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. Aerospace 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 Aerospace Engineering
GITAM (Deemed to be University)

B Tech (Aerospace Engineering) Programme

VISION

Strive to be globally renowned department for its academic, professional and industrial excellence

MISSION

To provide internationally recognized leadership in aerospace engineering discipline, through updated educational program for graduate students with strong engineering fundamentals, would be able to cherish in the areas of applied engineering, innovative research and entrepreneurship.

PROGRAM EDUCATIONAL OBJECTIVES

PEO1	To demonstrate their expertise in solving contemporary problems through design, analysis, implementation and evaluation of hardware and software systems
PEO2	To engage in the Aerospace Engineering profession locally and globally by contributing ethically to the competent and professional practice of Engineering or other professional careers.
PEO3	To adapt to a constantly changing world through professional development and sustained learning
PEO4	To exhibit leadership and entrepreneurship skills by incorporating organizational goals and providing facilities for peer members with defined objectives
PEO5	To develop communication skills and show a commitment to teamwork necessary to function productively and professionally on multidisciplinary teams

Programme Outcomes

Upon successful completion of the programme, students will be able to

PO1	ENGINEERING KNOWLEDGE: Apply the knowledge of mathematics, science, engineering fundamentals, and Aerospace engineering specialization to the solution of complex engineering problems.
PO2	PROBLEM ANALYSIS: Identify, formulate, research literature, and analyze complex Aerospace engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	DESIGN/DEVELOPMENT OF SOLUTIONS: Design solutions for complex Aerospace engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	CONDUCT INVESTIGATIONS OF COMPLEX PROBLEMS: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	MODERN TOOL USAGE: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex Aerospace engineering activities with an understanding of the limitations.
PO6	THE ENGINEER AND SOCIETY: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	ENVIRONMENT AND SUSTAINABILITY: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	ETHICS: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	INDIVIDUAL AND TEAMWORK: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	COMMUNICATION: Communicate effectively on complex Aerospace engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	PROJECT MANAGEMENT AND FINANCE: Demonstrate knowledge and understanding of the Aerospace engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	LIFELONG LEARNING: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSO)

Upon successful completion of BTech AE Programme, student will be able to

PSO 1	identify, formulate, and solve Aerospace engineering problems in the related domains to provide efficient solutions
PSO 2	analyze, design and develop applications of varying complexities in the emerging areas of Aerospace Engineering
PSO 3	provide a platform to engage in research with professional and ethical responsibility to meet the societal needs

PROGRAMME STRUCTURE

BTech Programme consists of courses which could be grouped under University Core (UC), Faculty Core (FC), Major/Programme Core (PC), Major/Programme Electives (PE) and University Electives (UE) as the below breakup

Category	Credits	% of Program (in credits)
University Core (UC)	12	8%
Faculty Core (FC)	57	36%
Major Core (PC)	52	32%
Major Electives (PE)	15	9%
Open Electives (UE)	24	15%
Total	**160**	

Courses offered under University Core are common to all undergraduate level programmes offered by GITAM. Courses offered under Faculty core are common to all BTech programmes offered by GITAM and are meant to acquaint the student with general engineering principles in all disciplines of engineering. Based on the chosen BTech Programme, the student shall complete courses under Major Core (specific to be chosen branch of engineering).

Each course is assigned a certain number of credits depending upon the number of contact hours (lectures/tutorials/practical) per week. In general,

- **Theory:** A student attending classroom lecture/ tutorial/ skill development activity of 50 minutes' duration per week, spread over the entire semester is awarded one credit.
- **Practical:** A student attending a minimum of 100 minutes per week of laboratory session/ practical is awarded - one credit.
- **Project Work:** A student working for 50 minutes of project work per week with 3 hours of work performed independent of the instructor during the entire semester is awarded - one credit
- **Internship:** 8 hours in a day for four weeks is required for earning internship credits.

The list of courses to be taken by Students under **University Core** are listed below

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 & Quantitative Aptitude (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 (Softskills 5C)	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

The list of courses to be taken by students under **Faculty Core** are listed below

Faculty Core (FC)

Course code	Level	Course title	L	T	P	S	J	C
		Management Basket	3	0	0	0	0	3
PHYS1001		Physics Basket 1	2	1	2	0	0	4
PHYSXXXX		Physics Basket 2	3	1	0	0	0	4
CHEM1001		Chemistry	2	1	2	0	0	4
MATHXXXX		Maths Basket 1	2	0	0	0	0	2
MATHXXXX		Maths Basket 2	2	0	0	0	0	2
MATHXXXX		Maths Basket 3	2	0	0	0	0	2
MATHXXXX		Maths Basket 4	2	0	0	0	0	2
MATHXXXX		Maths Basket 5	2	0	0	0	0	2
MATHXXXX		Maths Basket 6	2	0	0	0	0	2
		Design Thinking	0	0	2	0	0	1
CSEN1031		Artificial Intelligence Applications	0	0	2	0	0	1

CSEN1031		Probability and Statistics	3	0	0	0	0	3
MECH1011		Engineering Visualization and Product Realization	0	0	4	0	0	2
MECH1021		Workshop	0	0	4	0	0	2
EECE1001		Basic Electrical and Electronics Engineering	2	1	2	0	0	4
CSEN1011		Problem Solving and Programming in C	0	0	6	0	0	3
CSEN1021		Programming with Python	0	0	6	0	0	3
		Internship 1	0	0	0	0	1	1*
		Internship 2	0	0	0	0	1	3
		Comprehensive Examination	1	0	0	0	0	1*
		Capstone Project - Introduction	0	0	0	0	2	2
		Capstone Project - Final	0	0	0	0	6	6
		Universal Human Values	3	0	0	0	0	3*
		Project Exhibition 1	0	0	0	0	1	1*
		Project Exhibition 2	0	0	0	0	1	1*

* Pass/Fail courses

Courses Offered under Mathematics Basket

S. No	Level	Course code	Course name	Offered to	L	T	P	S	J	C
1	1	MATH1001	Single variable calculus	All BTech branches						
2	1	MATH1011	Several variable Calculus							
3	1	MATH1021	Transform Techniques							
4	1	MATH1031	Differential Equations							
5	1	MATH1041	Discrete Mathematics	CSE						
6	1	MATH1051	Graph Theory	CSE						
7	1	MATH1061	Introduction to Mathematics - I	BT						
8	1	MATH1071	Introduction to Mathematics - II	BT						

Courses Offered for BioTechnology Department

S. No	Level	Course code	Course name	Offered to	L	T	P	S	J	C
1	1	BTEN1001	Introduction to Biotechnology-I	BT						
2	1	BTEN1011	Biotechnology Workshop	BT						
3	1	BTEN1021	Introduction to Biotechnology-II	BT						
4	1	BTEN1031	Process Calculations	BT						

