization to meet the product demand from customers

Course Objectives:

1. Know the importance of Production Planning and Control, Forecasting and Master Production Schedule.
2. Acquaint with deterministic inventory models.
3. Evaluate costs of production and inventory.
4. Familiarize with planning procedure, seasonal and non seasonal demand, make or buy decisions.
5. Understand types production control, applications of computers in production planning and control

Course Outcomes:

After successful completion of this curse the student will be able to

1. acquaint with basic concepts of production planning and control and apply appropriate forecasting modelsto predict the demand.
2. solve problems pertaining to inventory by choosing right models.
3. acquire fundamental of cost accounting and evaluate the inventory models to reduce inventories costs.
4. apply planning strategies and scheduling, loading and other functions for smooth running of theorganization.
5. Apply controlling functions to manage manufacturing processes effectively.

UNIT I Introduction 10 Hrs

Introduction: Objectives of production planning and control, definition, functions of production planning and control, organization of production planning and control department, the internal organization of the department. **Forecasting**: Forecasting models, aggregate production planning, master production scheduling, materials requirements planning.

Learning outcomes:

At the end of this module, the student will be able to

- recognize the importance of Production Planning and Control [L2]
- understand the various planning methods and forecasting[L2]

UNIT II 10 Hrs

Inventory Control and Systematic Control of Inventory

Inventory Control: Objectives, economic and social complications of inventory management, limitations of inventory control. Functions of inventory, demand, and production characteristics. Measures of inventory performance.
Systematic Control of Inventory: Fixed order quantity systems, fixed interval systems, (s, S) systems, classification of items in inventory. Computer-based inventory control systems.

Learning outcomes:

At the end of this module, the student will be able to

- recognize the significance of Inventory Control[L2]
- understand Inventory systems[L2]

UNIT III **9 Hrs**

Cost Factor: The importance of costs, elements of costs, principles of cost determination and accounting systems,production and inventory cost factors, other costs to the firm.
Economic Quantities of Manufacture or Purchase: Lot size problems, finite production rates in manufacturing,quantity discounts.
Uncertainty: Effects of uncertainty, demand, and supply, safety stock, role of forecasting in production andinventory control. Uncertainty in production cycling.

Learning outcomes:

At the end of this unit, the student will be able to

- understand the significance of various costs associated with production and inventory[L2]
- solve lot size and discount quantity problems[L3]

UNIT IV **8 Hrs**

Production Planning: Scope of planning, types of production planning, demand analysis, seasonal and non- seasonal demand. Planning procedures, short term, and long term planning - make and buy decisions, product design and process selection, Scheduling, Loading

Learning outcomes:

At the end of this unit, the student will be able to

- understand planning procedure, seasonal and non-seasonal demand[L2]
- recognize the importance of make or buy decisions[L2]

UNIT V **8 Hrs**

Production Control: Control objectives, problems in production control, types of production and production control systems, controlling production, Dispatching, Controlling. The layout of the physical system, design of production planning, and control systems. Application of computers in production planning and control.

Learning outcomes:

At the end of this unit, the student will be able to

- understand Production control and associated problems[L2]
- recognize the role of computers in Production Planning and Control[L2]

Text Books

1 O. P Khanna, Industrial Engineering and Management, 4/e, Dhanpat Rai Publications, 2011.
2 Samuel Eilon, Elements of Production Planning and Control, Universal Publishing Corporation, 1999.

Reference Books

1 Magee and Boodman, Production Planning and Inventory Control, 2/e, McGraw Hill, 1967.
2 John E Biegal, Production Control: A Quantatative Approach, 2/e, Prentice Hall, 1971.
3 EH Mac Niece, Production Forecasting, Planning and Control, 3/e, John Wiley and Sons, 1961.
4 Seetharama L Narasimhan, Dennis W, McLeavey, Peter J Billington, Production Planning and InventoryControl, 2/e, PHI, 2004.

Evaluation Procedure						
Continuous Evaluation	Total 70 Marks					
	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2
	5	5	5	15	20	20
Sem End Examination	Total 30 Marks					

Course Outcome - Programe Outcome Mapping															
Course Outcomes :	Programme Outcomes														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	2	2	3	3	0	0	0	0	0	0	2	0	1	0	0
2	2	2	3	3	0	0	0	0	0	0	2	0	2	0	0
3	2	2	3	3	0	0	0	0	0	0	2	0	0	2	0
4	2	2	3	3	0	3	0	0	0	0	2	0	0	2	0
5	2	2	3	3	0	3	0	0	0	0	2	0	1	0	0

	Course Code	Course Title	L	T	P	J	S	C

	INVENTORY CONTROL	3	0	0	0	0	3
Course Owner	Department of MechanicalEngineering	**Syllabus version**					
Course Pre-requisite(s)	NIL	**Contact hours**					
Course Co-requisite(s)	NIL	**Date Approved**					
Alternate Exposure	NIL						

Course Description

The course exposes the students to understand the concepts and analytical approaches of inventory control its significance. It mainly focuses on the inventory control techniques under different demand and lead time varying environments. The course caters to the students who work with the industries in the future and familiarizes the inventory control techniques

Course Objectives:

1 Introduce to basic concepts of Inventory Management and its significance in Organization.
2 Explore the different Static Inventory models under risk
3 Analyze the Dynamic Inventory models
4 Acquire knowledge of selective inventory control systems
5 Analyze the inventory models with quantity discounts and acquaint with concepts of material handling,JIT, MRP.

Course Outcomes:

1 List the advantages and disadvantages of inventory control and costs associated. [L1]
2 classify the inventory models. and define the terms [L2]
3 solve problems pertaining to inventory by choosing right models. [L3]
4 Solve problems in price discounts and multi-level inventory problems.[l3]
5 apply latest emerging concepts like JIT, ABC, VSN and MRP for business organizations .[l4]

Specific Instructional Objectives

1 Case studies
2 Presentations Activity
3 Problem solving,, Group activity and Discussion based.

UNIT- I **8 L**

Introduction: Operating Environment. Supply Chain Concept, Material Flow,
Supply ChainMetrics.
Production Planning System: Manufacturing Planning and Control System. Sales and Operations Planning,
Manufacturing Resource Planning. Enterprise Resource Planning.
Makingthe Production Plan.