Courses Offered under Physics Basket

S. No	Level	Course code	Course name	Offered to	L	T	P	S	J	C
1	1	PHYS1001	Physics	All B.Tech branches						
2	1	PHYS1011	Mechanics and Properties of Matter	AE, CE, ME						
3	1	PHYS1021	Principles of Quantum Mechanics	CSE						

4	1	PHYS1031	Physics of Semi Conducting devices	ECE, EEE						
5	1	PHYS1041	Mechanics and Modern Physics	BT						

The list of courses to be taken by students under **Major Core (Programme Core)** are listed below

S.No.	Program Core	L	T	P	S	J	C
PC0	Aeromodelling Workshop	0	0	2			1
PC1	Introduction to Aerospace Engineering	2	0	0			2
PC2	Engineering Mechanics	2	1	0			3
PC3	Thermodynamics	3	0	0			3
PC4	Fluid Mechanics	3	0	2			4
PC5	Mechanics of Solids	3	0	2			4
PC6	Aerospace Materials Engineering	3	0	2			4
PC7	Computer Aided Aircraft Drawing	0	0	2			1
PC8	Aerodynamics – I	3	0	2			4
PC9	Mechanics of Aerospace Structures	3	0	2			4
PC10	Aircraft Propulsion	3	0	2			4
PC11	Aerodynamics –II	3	0	0			3
PC12	Analysis of Aerospace Structures	3	0	0			3
PC13	Flight Mechanics	3	0	0			3
PC14	Aerospace Propulsion	3	0	0			3
PC15	Computational Methods	2	0	2			3
PC16	Design Practice for Aerospace Engineering	2	0	2			3
	Total						**52**

The list of courses to be taken by students under **Major Electives (Programme Electives)** are listed below

S. No	Program Electives	L	T	P	S	J	C
1	Computational Aerodynamics	2	0	2	0	0	3
2	Wind Tunnel Techniques	3	0	0	0	0	3
3	Boundary Layer Theory	3	0	0	0	0	3
4	Industrial Aerodynamics	3	0	0	0	0	3
5	Flapping Wing Aerodynamics	3	0	0	0	0	3
6	Hypersonic Aerodynamics	3	0	0	0	0	3
7	Finite Element Analysis	2	0	2	0	0	3
8	Advanced Aerospace Structures	3	0	0	0	0	3
9	Vibrations and Acoustics	3	0	0	0	0	3
10	Theory of Elasticity	3	0	0	0	0	3
11	Mechanics of Composite Materials	3	0	0	0	0	3
12	Aero Elasticity	3	0	0	0	0	3
13	Aerodynamics of TurboMachinery	3	0	0	0	0	3
14	Theory of Cryogenics	3	0	0	0	0	3
15	Rockets and Missiles	3	0	0	0	0	3
16	Flight Dynamics	3	0	0	0	0	3
17	Space Technology	3	0	0	0	0	3
18	Space Mechanics	3	0	0	0	0	3

19	Satellite Attitude and Control	3	0	0	0	0	3
20	Guidance and Control	3	0	0	0	0	3
21	Experimental Techniques	3	0	0	0	0	3
22	Aircraft Systems and Instrumentation	3	0	0	0	0	3
23	Airport and Airline Management	3	0	0	0	0	3
24	Air Transportation Systems	3	0	0	0	0	3
25	Helicopter Engineering	3	0	0	0	0	3
26	Avionics	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 courses and earn 24 credits

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
8. Latham-Koenig, C. & Oxenden, C. (2014). American English File. Oxfor: OUP.
9. McCarthy, M. & O' Dell. F. (2016). Academic Vocabulary in Use. 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/
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.

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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

- 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 <u>expected</u> 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.

<u>Group Project Overview</u>

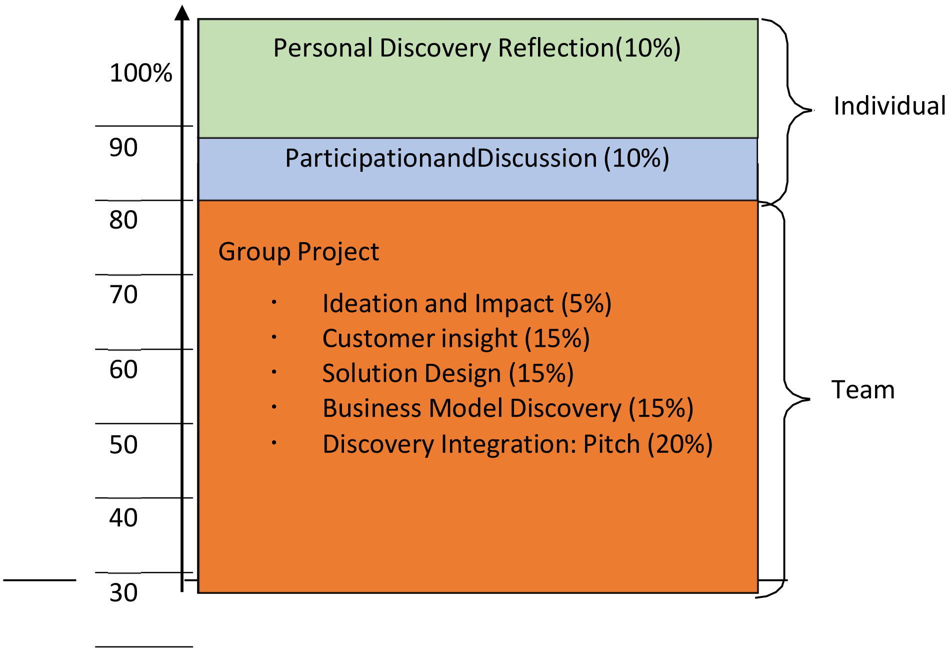
This is a semester length project and the cornerstone component of the course. The group project will give you the opportunity to apply the course concepts to a real situation. You will learn about the entrepreneurship for your own business or your work in organizations. Even if you are not going to 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.