Learning Outcomes:

After completing this UNIT, the student will be able to

- apply logistics and purchasing concepts to improve supply chain operations**[L3]**
- evaluate complex qualitative and quantitative data to support strategic and operational decisions.**[L4]**
- analyzesystematic planning of production activities to achieve the highest efficiency in production ofgoods/services**. [L4]**

UNIT II **8 L**

Inventory Fundamentals: Aggregate Inventory Management, Item Inventory Management, Inventory and Flow of Material, Supply and Demand Patterns, Functions of Inventories,Objectives of Inventory Management, Inventory Costs, Financial Statements and Inventory, ABC Inventory Control.
Order Quantities: Economic Order Quantity (EOQ), Variations of EOQ Model. QuantityDiscounts, Use of EOQwhen Costs are not known, Period Order Quantity (POQ).
Learning Outcomes:
After completing this UNIT, the student will be able to
- identify the role of information technology in managing inventories. **[L2]**
- categorize the ABC analysis of inventory items**[L4]**
- describe the continuous or periodic review inventory-control system. **[L1]**

UNIT III **8 L**

Independent Demand Ordering Systems: Order Point System, Determining Safety Stock. Determining Service Levels, Different Forecast and Lead Time Intervals, Determining when Order Point is reached, Periodic Review System, Distribution Inventory.

Learning Outcomes:

After completing this UNIT, the student will be able to
- determine differentinventory performance measures and relevant costs **[L3]**
- analyze thewarehouse/Distribution Centre Management**[L4]**
- apply quality management tools for process improvement**[L3]**

UNIT IV **6 L**

Purchasing: Establishing Specifications, Functional Specification Description, Selecting Suppliers, Price Determination, Impact of MRP on Purchasing, Organizational Implications ofSCM.
Learning Outcomes:

After completing this UNIT, the student will be able to
- apply the sales and operations planning, MRP and lean manufacturing concepts**[L3]**
- examine the methods used by organizations to obtain the right quantities of stock or

inventory, **[L1]UNIT V** **8 L**

Physical Inventory and Warehouse Management: Warehousing Management, Physical Control and Security,Inventory Record and Accuracy.
Physical Distribution: Physical Distribution System, Interfaces, Transportation. Legal Types ofCarriage. Transportation Cost Elements, Warehousing, Packaging, Materials Handling. Multi- Warehouse Systems.

Learning Outcomes:

After completing this UNIT, the student will be able to
- familiarize themselves with inventory management practices. **[L2]**
- assess the different levels of transportation costs, warehouse utilization metrics and productivityimprovement methods**[L4]**

Text Books

1. Starr M K & Miller D W, Inventory Control Theory and Practice, Prentice-Hall

Reference Books

1. S. D. Sharma, Operations Research, 14/e, Kedar Nath Ram Nath & Co., 2005

Evaluation Procedure						
Continuous Evaluation	**Total 70 Marks**					
	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2
Sem End Examination	Total 30 Marks					

Course Outcome - Programe Outcome Mapping															
Course Outcomes :	**Programme Outcomes**														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	1	2	2		1								2		
2	1	1	2			1					1		2		
3	2	2	1										2	1	
4	2	3	2		1								2	1	
5	2	2	1										2	1	

	Course Code	Course Title	L	T	P	J	S	C
	EHS 402	OPERATIONS AND SUPPLY CHAIN MANAGEMENT	3	0	0	0	0	3
	Course Owner	Department of MechanicalEngineering	Syllabus version					
	Course Pre-requisite(s)	Engineering Economics and Management	Contact hours					
	Course Co-requisite(s)	NIL	Date Approved					
	Alternate Exposure	Project Management						

Course Description

The course under Operations and supply chain management has been designed to cover the basic concepts of operations management and supply chain management. The students will understand the role of logistics, drivers and metrics in supply chain and how to design the network. The students will understand the globalization and its risks and forecasting in supply chan. The students will understand collaborative planning and replenishment strategies and how to manage uncertainties in inv entory. The students shall also be able to understand the role of information technology in inventory management and transportation in supply chain.

Course Objectives:

1. To introduce operations management, role and responsibilities of operations manager.
2. To explain the importance of logistics and supply chain management and the relevant drivers and metrics.
3. To demonstrate the technique of forecasting to reduce uncertainty by identifying the risks in a global supplychain setting
4. To impart knowledge of collaborative planning, forecasting and replenishment methodologies to achievebetter coordination in a supply chain.
5. To summarize the importance of technology in operations, logistics and supply chain management.

Course Outcomes:

1. Identify various operations required for successful management of manufacturing systems.
2. Understand the design of distribution networks by interpreting the drivers and metrics.
3. Apply forecasting techniques to quantify the risks and lessen uncertainty.
4. Illustrate inventory management through the application of CPFR techniques.
5. Determine the role of latest technologies for effective inventory and transportation management.

UNIT I **8 Hrs**

Introduction to Operations Management

History of operations management, types of manufacturing systems, roles and responsibilities of operations manager, Product operations and service operations, Current Trends in Operations Management

UNIT II **8 Hrs**

Understanding the Logistics and Supply Chain

Introduction to supply chain, supply chain links, role of logistics in supply chain, drivers and metrics in supply chain, designing the supply chain network, online sales and distribution network, factors influencing the network design.

UNIT III **8 Hrs**

Impact of Uncertainty in Network

Globalization and supply chain, risk management in global supply chain, demand forecasting in supply chain roleof information technology in forecasting.

UNIT IV **8 Hrs**

Coordination in Supply Chain
Collaborative planning and replenishment strategies, CPFR, managing uncertainties in inventory.

UNIT V **8 Hrs**

Impact of Replenishment Policies in Safety Inventory
Role of information technology in inventory management, transportation in supply chain.

Text Books

1. Sunil Chopra, Supply Chain Management, Pearson Publications, 2012.

Reference Books

1. Sridhara Bhatt, Logistics and Supply Chain Management, Himalaya Publishers, 2011
2. D.K Agarwal, Logistics and Supply Chain Management, Macmillan Publishers, 2013.