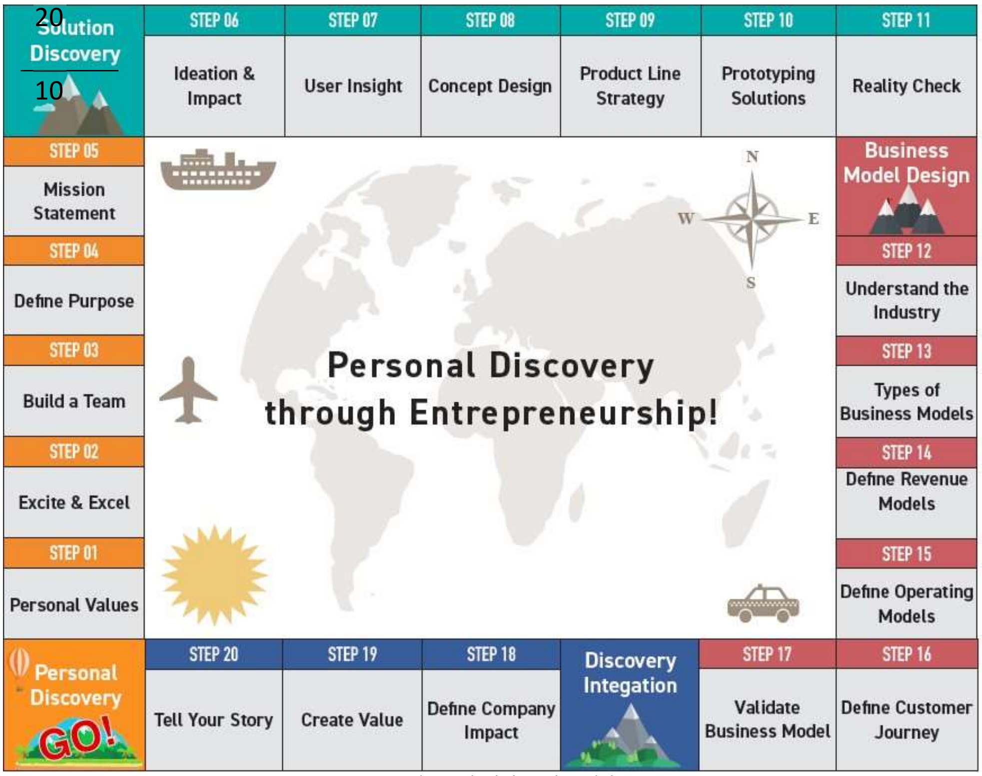
<u>Talking to customers</u> is one of the most important steps in investigating your business because your entrepreneurial vision must correspond to a true market opportunity. With your group, select 5-6 potential customers willing to be interviewed. They should represent a cross-section of our target 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.
<u>"Design"</u> 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.

<u>Business modeling</u> 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 <u>the final outcome</u>, 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	**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**
	14			

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	**Business Model** (Steps 14, 15, 16, 17)	· Revenue and Expenses	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.
	26		· 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.)	
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

Week	Session	Topics and Steps	Key CONCEPTS Introduced in Class	Team or Individual Activity
15	29 30	**Tell Your Story**	• 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.)	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.
Final Course Deliverables			Due on the Monday after the weekend of the final class meeting.	**Team: Your Venture PPTs** **Individual: Insight Learning Reflection Journal**

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) $\lim\limits_{x \to a} \dfrac{x^n - a^n}{x - a}$ 2) $\lim\limits_{\theta \to 0} \dfrac{\sin\theta}{\theta}$ 3) $\lim\limits_{n \to 0} \left(1+n\right)^{\frac{1}{n}}$ 4) $\lim\limits_{x \to 0} \dfrac{e^x - 1}{x}$

5) $\lim\limits_{x \to 0} \dfrac{a^x - 1}{x}$

(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 $x\cos\alpha + y\sin\alpha = p$, 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= coshz) .

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,4^{th} 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 model**s** (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 2nd and 4th 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
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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

PC0: AEROMODELLING WORKSHOP

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

Preamble:
This course is intended to make students learn about the design of an RC plane and students will have hands-on experience to build and fly a RC plane.

Course Objectives:
- Facilitate to design, build and fly model airplanes.
- Train to have hands-on experience necessary for developing a practical aptitude.
- Demonstrate the flying characteristics like speed or duration of flight.

List of Exercises:
1. Making of symmetric airfoil
2. Making of Cambered airfoil
3. Modelling skeleton structure of wing
4. Skin moulding of aircraft wing
5. Making of winglet
6. Sheet forming of empennage
7. Design, fabrication and flying of engine powered RC plane
8. Design, fabrication and flying of battery powered RC model airplanes.
9. Design, fabrication and flying of quadcopters.
10. Design, fabrication and flying of gliders.
11. Design, fabrication and flying of solar powered RC planes.
12. Design, fabrication and flying of a blended wing body.
13. Design, fabrication and flying of parachutes.

Note:
1. **Exercises No. 1 to 6 are mandatory.**
2. **Any 4 models can be performed out of above 7 to 13 exercises.**

Course Outcomes:
At the end of the course the student will be able to
- demonstrate logical, analytical, strategic and critical thinking skills for developing new designs of different aircraft models. (L4)
- hands on creation of electronic circuit, biomechanical model using kits. (L4)
- analyze the aerodynamics, stability and structural criteria of the model. (L4)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	0	1	1	1	1	0	0	0	0	1	1	3	3	1
CO2	2	2	3	1	2	1	0	1	1	0	1	0	1	3	1
CO3	2	2	3	2	1	0	1	0	0	1	1	1	2	3	1
CO4	2	2	3	1	1	1	1	1	1	0	2	1	2	3	1
CO5	3	2	3	1	1	0	0	1	0	0	1	1	2	3	1

PC1 : INTRODUCTION TO AEROSPACEENGINEERING

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

Preamble:
This course is designed specifically for the branch of Aerospace engineering. This course will give a brief introduction of aircrafts and different streams in aerospace engineering which will help to understand the requirements for the design of an aircraft.

Course Objectives:
- Familiarize the basic concepts of airplanes and space vehicles.
- Provide 360-degree view in Aerodynamics, Propulsion, Structures, and Systems etc.

UNIT I **7 hours**

Introduction
Evolution of airplanes, pre-Wright brother era to present plane, classification of aircrafts and space vehicles, functions of major components of an airplane. Role of DGCA in air safety as regulatory authority.

Learning Outcomes:
At the end of the unit, learners will be able to
- understand the evolution of planes
- learn about the major parts of the aircraft and their functions
- learn about the roles of DGCA in air safety

UNIT II **7 hours**
Basic Aerodynamics:
Introduction to Atmosphere - characteristics, pressure, temperature and density variations, airfoil nomenclature, types of airfoils, forces acting on airfoil.
Flight Control Surfaces:
Aircraft principle axes, Primary and Secondary control surfaces.

Learning Outcomes:
At the end of the unit, learners will be able to
- understand the atmosphere used in aviation
- understand the effect of altitude in pressure, temperature and density variations
- learn about the nomenclature of airfoil, aerodynamic forces on airfoils
- learn about the control surfaces of an aircraft and their functions

UNIT III **5 hours**
Structures:
Types of structures - Truss, monocoque, semi-monocoque, and geodesic construction. Structural layout of wing, fuselage and tail plane. Types of wings and tail planes.

Learning Outcomes:
At the end of the unit, learners will be able to
- understand about the different structures
- understand about the layout of wing, fuselage and tail plane and types of wings

UNIT IV **6 hours**
Propulsion
Introduction to Thrust production - Types of aircraft engines (Piston, Turbojet, Turbofan, Turboprop, Turboshaft, Ramjet, Pulsejet and Scramjet). Rockets - principle of operation, types and applications.
Helicopters: Rotorcraft, types of rotorcraft, autogyro, gyrodyne.