Evaluation Procedure						
Continuous Evaluation	**Total 70 Marks**					
	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2
Sem End Examination	Total 30 Marks					

Course Outcome - Programe Outcome Mapping															
Course Outcomes :	**Programme Outcomes**														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1				2	3				3				1	0	1
2	2			2				2	3	2			1	0	1
3					5				2				0	1	1
4				3	3				3	2	2	2	1	0	1
5	2				4					2		2	1	1	1

	Course Code	**Course Title**	L	T	P	J	S	C
		ENTERPRISE RESOURCE PLANNING	3	0	0	0	0	3
	Course Owner	Department of Mechanical Engineering	**Syllabus version**				1	

Course Pre-requisite(s)	This course requires understanding of school levelcomputer science education and IT for Managers	**Contact hours**	
Course Co-requisite(s)	NIL	**Date Approved**	
Alternate Exposure	NIL		

Course Description

This course ENTERPRISE RESOURCE PLANNING focuses on Industry specific enterprise application like manufacturing and service industry. This course also covers different functional areas covered by ERP and Enterprise. It includes applications of ERP in various areas such as human capital management, customer relationship management, financial management etc. It also includes lifecycle of ERP/Enterprise Applications

Course Objectives:

1 To provide awareness about the ERP concepts and the technologies
2 To Understand ERP Implementation Procedure
3 To know the process of Post Implementation of ERP.
4 To provide knowledge of ERP for various unit s.
5 To help in understanding how companies have implemented ERP successfully.

Course Outcomes:

1 obtain a basic understanding of the concept of ERP. [L-1]
2 comprehend the significance of the ERP implementation Procedure. [L-2]
3 apply design principles for various business modules in ERP.[L-4]
4 learn various ERP units and software's related to ERP. [L-3]
5 analyze security issues in procuring and implementing ERP. [L-4]

UNIT I **8 L**

Introduction: Concept of Enterprise, ERP Overview, Integrated information system, The role of Enterprise, Business Modeling, Myths about ERP, Basic ERP Concepts, Intangible benefits of ERP, Justifying ERP investment, Risks of ERP, Benefits of ERP

Learning Outcomes:

At the end of this UNIT, the student will be able to

- understand the concept of enterprise resource planning. [**L2**]
- apply and interpret basic summary and modelling techniques of business modelling in ERP. [**L3**]
- recognize the myths, risks and benefits of ERP. [**L2**]
- knowledge in the areas where ERP has significance. [**L1**]

UNIT II **8 L**

Implementation: Life Cycle, Methodologies, Strategy, Business Case and Return on Investment Analysis for ERP, Selecting Consulting Partner, ERP Package Selection, ERP Project Team and Project Organization Structure, ERP Project Management, Managing Requirements, Business Process Re-engineering, Business Process Modeling andBusiness Modeling.

Learning Outcomes:

At the end of this UNIT, the student will be able to

- understand the concept of life cycle and strategies involved in ERP. [**L2**]
- compile the ideas of any project team and develop modelling techniques in the structure of ERP.[**L5**]
- identify the process of selecting consulting partner and package selection. [**L1**]
- analyze wide knowledge in business process re-engineering. [**L4**]

UNIT III **8 L**

Post ERP Implementation: Post-Implementation Review of ERP Systems, Post-Implementation

Support, Maintenance and Security of ERP, Gaps Identification and Strategies to Bridge the Gap, Configuring and Testing of the Solution, Data Migration, Cutover Planning and Go Live Preparation, Training, Change Management, Success or Failure of ERP Implementation.

Learning Outcomes:
At the end of this UNIT, the student will be able to
- identify the gaps in the maintenance and security of ERP systems. [**L1**]
- test the solutions in data migration. [**L3**]
- extend wide knowledge in the success and failure of ERP. [**L3]**

UNIT IV **8 L**
ERP Functional UNITs: Human Capital Management, Financial Management Procurement, Inventory Management through ERP, Supplier Relationship Management, Production Planning, Execution, Supply Chain Planning, Sales and Service, Logistics Execution, Warehouse and Transport Management, Customer Relationship

Management, Quality Management, Maintenance Management, Enterprise Asset Management, Product LifecycleManagement.
Learning Outcomes:
At the end of this UNIT, the student will be able to
- understand the concept and distinguish the features between capital management, financial managementand inventory management. [**L2**]
- recognize the execution of logistics, warehouse and transport management. [**L1**]
- Interpret the difference between customer relationship management, quality management and enterprisemanagement. [**L1**]
- identify the features of product life cycle management. [**L1**]

UNIT V **8 L**
ERP Applications: Portal, Content Management, Knowledge Management, Data Warehousing, Data Mining, Business Intelligence and Analytics, ERP and Enterprise Applications, Emerging Trends, ERP for Industries- ERPs for Different Manufacturing Industries, ERPs for Different Service Industries, Case Studies.
Learning Outcomes:
At the end of this UNIT, the student will be able to
- identify the gaps in the maintenance and security of ERP systems. [**L1**]
- configure and test the solutions in data migration. [**L2**]
- obtain the process of cutover planning, preparation, and training. [**L1**]
- enhance wide knowledge in the success and failure of ERP. [**L2**]

Text Books

1 Rajesh Ray, Enterprise Resource Planning, 1stEdition, McGraw Hill Education, 2010.
2 Robert D.Hisrich, Michael P.Peters, Mathew J. Manimala and Dean A. Shepherd, Entrepreneurship,9thEdition, McGraw Hill Education, 2010

Reference Books

1 D. P. Goyal, Enterprise Resource Planning A Managerial Perspective, 1stEdition, McGraw Hill Education,2011
2 L.Wagner, Concepts in Enterprise Resource Planning, 4th Edition, engage Learning India Pvt. Ltd, 2014.
3 A. leon, Enterprise Resource Planning, 3rdEdition, McGraw Hill Education, 2014.

Evaluation Procedure						
Continuous	**Total 70 Marks**					
	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2

Evaluation	20	20	20	10	40	30
Sem End Examination	Total 30 Marks					

Course Outcome - Programe Outcome Mapping															
Course Outcomes :	**Programme Outcomes**														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	2	2	2	3	3	2	0	0	0	2	2	1	0	1	2
2	1	1	2	2	2	2	0	0	0	1	1	0	0	1	2
3	3	3	3	1	1	2	0	0	0	1	1	0	0	1	2
4	2	2	2	1	1	2	0	0	0	1	1	2	0	1	2
5	1	1	1	1	1	2	0	0	0	1	1	2	0	1	2

Course Code	Course Title	L	T	P	J	S	C
EME452	**MANAGEMENT INFORMATION SYSTEMS**	3	0	10	0	0	8
Course Owner	Department of MechanicalEngineering	**Syllabus version**					
Course Pre-requisite(s)	Supply chain management,Materials Management	**Contact hours**					
Course Co-requisite(s)	Logistics and Supply chain management, Organizationalbehaviour	**Date Approved**					
Alternate Exposure	NIL						

Course Description

The course is a unified approach on computer-based information systems in business firms and government agencies. MIS combines the work of computer science, management science, and operations research with a practical orientation toward developing system solutions to real-world problems and managing information technology resources. It is also concerned with behavioral issues surrounding the development, use, and impact ofinformation systems, which are typically discussed in the fields of sociology, economics, and psychology.