Learning Outcomes:
At the end of the unit, learners will be able to
- gain knowledge on working of piston and gas turbine engine
- exercise critical thinking of different means of thrust generation
- distinguish between subsonic and supersonic jet engines
- demonstrate knowledge of working of rocket engines, helicopters, rotor systems and power transmission systems
- clearly identify different types of applications of engines

UNIT V **6 hours**
Satellite Systems: Elements, operations, structures, power systems, satellite missions, communication and telemetry - Indian satellites and launch vehicles.

Learning Outcomes:
At the end of the unit, learners will be able to
- gain knowledge on different elements of satellite systems
- identify mission objective of different satellites
- demonstrate good command on communication and telemetry systems of satellite
- exercise command on different Indian satellites and launch vehicles
- executes abstract design of satellite subsystems specific to a mission

Course Outcomes:
At the end of the course the student will be able to:
- demonstrate knowledge on evolution of plates, functioning of different components, role of regulatory and authorities and safety aspects of flight.
- gain knowledge on aerodynamic behavior of rigid curved surfaces and their significance in controlling flight
- exercise good command on structured anatomy and strength aspects of different components of aircraft.
- identify different types of engines that suit the needs of different aerospace vehicles
- exhibit the science of flying an aerospace vehicle and controlling of crucial subsystems that make a full-fledged flight

Text Book(s)

1. J. D. Anderson, Introduction to Flight, 6/e, McGraw Hill, 2010.
2. R. S. Shevell, Fundamentals of Flight, 2/e, Pearson, 2004.

References

1. A. C. Kermode, Flight Without Formulae, 5/e, Pearson, 1989.
2. L. Gupta, Helicopter Engineering, Himalayan Books, 1996.
3. D. Newman, Interactive Aerospace Engineering and Design, McGraw Hill, 2002.
4. R. H. Barnard and D. R. Philpot, Aircraft Flight, 3/e, Pearson, 2004.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	0	2	0	2	0	0	1	0	2	2	1	1
CO2	3	2	1	0	2	0	1	1	0	0	0	2	1	2	1
CO3	3	1	1	2	0	0	1	0	1	1	0	1	1	1	2
CO4	2	1	0	1	2	1	2	1	1	0	0	2	2	1	1
CO5	2	1	1	1	1	0	1	0	0	0	0	1	1	1	2

PC2_ENGINEERING MECHANICS

L	T	P	S	J	Letter
2	1	0	0	0	3

Preamble:

This course is an introduction to learning and applying the principles required to solve engineering mechanics problems. Concepts will be applied in this course from previous courses of basic mathematics and physics This course addresses the modeling and analysis of static equilibrium problems with an emphasis on real world engineering applications and problem solving. This course forms the backbone of mechanical engineering design and acts as a prerequisite to mechanics of solids, design of machines and dynamics of machinery.

Course Objectives

- Explain the effect of force and moment and equilibrium in engineering applications.
- Compute geometric properties such as centroid and moment of inertia of various plane sections.
- Explain kinematics of particles and rigid bodies.
- Analyze the rigid bodies under dynamic conditions.
- Expose the concepts of work-energy, conservation of energy and momentum to rigid bodies.

UNITI **8 hours**

Introduction to Engineering Mechanics: Basic concepts, Force systems and types, resultant of force system, particle equilibrium 2D and 3D, resultant of rigid body - Moment, couple, law of transmissibility, varignon's theorem, rigid body equilibrium – free body diagrams, coplanar non concurrent force systems and applications

Learning Outcomes:

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

- Recognize the significance of Engineering Mechanics in design.(L1)
- Calculate the moments and resultant forces.(L3)
- Draw free body diagrams.(L3)
- Utilize the concept of equilibrium.(L3)

UNIT II **8 hours**

Friction: Laws of friction, types of friction, equilibrium of force systems involving frictional forces, Free body diagrams involving frictional forces. Belt friction

Analysis of Structures: Introduction to plane trusses, analysis of plane trusses by method of joints and method of sections.

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

- Comprehend the concept of friction.(l2)
- Identify different types of trusses.(l2)
- Analyze the plane trusses by method of joints and the method of sections.(l4)

UNIT III **8 hours**

Properties of Surfaces: Centroid, derivation of centroids from first moment of area, centroids of composite areas, center of gravity and its applications.

Moment of Inertia: Area moment of inertia of plane and composite shapes, parallel axis theorem, perpendicular axis theorem, polar moment of inertia, radius of gyration. Mass moment of inertia – regular and composite bodies

Learning Outcomes:

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

- Identify the centre of gravity of plane figures.(l2)
- Calculate the centre of gravity of composite plane shapes.(l3)
- Understand the concepts of moment of inertia and radius of gyration.(l2)
- Determine moment of inertia for composite plane shapes.(l3)

UNITIV **8 hours**

Kinematics: Particles: Kinematic parameters of interest, 2D motion equations of rectilinear and curvilinear (normal and tangential) types , Rigid body: plane motion of 2D objects - velocity and acceleration, instantaneous center of rotation

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.(L3)
- Find velocity and acceleration in rectilinear and curvilinear motions.(l4)
- Trace the path of projectile.(l3)

UNITV **8 hours**

Kinetics:

Force-acceleration concepts of particles and rigid bodies in two-dimensional motion, work-energy principles of particles and rigid bodies in two-dimensional motion, Impulse and momentum of particles: types of impact and coefficient of restitution, principle of momentum and its conservation

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

- Apply Newton's 2ndlaw and D'Alembert's principle in rectilinear translation.(L3)
- Utilize the principle of work and energy in dynamic systems.(L3)
- Make use of principle of momentum and impulse on dynamic bodies.(L4)

Course Outcomes:

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

- Obtain a basic understanding of the laws of solid mechanics.
- Comprehend the significance of the concepts of solid mechanics in engineering systems.
- Calculate the physical properties of rigid bodies required for the analysis of engineering systems.
- Apply the principles of statics and dynamics to solve engineering problems.
- Analyze various static and dynamic engineering systems and understand the underlying mechanics and drawbacks/problems.

Text Book(s):

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 units), 5/e, McGraw Hill, 2013.

References:

1. Basudeb Bhattacharya, Engineering Mechanics, 2/e, Oxford University Press (India),2015.
2. Irving Shames, G.K.M. Rao, Engineering Mechanics: Statics and Dynamics, 4/e, Pearson,2009.
3. K.L. Kumar, Venu Kumar, Engineering Mechanics, 4/e, Tata McGraw Hill,2010.
4. S.S. Bhavikatti, Engineering Mechanics, 4/e, New Age International,2008.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	1	1	1	2	1	1	2	1	3	2	1
CO2	3	2	2	1	1	1	1	1	1	1	2	1	3	2	1
CO3	3	3	2	1	1	1	1	2	1	1	2	1	3	2	1
CO4	2	2	2	1	1	1	1	2	1	1	2	1	2	2	1
CO5	3	3	2	1	1	1	1	1	1	1	1	1	1	1	0

PC3: THERMODYNAMICS

L	T	P	S	J	Letter	P/F
3	0	0	0	0	3	

Preamble:

This course deals with the fundamentals of thermodynamics including thermodynamic systems and properties, relationships among the thermo-physical properties, the laws of thermodynamics and applications of these basic laws in thermodynamic systems.