Course Objectives:

1 To provide overall understanding of the fundamental concepts of information systems, and to highlight theimportance of information systems in modern organizations and societies
2 To understand the information processing pertaining to achieving goals, objectives and targets of businessorganization
3 To understand how Decision Support Systems (DSS) use models to process data and information
4 To impart knowledge on basic components of information technology infrastructure
5 To gain insight of concepts of Business process reengineering (BPR) and process improvement, businessvalue of systems

Course Outcomes:

1 Assess role of MIS in ever evolving complex business scenario
2 Assimilate knowledge obtained in core concepts like Decision support systems and AI.
3 Appreciate the role of MIS in organizations related to service and manufacturing sectors
4 Analyze real cases study by studying BPR (business process reengineering) to manage resources effectivelyand incorporating latest-cutting edge technology
5 Develop IT skills to become a successful IT and Business managers

UNIT I **9 Hrs**

Organizations, Management and the Networked Enterprise

Managing digital firm; Necessity of information systems (IS); New Role of IS in organizations; New opport**UNIT** ies with technology for IS. IS in the Enterprise: Major types, functional perspective and enterpriseapplications. IS, organizations, management and strategy.

Learning Outcomes:

- define information systems and comprehend the basic terms [L1]
- list types of enterprises [L2]
- summarize enterprise applications [L1]
- list organisations [L2]

UNIT II **9 Hrs**

Information Technology Infrastructure

Categories of computer systems, types of software, managing hardware and software assets. Managing dataresources; Telecommunications and networks.

Learning Outcomes:
- define network [L1]
- list types of computer systems [L1]
- analyze managing data resources in telecommunications [L4]

UNIT III **9 Hrs**

Management and Organizational Support Systems for Digital Firm

Managing knowledge for the digital firm; Information and knowledge work systems, artificial intelligence, otherintelligence techniques. MIS and decision support system (DSS).

Learning Outcomes:
- Interpret decision support systems with other intelligence techniques L2
- distinguish artificial intelligence and MIS L3
- analyse the managing knowledge for the digital firms L4

UNIT IV **9 Hrs**

Building Information Systems in the Digital Firm

Redesigning the organization with IS; Systems as planned organizational change; Business process reengineering(BPR) and process improvement. Understanding the business value of systems

Learning Outcomes:
- Define business process reengineering [L1]
- Understand the business value [L2]
- estimate the process improvement [L4]

UNIT V **9 Hrs**

Managing Change

Importance of change management in IS success and failure; Managing implementation.

Learning Outcomes:
- List changes in management [L1]
- Understand the importance of change management [L2]
- Apply IS success and failure to any real time problem[L3]

Text Books

1. K.C.Laudon and J.P.Laudon, Management Information Systems - Managing the Digital Firm, 8/e, PHI, 2004.

Reference Books

1. Data C.J, An introduction to Data Base Management System, Narosa Publication House,, 1985.
2. Murdic, Ross and Clagget, Information Systems for Modern Management, PHI, 1985.
3. Davis Gordon, Management Information Systems – Conceptual Foundations, McGraw Hill, 1993

Evaluation Procedure						
Continuous Evaluation	**Total 70 Marks**					
	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2
	20	20	20	10	40	30

Sem End Examination	Total 30 Marks

Course Outcome - Programe Outcome Mapping															
Course Outcomes :	Programme Outcomes														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1					2			2		1	1				
2		3		3		3		1			1				
3				3				3	3						
4				3	3	3			3						
5				3				3	3						

	Course Code	Course Title	L	T	P	J	S	C

	OPTIMIZATION TECHNIQUES	3	0	0	0	0	3
Course Owner	Department of MechanicalEngineering	**Syllabus version**					
Course Pre-requisite(s)	Mathematics	**Contact hours**					
Course Co-requisite(s)	NIL	**Date Approved**					
Alternate Exposure	NIL						

Course Description

This course exposes the evaluation of the best possible solution for various engineering planning and design problems. The aim of the course is to train the students to develop a mathematical model and to solve the model by applying an appropriate mathematical programming technique. This course also covers advanced optimization techniques to solve dynamic and integer programming problems.

Course Objectives:

1. To illustrate the importance of optimization techniques in theory and practice.
2. To formulate and solve engineering design problems in the industry for optimal results
3. To test the analytical skills in solving real engineering problems by applying appropriate optimizationtechnique
4. To demonstrate various advanced optimization techniques being developed in recent times.
5. To develop and promote research interest in problems of Engineering and Technology

Course Outcomes:

1. After successful completion of this course, the students will be able to classify optimization problems and apply classical optimization techniques to solve NLPPs having differentiable functions [L2&L3]
2. apply the concept of uni-modal function to solve one dimensional minimization problems [L3]
3. solve any multi variable optimization problems[L3]
4. solve any complex optimization problem as a dynamic programming problem and analyze its solution[L3&L4]
5. recognize the significance of integer and/or binary solutions and apply a suitable algorithm for betterdecision making [L1&L3]

UNIT I **8 Hrs**

Introduction to optimization: Introduction, engineering applications of optimization, statement of an optimization problem-design vector, design constraints, constraint surface, objective function, classification of optimization problems.

Classical Optimization techniques: Introduction, single variable optimization, multi variable optimization withno constraints, multi variable optimization with equality and inequality constraints.

Learning outcomes:

After completing this unit, the student will be able to

- **describe** the need and origin of the optimization methods [**L1]**
- **classify** design points, constraints, and optimization problems **[L2]**
- **choose** the method needed to solve the optimization problem [**L3]**

UNIT II **10 Hrs**

One Dimensional Minimization Methods: Introduction, unimodal function, elimination methods-exhaustive search, interval halving method, Fibonacci method, golden section method, interpolation methods-quadratic & cubic interpolation methods, direct root methods-Newton method, secant method.

Learning outcomes:
After completing this unit, the student will be able to
- **apply** elimination methods to find the narrowest region in which optimum point lies **[L3]**
- **solve** one dimensional minimization problems using interpolation and direct root

methods **[L3]UNIT III** **8 Hrs**

Unconstrained Minimization Methods: Introduction, Direct Methods- random search methods, univariatemethod, Powell's method. Descent method - steepest descent method (Cauchy's method)

Learning outcomes:
After completing this unit, the student will be able to
- **apply** random search methods to solve unconstrained multi-variable optimization problems [**L3]**
- **employ** pattern directions to find the optimal solution [**L3]**

UNIT IV **8 Hrs**

Dynamic Programming: Introduction, Bellman's optimality principle, application of Dynamic Programming -
Shortest Path Problem, cargo-loading problem, optimal subdividing problem, Linear programming problem.

Learning outcomes:
After completing this unit, the student will be able to
- **formulate** the given linear/non-linear programming problem as a dynamic programming problem[**L6**]
- **evaluate** the optimal solution to dynamic programming problems using multi-stage decision

process [**L4]UNIT V** **8 Hrs**

Integer Programming: Introduction, All Integer and Mixed Integer Programming problems- Gomory's cuttingplane method & Branch-and-bound method. Balas algorithm for zero-one programming.

Learning outcomes:
After completing this unit, the student will be able to
- **formulate** the integer and/or binary programming problem [**L3**]
- evaluate the optimal solution to integer and/or binary programming problem [**L4**]

Text Books
S.S.Rao, Engineering optimization theory and practice,3rd Edition, New age international,2007

Reference Books
1. H.A.Taha, Operations Research, 9th Edition, Prentice Hall of India, 2010
2. F.S.Hillier, and G.J.Lieberman, Introduction to Operations Research, 7th Edition, TMH, 2009.

Evaluation Procedure						
Continuous Evaluation	**Total 70 Marks**					
	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2
	5	5	5	15	20	20
Sem End Examination	Total 30 Marks					

Course Outcome - Programe Outcome Mapping															
Course Outcomes :	**Programme Outcomes**														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	3	1			2								3		
2	3	1	1	1	2								3		
3	2	2	1	2	3	2		1	1				3	1	
4	2	2			3			1					3	1	
5	1	2	2	3	3	2	1	1	1	1	1	1	3	1	1
6															

Course Code	**Course Title**	L	T	P	J	S	C
	PROJECT PLANNING AND MANAGEMENT	3	0	0	0	0	3
Course Owner	Department of MechanicalEngineering	**Syllabus version**				1	
Course Pre-requisite(s)	Operations Research	**Contact hours**					
Course Co-requisite(s)	NIL	**Date Approved**					
Alternate Exposure	NIL						

Course Description

This course provides an in-depth insight into the concepts, principles, formulation of projects and network techniques of project management, The appraisal Techniques to evaluate the projects which could be successfullyused for improving the quality of managerial decisions. The students will study this course with a generalist approach

Course Objectives:

1 This course is an introduction to the basic processes of project management for instructional designprojects.

2 Students will be introduced to organizational issues, methods of planning, and techniques for managing thebusiness and creative processes that determine the success of a project.

3 Students will learn to use project management software for organizing, scheduling and monitoring projectprogress.

Course Outcomes:

1 Apply theoretical aspects and approaches to managing technology based projects

2 Identify potential factors that impact successful project management including scope creep, budgeting

3 Apply algorithms to solve real time network problems

4 Solve by linear programming in real time network problems

5 outline the operation of projects under resource constrained environment and closing the projects

Unit I **8 Hrs.**

Project Planning: Analysis and Appraisal Generation of project ideas, Scouting for project ideas, Preliminary screening, Project rating index, Cost of project.

Investment Appraisal: Social cost benefit analysis, UNIDO approach, Net benefit in terms of economic prices, Measurement of impact on distribution, Savings impact and its value, Income distribution impact, Adjustment formerit and demerit, Goods Little Mirrless approach, Shadow prices.

Learning outcomes:

After completing this unit, the student will be able to

- Understand the role of Project Management in instructional technology and project development (L2)
- Apply theoretical aspects and approaches to managing technology-based projects (L2)
- Comprehend the importance of social cost benefit analysis(L2)
- Interpret the usage of social cost benefit analysis, UNIDO approach(L2)

Unit II **10 Hrs.**

Project Implementation: Development of project network, Dummy activities, Activity on node networks, Cyclicnetwork, Forward pass and backward pass computations, Algorithm for critical path, Total slacks, free slacks, andtheir interpretations.

Time-cost Trade off Procedure: Schedule related project costs, Time cost trade off, lowest cost schedule. **PERT Network:** Three time estimates for activities, Estimation of mean and variance of activity times, Eventoriented algorithm for critical path, Probability of meeting a schedule date.

Learning outcomes:

After completing this unit, the student will be able to

- Identify major stakeholders and organizational dynamics in a projects life cycle (L2)
- Identify potential factors that impact successful project management including scope creep, budgeting,team dynamics and working with overseas development vendors(L2)
- Apply knowledge and skills to create a formal project planning document (L2)

Unit III **8 Hrs.**

Network Analysis:

Algorithms for shortest route problems-Dijkstra's, Floyd's, and Pollack's, algorithms.Algorithms for minimal spanning tree- Kruskal's algorithm and Prim's algorithm; Algorithms for maximal flow problems-Ford and Fulkerson's algorithm.

Learning outcomes:

After completing this unit, the student will be able to

- Recognize the importance of evaluating emerging technology in technology project management(L2)
- Explores algorithms and uses them in real time environments(L2)

Unit IV **8 Hrs.**

Linear Programming Formulation of Network Problems: A flow network interpretation for determination of critical paths, Time cost trade off and maximal flow, Chance constrained linear programming for probabilistic durations of activities in PERT network.

Learning outcomes:

After completing this unit, the student will be able to

- Apply theoretical aspects and approaches to managing technology based projects in network problems(L2)
- Explores linear programming problems and uses them in real time environments(L2)

Unit V **8 Hrs**

Project Scheduling with Limited Resources: Complexity of project scheduling with limited resources, levelingthe demands on key resources, a simple heuristic program for resource allocation.