Course Objectives:

- Familiarize the laws of thermodynamics to estimate the potential for thermo-mechanical energy conversion in aerospace power and propulsion systems.
- Explain the role of internal energy, enthalpy, entropy, and other thermodynamic properties.
- Impart the knowledge of entropy calculation for closed and open systems.
- Focus on understanding the phase diagrams of pure substances, properties of steam and dryness fraction measurement
- Demonstrate the working of I.C. Engines and analysis of vapor and air standard cycles.

UNIT I **9 hours**

Fundamental Concepts: Macroscopic and microscopic viewpoints, thermodynamic system, boundary, surrounding, control volume, state, property, process, cycle, thermodynamic equilibrium, quasi - static process, energy in state and in transition, types of work, heat, point and path function, Zeroth law of thermodynamics.

First law of Thermodynamics: Joule's experiment, first law of thermodynamics, corollaries, first law applied to a process, applied to a flow system, steady flow energy equation and its applications

Learning Outcomes:

After completion of this unit the student will be able to

- Understand the thermodynamic fundamental concepts. (l1)
- Apply first law to solve the open and closed system problems. (l3)
- Identify and evaluate the type of work and heat transfer involved in a given problem. (l2)
- Appreciate the qualitative difference between different forms of energy. (l2)

UNIT II **7 hours**

Second Law of Thermodynamics: Heat engine, Heat pump and Refrigerator, Kelvin - Planck statement and Clausius statement and their equivalence, corollaries, perpetual motion machines of first kind and second kind, reversibility and irreversibility, cause of irreversibility, Carnot cycle, Carnot theorem, Carnot efficiency.

Learning Outcomes:

After completion of this unit the student will be able to

- Understand the concept of heat engine and heat pump devices. (l1)
- Understand and apply second law to solve the practical problems. (l3)
- Gain knowledge on ideal thermodynamic cycle formulation (Carnot cycle) (l2)

UNIT III **9 hours**

Entropy: Concept of entropy, Clausius theorem, Clausius inequality, principles of increase of entropy.

Availability and Non-Availability: Introduction.

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

- Understand qualitatively, the concept of entropy.(l2)
- Apply the entropy principle for any process and cycle.(l3)
- Gain knowledge on the cause for irreversibility in a process(l2)

UNIT IV **7 hours**

Properties of pure substances: p-v, T-s, p-T and h-s diagram for a pure substance, dryness fraction, steam tables, measurement of steam quality.

Thermodynamic Relations: Maxwell equations, T-ds equations, difference in heat capacities, ratio of heat capacities, Joule-Kelvin effect, Clausius-Clapeyron equation.

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

- Calculate the dryness fraction of a given liquid-vapor mixture.(l4)
- Understand the properties of pure substances on thermodynamic state diagrams. (l2)
- Use the steam tables and mollier chart for solving the problems (l1)
- Understand the joule-kelvin throttling process and its practical significance. (l1)

UNIT V **10 hours**

POWER CYCLES

Vapor Power Cycles: Rankine cycle- thermodynamic variables affecting efficiency and output of rankine cycle- improvements of efficiency.

Gas Power Cycles: I.C engines, classification, comparison of two stroke and four stroke engines, comparison of S.I .and C.I. Engines. Air standard cycles- Otto, Diesel, Dual, their analysis. Brayton cycle, effect of regeneration, pressure ratio, intercooling and reheating on Brayton Cycle.

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

- Represent the events occurring in any engine on a thermodynamic plot (L3)
- Understand the working of 2-stroke and 4stroke engines.(L2)
- Analyze the methods of improving efficiency of vapor and gas power cycles (L4)

Course Outcomes:

After successful completion of this course the students will be able to:

- Explain the concepts of work, power, and heat in thermodynamics; determine work and heat sign conventions; determine work involved with moving boundary systems
- Apply the first law of thermodynamics for a control volume, including with turbines, compressors, nozzles, diffusers, heat exchangers, and throttling devices..
- Explain the second law of thermodynamics, including why it is necessary, how it is defined (kelvin-planck and clausius), the nature of irreversibility, and the carnot cycle.
- Determine thermodynamic properties of pure substances.
- Compute and analyze the thermal efficiency of systems based on various vapor power and gas power cycles.

Text Book(s)

1. P.K.Nag, Engineering Thermodynamics, 5/e, Tata McGraw Hill, 2013.
2. Yunus A. Cengel, Michaela A. Boles, Thermodynamics, 7/e, Tata McGraw Hill, 2011.

References

1. R.K. Rajput, S.Chand& Co., Thermal Engineering, 6/e, Laxmi publica-tions, 2010.
2. J.B.Jones and G.A.Hawkins, Introduction to Thermodynamics, 2/e, John Wiley & Sons, 2012.

	PO1	P O2	P O 3	P O4	P O5	P O6	P O 7	P O8	P O9	PO 10	PO 11	PO 12	PS O 1	PS O 2	PS O 3
CO1	3	2	1		1	1	1	1	1	1	1	1	3	1	1
CO2	3	2	1	1	1	2		1	1	1	1	1	3	2	1
CO3	3	2	1	1	1	2	1	1	1	1	1	1	3	1	1
CO4	2	2	1		1	1		1	1	1	1	1	2	1	1
CO5	3	2	1	1	1	1	1	1	1	1	1	1	3	2	1

PC4: Fluid Mechanics

L	T	P	S	J	Letter	P/F
3	0	2	0	0	4	

Preamble:

This course is designed for Aerospace Engineering undergraduate students. This course aims to introduce and explain the basic concepts in fluid mechanics. Understanding these concepts will help in analyzing both internal and external flows. It is designed for the students for the experimental understanding of fluid flows.

Course Objectives:

- Explain different properties of Newtonian fluids.
- Familiarize governing equations of a fluid at rest and in motion.
- Demonstrate how the governing equations can be used to analyze different flow problems.
- Familiarize fundamental concepts in boundary layer flows.
- Introduce the concepts of modelling and similitude.

UNIT I **7 hours**

Fluid Properties and Statics: Density, viscosity, vapor pressure, compressibility, surface tension and capillarity. Pressure definition, Pascal's law and hydrostatic law.

Measurement of Pressure: Types of manometers. Total pressure and center of pressure of horizontal, vertical and inclined plane surfaces.

Learning Outcomes

After completion of this unit the student will be able to

- identify and explain different fluid properties (L2).
- describe the effect of change in pressure and temperature on fluid properties (L2).
- calculate fluid properties given appropriate information (L3).
- determine the pressure at various locations in a fluid at rest(L3).
- demonstrate how manometers are used for pressure measurement (L3).

UNIT II **10 hours**

Fluid Kinematics: Types of fluid flows, velocity and acceleration, stream function, potential function, types of motion, vorticity and circulation, free vortex flow and forced vortex flow.