Learning outcomes:
After completing this unit, the student will be able to

- Identify the technical requirements of project management using MS Project(L2)
- Create and manipulate a projects specifics using Microsoft Project (L2)
- Apply knowledge and skills to create a formal scheduling project(L2)

Text Books

1. Parameshwar P. Iyer. Engineering Project Management with Case Studies, Vikas Publishing House Pvt. Ltd.New Delhi, 2005.
2. Prasanna Chandra, Projects Planning, Implementation and Control, Tata McGraw Hill Publishing CompanyLimited, New Delhi, 1995.

Reference Books

1. Project Management Institute (PMI), A Guide to the Project Management of Knowledge Newton Square, PA,1996
2. J.R. Meredith and S.J. Mantel. Project Management: A Managerial Approach. John Wiley and Sons, New York,1995.
3. L.S. Srinath, PERT & CPM Principles & Applications, 3rd edition, East west Press,2001.

Evaluation Procedure						
Continuous Evaluation	**Total 70 Marks**					
	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2
Sem End Examination	Total 30 Marks					

Course Outcome - Programe Outcome Mapping															
Course Outcomes :	**Programme Outcomes**														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	2	1		2			1	2	1	2		1		2	1
2	2	1		2	1	1		2		2	1			2	1
3	3	2		1	2	1								2	
4	2	1		1	1	1								2	
5	2	2		2	1	1	1	2	1	1				2	
6															

Course Code	Course Title	L	T	P	J	S	C
	DECISION MODELLING	3	0	0	0	0	3
Course Owner	Department of MechanicalEngineering	**Syllabus version**				1.0	
Course Pre-requisite(s)	OPERATIONS RESEARCH	**Contact hours**					
Course Co-requisite(s)	NIL	**Date Approved**					
Alternate Exposure	OPTIMIZATION TECHNIQUES						

Course Description

The primary course objective is to improve managerial effectiveness through clearer thinking about complex decision issues, and through the application of powerful analytical tools to a wide variety of common management problems. This course will include advanced topics and tools for decision analysis of problems with "real-world" complications, such as integer programming with emphasis to its relation with linear programming. The principle behind decision natures and their utility towards decision making process in deterministic as well as stochastic models are focused.

Course Objectives:

1. To primarily understand the basic operation research methods and their sensitivity analysis course objectiveis to improve managerial effectiveness through clearer thinking about complex decision issues, and through the application of powerful analytical tools to a wide variety of common management problems.
2. Identify real-life problems and choose appropriate tool/technique to model them, being aware of the assumptions underlying the tools. To introduce and conceptualize of integer programming and its types like branch and bound and cutting plane method.
3. To make reader understand the advanced topics and tools for decision analysis of problems with "real- world" complications such as decision analysis and understand the need and origin of the Decision models
4. To make use of principles of branch and bound and outer linearization methods for mixed integer problemsto solve integer linear programming problems.
5. To analyze complex problems through the techniques learnt, and to suggest the optimum solution.
6. To solve single variable unconstrained Non-Linear programming problems and also to analyze in solving single variable constrained Non-Linear programming problems

Course Outcomes:

1. To understand the need, origin of the optimization methods and to suitably choose the optimization methodneeded to solve the particular type of problem.
2. To apply the basic formulation and solve integer linear programming models and also to efficientlyinterpret network diagrams for proper decisions making of the model.
3. To use the principles of the need, types and procedure of decision analyzing.
4. To use the principles of need and problem solve using sequential decision making concept which aredeterministic and stochastic in nature.
5. To use the working of the steps involved in algorithm generation of un-constrained and constrainedoptimization decision models.

UNIT I **8 Hrs**

Introduction to optimization

Introduction, Theory of Simplex Method, Duality Theory, Duality theorems, Dual simplex method, revisedsimplex, Bounded variables algorithm, Sensitivity analysis.

UNIT II **8 Hrs**

Integer Programming

Cutting plane method, Branch and bound method. Network Models and Solutions, Shortest Route problems,Minimal spanning tree problems, Maximal flow problem.

UNIT III **8 Hrs**

Introduction to Decision Making
Decision analysis, Decisions under risk, Decision trees, Decision analysis with experimentation, Utility theory,Decisions under uncertainty, Introduction to multi-objective Decision Models.

UNIT IV **10 Hrs**

Sequential Decision Making (Deterministic Case)

Sequential decision models, Dynamic programming, Bellman's principle of optimality, Forward recursion and backward recursion, Sequential Decision Making (Stochastic Case): Stochastic processes, Markov processes, Markov chains, Markov decision problems.

UNIT V **11 Hrs**

Algorithms for Unconstrained and constrained Optimization
Algorithms for Unconstrained Optimization, Fibonacci search method, Golden section search method, Hooke andJeeve's method, Newton-Raphson method, Cauchy's (Steepest descent) method Algorithms for Constrained Optimization: Penalty function methods, Quadratic programming, Separable convex programming.

Text Books
1. Hillier, F.S. and Lieberman, G.J. Introduction to Operations Research, 8/e, McGraw-Hill, 2008.
2. Rao, S.S. Optimization: Theory and Applications, 3/e, Wiley Eastern, 2008.

Reference Books
1. Ravindran, A., Philips, D.T., and Solberg, J.J., Operations Research: Principles and Practice, 3/e, John Wiley &Sons, 2006.
2. Taha, H.A., Operations Research: An Introduction, 6/e, Prentice-Hall, 1999
3. Sharma, J.K. Operations Research: Theory and Applications, 5/e, MACMILLAN.

Evaluation Procedure						
Continuous Evaluation	**Total 70 Marks**					
	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2
	20	20	20	10	40	30
Sem End Examination	Total 30 Marks					

Course Outcome - Programe Outcome Mapping															
Course Outcomes :	**Programme Outcomes**														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	3	2	3	2									3	2	
2	3	2	3	2	1	1							3	2	1
3	1	2	2	1	2	1	2		1				3	2	2
4	3	1	3	1	1	1							3	2	
5	3	2	3	2	1	1							3	2	

Course Code	Course Title	L	T	P	J	S	C
	TOTAL QUALITY MANAGEMENT	3	0	10	0	0	8
Course Owner	Department of MechanicalEngineering	**Syllabus version**					
Course Pre-requisite(s)	Industrial Engineering Management, Materialsmanagement	**Contact hours**					
Course Co-requisite(s)	Logistics & Supply Chain Management, Statistical Quality control	**Date Approved**					
Alternate Exposure	NIL						

Course Description

This Course is to introduce the applications to formulate new plans/procedures to be implemented to achieve the desired quality status by knowing about the various principles of quality management. The total quality management tools will help the student to understand the procedures in measuring the quality of the organization/process and will also enable them to identify the parameters that are improving/depriving the quality. By knowing about the quality ISO systems, the student will maintain processes/documentation properly so that thequality maintained by the organization gets recognized.