Fluid Dynamics: Continuity equation in cartesian and cylindrical coordinates; Euler's and Bernoulli's equation of motion, applications of Bernoulli's equation.

Learning Outcomes

After completion of this unit the student will be able to

- explain differences between Eulerian and Lagrangian description of fluid motion (L2).
- determine various kinematic elements of the flow given a velocity field (L3).
- summarize differences between streamlines, streaklines and pathlines (L2).
- explain different types of flows and motions (L2).
- write the governing equations of a fluid in motion (L1).
- interpret the physical meaning of different terms in Bernoulli's equation (L2).
- apply Bernoulli's equation in combination with the continuity equation to solve simple flow problems (L3).

UNIT III **8 hours**

Closed Conduit Flow: Characteristics of real fluids, Reynolds experiment, Darcy's equation; Major and minor energy losses in pipes, pipes in series, pipes in parallel, flow through circular pipes: Hagen-Poiseuille law and flow between two parallel plates.

Learning Outcomes

After completion of this unit the student will be able to

- compare the differences between an ideal and real fluid (L2).
- explain the general characteristics of flow in a pipe (L2).
- distinguish between major and minor losses in pipes (L2).
- apply appropriate equations and principles to analyze a variety of pipe flow situations and flow between two parallel plates (L3).

UNIT IV **10 hours**

Boundary Layer Flow: Boundary layer thickness, boundary layer over a thin flat plate, characteristics of laminar, transitional and turbulent boundary layer, momentum integral equation of the boundary layer, boundary layer separation and its control.

Learning Outcomes

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

- explain the reason for the formation of a boundary layer on the surface (L2).
- discuss the characteristics of the laminar, transitional and turbulent boundary layer (L2).
- illustrate and explain the growth of the boundary layer over a flat plate (L2).
- develop governing equations of boundary layer using the order of magnitude analysis (L3).
- describe various methods of controlling the boundary layer (L2).

UNIT V **9 hours**

Dimensional Analysis: Dimensional homogeneity, methods of dimensional analysis: Rayleigh method and Buckingham pi theorem, Types of similarity, force ratios, dimensionless numbers, Illustrative examples.

Learning Outcomes

After completion of this unit the student will be able to

- describe the principle of dimensional homogeneity (L2).
- interpret the physical meaning of common dimensionless numbers (L2).
- apply dimensional analysis to establish a set of similarity requirements between model and prototype (L3).
- describe the importance of dimensional analysis in the efficient handling, interpretation and correlation of experimental data (L2).

Course Outcomes:

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

- compute fluid properties and pressure in a fluid at rest given appropriate information.
- apply bernoulli's equation in combination with the continuity equation to solve simple flow problems.
- apply appropriate equations and principles to analyze a variety of pipe flow situations and flow between two parallel plates.
- explain the characteristics of different types of boundary layers and the reason for flow separation.
- develop a set of dimensionless variables for a given flow situation using different dimensional analysis methods.

Text Book(s)

1. F. M. White, Fluid Mechanics, 8/e, McGraw Hill, 2017.
2. P. N. Modi and S. M. Seth**,** Hydraulics and Fluid Mechanics including Hydraulics Machines, 20/e, Standard Publishers, 2015.

References

1. R. K. Bansal**,** A Textbook of Fluid Mechanics and Hydraulic Machines**,** 9/e**,** Laxmi Publications, 2011.
2. K. L. Kumar, Engineering Fluid Mechanics, 8/e, Eurasia Publishing House, 2010.
3. V. Gupta, S. K. Gupta, Fluid Mechanics and its Applications, 2/e, New Age International, 2011.
4. R. W. Fox, P. J. Pritchard, A. T. McDonald, Introduction to Fluid Mechanics, 7/e, Wiley India, 2011.
5. K. W. Bedford, V. Streeter, E. B. Wylie., Fluid Mechanics, 9/e, McGraw Hill, 2010.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	2	1	1	1	1	1	1	3	1	1
CO2	3	2	1	1	1	1	1	1	1	1	1	1	3	1	1
CO3	3	2	1	1	1	1	1	1	1	1	1	1	3	1	1
CO4	2	2	1	1	1	1	1	1	1	1	1	1	2	1	1
CO5	3	2	1	1	1	1	1	1	1	1	1	1	3	1	1

Course Objectives:

- Use various flow measuring devices for making engineering judgments.
- Provide practice in estimating friction losses
- Understand experimentally,the performance of hydraulic turbine and compressor

List of Experiments:

1. Calibration of venturimeter, orifice meter and flow nozzle.
2. Calibration of Pitot tube.
3. Determination of friction factor of a given pipe.
4. Calculation of force exerted by a jet on stationary flat plate, inclined plate and curved vane.
5. Performance characteristics of centrifugal and reciprocating pump

Course Outcomes:

After successful completion of this course the students will be able to

- Understand the concepts of fluid mechanics in a more practical way.
- Estimate the friction and measure the frictional losses in fluid flow.
- Experiment with flow measurement devices like venturimeter and orifice meter.

PC5: MECHANICS OF SOLIDS

L	T	P	S	J	Letter
3	0	2	0	0	4

Preamble

This course projects concepts connected to understanding the strength of different elements that forms the basis for a typical structural system. It focuses mainly on the initial design aspect of elements subjected to mechanical loads and their implications. Course finds appealing and enhances interest in aerospace structures.

Course Objectives:

- To make learn the fundamentals connected to mechanics of different structural members.
- To impart knowledge of complex stresses and strains.
- To teach concepts of shear force and bending moment section loads.
- To train basic design principles of flexural members
- To give exposure to analyzing strength of thin cylinders.

UNITI **8 hours**

Simple Stresses and Strains: Classification of loads, stress, strain, stress and elongation produced in a bar due to its self-weight, tie bar of uniform strength, stress in a bar due to rotation, elongation in case of a taper rod, Poisson's ratio, relation between the elastic units, stresses induced in compound bars, thermal stress and strain.

Learning Outcomes

At the end of unit student will be able to

- understand basic strength calculations of different structural elements(L2)
- gain knowledge on loaded members response through various applications(L2)
- develop strong command on deducing material constants with available inputs(L6)
- assess the impact of thermal loads on members(L4)
- exhibit design skills of different axial members(L4)

UNITII **12 hours**

Complex and principal Stresses: Introduction, stresses on an oblique plane under-uniaxial loading, stresses on an oblique plane under biaxial loading, biaxial stresses combined with shear stresses, principal stresses and principal planes, Mohr's circle for complex stresses.

Principal Strains: Introduction, strains on an oblique plane under uni-axial loading, strains on an oblique plane under biaxial loading, biaxial strains combined with shear strains, principal strains, and Mohr's circle for complex strains

Theories of Failure: Maximum normal stress theory, maximum shear stress theory, maximum strain energy theory and maximum distortion energy theory.