Course Objectives:

1 The overall purpose of the course is to provide an understanding of the process of managing quality andmanaging services.
2 The principles of Quality, Quality Assurance, and Total Quality Management will provide an insight intothe concepts of Excellence and Best Value and the contribution of quality to strategic management.
3 Understand the uasage of several techniques and quality management tools.
4 Identify the elements that are part of the quality measuring process in the industry.
5 Learn various Customer satisfaction measurement techniques

Course Outcomes:

1 Understand the fundamental principles of Total Quality Management
2 Choose appropriate statistical techniques for managing and improving processes in Organisations
3 Develop skills on Quality control and improvement tools
4 Understand benefits of control charts and their applications
5 Analyse Customer relationship management techniques

UNIT I **9 Hrs**

Quality, Strategic Planning and Competitive Advantage

Brief history, definitions of quality. Quality in manufacturing and service systems. Quality and price, quality andmarket share, quality and cost, quality & competitive advantages. ISO 9000, 14000.

UNIT II **9 Hrs**

Managing and Organization for Quality

Quality policy, quality objectives, leadership for quality, quality and organization culture, cross-functional teams,supplier/customers partnerships.

UNIT III **9 Hrs**

Quality Control and Improvement Tools

Cheek sheet, histogram, pareto chart, cause and effect diagram, scatter diagram, control chart, graph, affinity diagram, tree diagram, matrix diagram, process decision program chart, arrow diagram, acceptance sampling, process capability studies, zero defect program (POKA-YOKE)

UNIT IV **9 Hrs**

Quality Circles

Concept and total quality through bench marking, Japanese 5-S, quality management systems QS 9000, ISO 14000. Statistical process control: Control chart - X bar R, P, np and C Charts, benefits of control charts and applications (10 %)

UNIT V **9 Hrs**

Customer Focus and Six sigma principles

Customer satisfaction measurement techniques, customer relationship management techniques, Concept of SixSigma, Six Sigma for manufacturing, Six Sigma for service, Understanding Six Sigma organization.

Text Books

1. J.M. Juran, & F.M. Gryna, Quality Planning and Analysis, McGraw-Hill, 1993
2. Dale H.Besterfiled, et al., "Total Quality Management", Pearson Education, Inc.2003. (Indian reprint2004).
3. Evans. J. R. & Lindsay. W,M "The Management and Control of Quality", (5thEdition),SouthWestern(Thomson Learning), 2002
4. Geoff Tennant, Six Sigma: SPC and TQM in Manufacturing and Services, 1/e, Gower PublishingLtd., 2001.

Reference Books

1. J.Bank, Essences of Total Quality Management, Prentice Hall, 2007
2. Joel E. Ross - Text & Cases, Total Quality Management , St. Lucie Press, 1995
3. D.L. Goetsch & S. Davis, Introduction to Total Quality, Prentice- Hall, 2002.
4. R. Cavanagh, R. Neuman, P. Pande, What is Design for Six Sigma, 1/e, Tata McGraw- Hill, 2005.

Evaluation Procedure						
Continuous Evaluation	**Total 70 Marks**					
	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2
Sem End Examination	Total 30 Marks					

Course Outcome - Programe Outcome Mapping															
Course Outcomes :	**Programme Outcomes**														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	0	2	0	0	0	0	0	0	0	2	0	0	0	0	1
2	0	0	1	1	0	0	0	0	1	0	0	0	0	0	1
3	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0
4	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0
5	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1
6															

	Course Code	Course Title	L	T	P	J	S	C
		ENERGY AND ENVIRONMENT	3	0	0	0	0	3
	Course Owner	Department of MechanicalEngineering	**Syllabus version**					
	Course Pre-requisite(s)	NIL	**Contact hours**					
	Course Co-requisite(s)	NIL	**Date Approved**					
	Alternate Exposure	NIL						

Course Description

This course introduces the basic principles and different technologies of energy and environment. Student will beable to appropriately identify the sources of energy and its impact on environment at different capacities dependingon application requirements.

Course Objectives:

1 To understand the forms of energy and its importance in different applications
2 To famalarize energy storage ,management and audit methods
3 To impart environment and eco system importance and its scope
4 To understand environmental pollutions causes and control measures
5 To famalarize social issues related to environment

Course Outcomes:

1 Understand the basic concepts of energy, its distribution and general indian Scenario.
2 Explain different methods of energy storage systems, energy management techniques, audit and economicanalysis.
3 analyse the environment eco system and its need for awareness.
4 Identify the various types of environment pollution and its causes with effects.
5 Explain the social issues of the environment with associated acts.

UNIT I **8 Hrs**

Basic Introduction to Energy: Energy and power, forms of energy, primary energy sources, energy flows, world energy production and consumption, Key energy trends in India: Demand, Electricity, Access to modern energy, Energy production and trade, Factors affecting India's energy development: Economy and demographics Policy and institutional framework, Energy prices and affordability, Social and environmental aspects, Investment.

Learning Outcomes:

After the completion of this **UNIT** , the student will be able to

- distinguish between different types ofenergy (L1)
- classify the different types of sources of energy and key consumptions (L3)
- identify the factors affecting energy development their applications(L4)

UNIT II **8 Hrs**

Energy storage systems: Thermal energy storage methods, Energy saving, Thermal energy storage systems; Energy Management: Principles of Energy Management, Energy demand estimation, Energy pricing; Energy Audit: Purpose, Methodology with respect to process Industries, Characteristic method employed in Certain Energy Intensive Industries; Economic Analysis: Scope, Characterization of an Investment Project

Learning Outcomes:

After the completion of this **UNIT** , the student will be able to

- classify the different types of energy storage systems(L1)
- describe the different methods of enegy demand estimation(L2)
- explain the characterization of an investment project(L2)

UNIT III **8 Hrs**

Environment: Introduction, Multidisciplinary nature of environmental studies- Definition, scope and importance, Need for public awareness; Ecosystem: Concept, Energy flow, Structure and function of an ecosystem. Food chains, food webs and ecological pyramids, Forest ecosystem, Grassland ecosystem, Desert ecosystem and Aquatic ecosystems, Ecological succession.

Learning Outcomes:

After the completion of this **UNIT** , the student will be able to

- explain the need of public awareness(L2)
- describe the food chain system(L2)
- elaborate the ecological succession(L3)

UNIT IV **8 Hrs**

Environmental Pollution: Definition, Cause, effects and control measures of - Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution and Nuclear hazards , Solid waste Management, Disaster management Role of an individual in prevention of pollution, Pollution case studies.

Learning Outcomes:

After the completion of this **UNIT,** the student will be able to

- list the different environmental pollution(L1)
- elaborate the solid waste management (L2)
- classify the different pollution case studies(L3)

UNIT V **8 Hrs**

Social Issues and the Environment: Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies. Wasteland reclamation, Consumerism and waste products, Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation.

Learning Outcomes:

After the completion of this **UNIT** , the student will be able to

- explain the basic principle of ozone layer depletion(L2)
- classify different environmental issues(L3)
- describe the differnt acts and their benefits (L2)

Text Books

1 Textbook for Environmental Studies For Undergraduate Courses of all Branches of Higher Education byUniversity grant commission and Bharathi Vidyapeeth Institute of environment education and Research ,Pune

Reference Books

1 Turner, W. C., Doty, S. and Truner, W. C., Energy Management Hand book, 7th edition, Fairmont Press, 2009.
2 Murphy, W. R., Energy Management, Elsevier, 2007.
3 Smith, C. B., Energy Management Principles, Pergamum, 2007
4 Environmental studies, by Benny Joseph, Tata McGraw Hill, 2008, 2nd edition.

Evaluation Procedure						
Continuous Evaluation	**Total 70 Marks**					
	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2
	5	5	5	15	20	20
Sem End Examination	Total 30 Marks					

Course Outcome - Programe Outcome Mapping															
	Programme Outcomes														
Course Outcomes :	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	2	3	2	2	1	3	0	0	0	1	1	1	2	1	0
2	2	1	1	2	1	3	0	0	0	1	1	1	2	0	0
3	2	3	1	2	1	3	0	0	0	1	1	1	2	1	0
4	2	1	1	2	1	3	0	0	0	1	1	1	2	0	0
5	2	1	1	2	1	3	0	0	0	1	1	1	2	1	0

	Course Code	Course Title	L	T	P	J	S	C
		FINANCIAL MANAGEMENT	3	0	0	0	0	3
	Course Owner	Department of MechanicalEngineering	**Syllabus version**					
	Course Pre-requisite(s)	NIL	**Contact hours**					
	Course Co-requisite(s)	NIL	**Date Approved**					
	Alternate Exposure	NIL						

Course Description

This course aims to familiarize the students with the skills related to basic principles, tools, and techniques of financial planning. These tools aid the firms to maximize value by improving decisions relating to working capital, cost of capital and capital structure and capital requirements of an organization.

Course Objectives:

1 Introduce the concept of financial management, with special emphasis placed on the development of a planor strategy
2 Estimate value the equity, operations, and debt of companies using different valuation approaches/modelsand financial statement information.
3 Analyze and reformulate financial statements to identify a firm's business strategy and value drivers so asto facilitate forecasting and valuation
4 Interpret the financial figures through various tools in the cost of capital
5 Demonstrate the valuation of bonds and finalcial leasing

Course Outcomes:

1 Apply and estimate the time value of money
2 Plan for the financial requirements of the company by analyzing the fund's flow and cash flow statements
3 Apply the concepts and techniques of working capital to determine the working capital requirements of anorganization and also can able to evaluate the risk and return trade-off using advanced techniques.
4 Analyze and interpret the financial figures through various tools in cost of capital
5 Understand the various financial options for gathering capital/investiment

UNIT I **8 Hrs**

Nature of Financial management and Concepts of Value and Return

Introduction to financial management, Organization of the financial management functions, sources of finance, present value and future value concept to single, mixed and annuities simple problems

UNIT II **8 Hrs**

Valuation of Bonds Shares

Valuation concepts, Bond valuation, Bonds with finite maturity, preferred stock valuation, Common stock valuation, Rates of return, Risk and return, Use of probability distributions to measure risk, Attitudes towards risk, Risk and return in a portfolio context, Diversification, Capital-Asset pricing model.

UNIT III **8 Hrs**

Financial Statements and Cash flow analysis

Financial Statements, Balance sheet ratios, Income statement, Trend analysis, Common size, and Index analysis. The flow of funds statement, Cash flows, forecasting, cash flow estimates, forecasting of financial statements.

UNIT IV **8 Hrs**

Capital Budget Decisions/Principles of working capital management

Issues with working capital, financing current assets, combining liability structure and current asset decisions, Capital budgeting, Generating investment project proposals, Project evaluation, and selection difficulties, Project monitoring.

UNIT V **8 Hrs**

Long Term Financing and Asset Based Leasing

Intermediate and long-term financing, Private placement, initial financing, signaling effects, secondary market, bonds and their features, long term debt instruments, Term loans and leases, Provision of loan agreements, equipment financing, Lease financing, and its evaluation.

Text Books

1. I M Pandey, Financial Management, Vikas, 10/e, 2010
2. J.C.Van Horne, J M. Wachowicz, Fundamentals of Financial Management, Pearson Education Asia,2002

Reference Books

1. Van Horne, Financial Management and policy, 12/e, Prentice Hall of India, 2002
2. B really and Myers, Principles of Corporate finance, 7/e, Tata McGraw Hill, 2002
3. Ross, Westerfield and Jordan, Fundamentals of Corporate finance, 6/e, Tata McGraw Hill, 2002
4. Damodaran, Corporate Finance, John Wiley & Sons, 2002

Evaluation Procedure						
Continuous Evaluation	**Total 70 Marks**					
	Quiz 1	Quiz 2	Quiz 3	Assignment	CAT 1	CAT 2
Sem End Examination	Total 30 Marks					

Course Outcome - Programe Outcome Mapping															
Course Outcomes:	**Programme Outcomes**														
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	0	0	1	0	3	0	0	0	0	3	1	0	0	0	2
2	0	0	1	0	3	0	0	0	0	3	1	0	0	0	2
3	0	0	1	0	3	0	0	0	0	3	1	0	0	0	2
4	0	0	1	0	3	0	0	0	0	3	1	0	0	0	2
5	0	0	1	0	3	0	0	0	0	3	1	0	0	0	2