Learning Outcomes

At the end of unit student will be able to

- understand significance of complex stresses and related strains(L2)
- asses the occurrence of principal stresses, strains and directions for biaxial members(L4)
- develop basic understanding of loaded member failure tendency(L2)
- appreciate and distinguish the simple, complex, and principal stresses(L4)
- develop interest on graphical method of assessment(L2)
- gain knowledge on different failure theories(L2)
- enhance learning of design theories associated with aircraft structures(L4)

UNIT III **10 hours**

Thin Cylinders and Spherical Shells: Stresses and strains (principal stress, principal strain, shear stress, shear strain and volumetric strain) in thin cylinders, thin spherical shell and wire wound cylinders.

Shear Force and Bending Moment: Basic definitions, classification of beams, types of loads, types of supports, shear force and bending moment diagrams for cantilever, simply supported and overhanging beams for different types of loadings, the point of contraflexure, general relation between the load, the shearing force and the bending moment.

Learning Outcomes

At the end of unit student will be able to

- understand the significance and applications of volumetric structural elements in aerospace engineering(l2)
- show command on design of cylinders and spherical shells(L4)
- develop understanding on design loads and their calculation(L2)
- exhibit strong skills of drawing BM and SF diagrams(L4)
- connect the interdependency of bending and shear loads(L6)
- learn different types of beams, supports and applied loads(L2)
- appreciate the variation of design loads and necessary variation in strength(L5)

UNITIV **8 hours**

Bending and Shear Stresses in Beams: Theory of simple bending (bending equation / flexural formula), position of neutral axis, section modulus, practical application of bending equation, shear stresses in beams, variation of shear stress distribution for rectangular, circular and I-sections.

Learning Outcomes

At the end of unit student will be able to

- understand theoretical model that fits strength aspects of members (L2)
- gain command on design knowledge of various beam members(L2)
- exhibit command on optimizing the design process(L4)
- effectively exercise the choice of suitable structural materials(L5)
- appreciate design philosophy and sizing of different beams as appropriate(L5)

UNITV **8 hours**

Deflection of Beams: Beam deflection, relation between slope, deflection and radius of curvature, slope and deflection at a section, double integration method, Macaulay's method and moment area method for cantilever, simply supported and fixed beams.

Learning Outcomes

At the end of unit student will be able to

- understand the concept of deflection of beams (l2)
- apply different methods to find the deflection of beams (l3)
- effectively exercise the selection of suitable method based on the type of beam (l4)

Course Outcomes

At the end of course student will be able to

- Assess the response of axially and transversely loaded structural members
- Deduces the complexities associated with bi axial loaded members
- Appreciates the modulation of applied loads to design flexural loads
- Exhibit strong design knowledge of various beams carrying transverse loads
- Estimate the deflection of beams

Text Book(s)

1. R.K Bansal, Strength of Materials, S Chand, 6/e.
2. F. P. Beer, E. R. Johnston Jr. and J. T. Dewolf, Mechanics of Materials, 6/e, Tata McGraw Hill, 2013.

References

1. Timoshenko, Strength of Materials, Part - I and II, 3/e, CBS Publishers,2011.
2. E. P. Popov, Mechanics of Solids, 2/e, Pearson Education, 2003.
3. I. H. Shames and J. M. Pitarres, Introduction to Solid Mechanics, 3/e, Prentice Hall India,2009

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	1	1	1	2	1	1	2	1	3	2	1
CO2	3	2	2	1	1	1	1	1	1	1	2	1	3	2	1
CO3	3	3	2	1	1	1	1	2	1	1	2	1	3	2	1
CO4	2	2	2	1	1	1	1	2	1	1	2	1	2	2	1
CO5	3	3	2	1	1	1	1	1	1	1	1	1	1	1	0

PC6: AEROSPACE MATERIALS ENGINEERING

L	T	P	S	J	Letter
3	0	0	0	0	3

Preamble:

This course is designed for Aerospace Engineering undergraduate students. It is designed for the students for the basic understanding of aerospace materials and processing technologies used.

Course Objectives:

- Facilitate the knowledge on recent developments in materials science and engineering within the framework of aerospace engineering.
- Demonstrate the introduction to metals, alloys and composites used for aerospace applications.
- Impart knowledge on manufacturing processes of aircraft parts.
- Train to understand the characterization of various types of composite materials.

UNIT I **8 hours**

Introduction to Aerospace Materials: Historical development, classification of materials, Properties of flight vehicle materials, importance of strength/weight ratio of materials for aerospace vehicles structures (importance of temperature variations, factors affecting the selection of material for different parts of airplanes); crystal structure of metals and alloys (metallography); Mechanical Properties of aerospace materials.

Constitution of alloys: Necessity of allying, types of solid solutions, intermediate alloy phases.

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

- Understand the historical development of aerospace materials
- Gain knowledge on the important properties of material
- Able to interpret the phase diagrams and correlate various phases existing in an alloy
- Understand the limitations of existing materials and design of new materials for current challenges in aerospace engineering requirements

UNIT II **8 hours**

Introduction to Binary Phase Diagrams: Interpretation of phase diagrams of Iron, Aluminium, Titanium and Nickel based alloys.

Classification of steels alloys, effect of alloying elements, properties and applications in aerospace industry; Introduction to Heat treatment processes and its important, initial stresses and stress alleviation procedures; corrosion prevention and protective treatments

Learning Outcomes:

After completion of this unit the student will be able to

- Gain knowledge on light metal alloys applications(L2)
- Classify the steel and magnesium alloys(L1)
- Explain the effect of alloying elements(L3)

UNIT III **8 hours**

Light Metal Alloys: Aluminium and its alloys, Titanium and its alloys, magnesium alloys and their properties: applications, machining, forming, welding and heat treatment;

Introduction to super alloys: High strength, high corrosion alloys and Heat Resistant Alloys: Classification of heat resistant materials, iron, nickel and cobalt based super alloys, properties of inconel, monal, nimonic and super alloys;

Introduction to refractory materials & ceramics;

Learning Outcomes:

After completion of this unit the student will be able to

- Gain knowledge on high strength alloys and its properties (L1)
- Demonstrate the procedures for heat treatment of steel alloys(L2)

UNITIV **8 hours**

Composite Materials: Classification, characteristics of composite materials, volume fraction, laminated composites, particulate composites and fibrous composites. Types of reinforcements, their shape and size, production and properties of fiber reinforced plastics.

Learning Outcomes:

After completion of this unit the student will be able to

Gain knowledge on classification and characteristics of composites. (l1)

Understand the types of reinforcements(l2)

Demonstrate the methods of processing of composite materials(l2)

UNITV 8 hours

Aircraft Manufacturing Processes: Profiling, hydro forming, spar milling, spark erosion and powdered metal parts, integral machining, contour etching, high energy rate forming and manufacturing of composites including honeycomb structures and general methods of construction of aircraft engine parts.

Learning Outcomes:

After completion of this unit the student will be able to

- Gain knowledge on various manufacturing process for different parts of aircraft(L1)
- Understand the methods of construction of aircraft engine parts(L2)

Course Outcomes:

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

- Demonstrate a general understanding of aerospace materials and the appropriate manufacturing techniques for the major critical components.
- Select appropriate manufacturing processes for composites.
- Describe likely performance of classes of aerospace materials in the context of specific
- applications
- Describe methods of processing aerospace materials particularly joining issues and propose
- suitable routes for selected applications
- Apply the knowledge on the criteria for the selection of material.

Text Book(s)

1. G. F. Titterton, Aircraft Materials and Processes, 5/e, Sterling Book House,1998.
2. F. C. Campbell, Manufacturing Technology for Aerospace Structural Materials, 1/e, Elsevier Publications,2006.

References

1. R. H. Avner, Introduction to Physical Metallurgy, 2/e, Tata McGraw Hill,1997.
2. W. D. Callister, D. G. Rethwisch, An Introduction on Material Science and Engineering, John Wiley,2010.
3. G. E. Dieter, Mechanical Metallurgy, 1/e, McGraw Hill, 1976.
4. L. Gupta, Advanced Composite Materials, 2/e, Himalayan Books,2006

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1		1	2	1	1	1	1	1	1	3	1	1
CO2	2	1		1	1	2		1	1	1	1	1	2	1	1
CO3	2	2	1	1	2	2	1	1	1	1	1	1	3	1	1
CO4	2	1	1		1	1		1	1	1	1	1	2	1	1
CO5	3	2	1	1	1	1	1	1	1	1	1	1	3	1	1

PC7: COMPUTER AIDED AIRCRAFT DRAWING

L	T	P	S	J	Letter	P/F
0	0	2	0	0	1	

Preamble: This course is designed for aerospace engineering students. It introduces the learning of CATIA software. This course is designed to acquaint the learners with basic modeling of 3D models used in aerospace and mechanical industry

Course Objectives:

- To introduce 2D and 3D Models of different types of Screw Threads used in aeronautical industries by using CATIA Software.
- To familiarize 2D and 3D Models of different types of Fasteners like Nuts, Bolts, Washers, Rivets etc. used in aeronautical industries by using CATIA Software.
- To introduce 2D and 3D Models of different types of Keys and Cotter Joints like Taper key, Sunk Key, Round Key, Feather key, Socket and Spigot Joint and Knuckle joints etc. used in aeronautical industries by using CATIA Software.
- To enable students to draw 2D and 3D Models of different types of Symmetrical and cambered Airfoils, NACA 4- and 5-Digits Airfoil used in flying vehicles by using CATIA Software

Sectional Views: Principles involved in sectional plane, convention representation of sectional plane, hatching, sectional views of machining components.

2 Classes

Fasteners: Bolted joints, screw joints, stud joints, riveted joints, welded joints and their conventional representation. **2 Classes**

Airfoil and Wing Drawings: NACA 4-digit airfoil (symmetrical, cambered), NACA 5-digit airfoil. Rectangular wing swept wing and delta wing configurations.

3 Classes

Aircraft Assembly Drawings: Different types of trusses used in wings, spars, ribs, stringers, skin, brackets, bulkhead, and rings (frame) longerons. Different types of fuselage, landing gear, hydraulic cylinder, connecting rod and piston engine.

Manufacturing Drawing: Dimensioning, representation of fits, dimensional tolerances, surface roughness and geometric tolerance. **2 Classes**

Text Book(s)

1. S. Tickoo, G. Verma, Catia V5-6R2012 for Engineers and Designers, Dreamtech Press, 2013.

Course Outcomes:

On successful completion of this module a student should be able to:

- Apply drawing and modeling concept by using CATIA Modeling Software.
- Acquire skills for applying the drawing methodology to different Joining parts of aircrafts.
- Analyze the drawback and limits of software while making drawing and modeling any objects.
- Use Computer Aided Design software to create simple 3D models using solid, assembly and surface modelling techniques.
- Apply their knowledge and skills to design aircraft components as part of the Group.

CO-PO-PSO-Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	3		1	2	1	1	1	1	1	1	2	1	1
CO2	2	2	1	2	2	2	1	1	1	1	1	1	3	1	2
CO3	3	2	3	2	1	1	1	1	1	1	1	1	2	2	1
CO4	2	2	3		1	2	1	1	1	1	1	1	2	1	1
CO5	2	2	2	1	2	1	1	1	1	1	1	1	2	1	2

PC8: AERODYNAMICS – I

L	T	P	S	J	Letter	P/F
3	0	2	0	0	4	

Preamble:

This course is designed for Aerospace Engineering undergraduate students. This course aims to introduce and explain the fundamental concepts of aerodynamics. Understanding these concepts will help in estimating aerodynamic forces and moments.

Course Objectives:

- Introduce governing equations of the fluid flow.
- Provide insight on flow characteristics over an airfoil and wing.
- Familiarize different theoretical and numerical methods used in the analysis of potential flow over an airfoil and wing.
- Introduce different sources of drag.

UNIT I **10 hours**

Governing Equations of Fluid Flow: Flow regimes, definition of incompressible and compressible flows, governing equations of inviscid incompressible and compressible flow in integral and differential forms, communication in gases, isentropic relations, stagnation state, stagnation properties and its use.

Learning Outcomes

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

- Classify different flow regimes based on the Mach number and describe their characteristics (L2).
- Compare the propagation of disturbances in different flow regimes (L2).
- Write the integral and differential form of the governing equations (L1).
- Interpret the physical meaning of different terms in the governing equations (L2).
- Modify governing equations for an inviscid incompressible and compressible flow (L3).
- Write isentropic relations and apply these relations to determine pressure, temperature and density (L3).
- Explain stagnation properties (L2).
- Calculate the stagnation properties of a flow given appropriate information (L3).

UNIT II **10 hours**

Basic Aerodynamics: Wing and airfoil geometry, aerodynamic force and moments, estimation of lift, drag and pitching moment from the pressure distribution, aerodynamic center, center of pressure, types of drag, characteristics of symmetric and cambered airfoils.

Learning Outcomes

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

- Classify different types of airfoils and wings (L2).
- Illustrate and explain the nomenclature of an airfoil and wing (L1).
- Describe aerodynamic forces and moments acting on an aircraft (L2).
- Calculate lift, drag and pitching moment from the pressure distribution on a 2D body (L3).
- Explain the difference between aerodynamic center and center of pressure (L2).
- Calculate aerodynamic center and center of pressure given appropriate information (L3)
- Explain different sources of drag, their causes and characteristics (L2).
- Describe the effect of angle of attack, camber, thickness and Reynolds number on the aerodynamic characteristics of an airfoil (L2).

UNIT III **10 hours**

Potential Flows: Laplace's equations, boundary conditions, basic elementary flows: uniform flow, source flow, doublet flow and vortex flow, superimposition of elementary flows, non-lifting and lifting flow over a circular cylinder. Kutta - Joukowski theorem and the generation of lift, numerical source panel method, comparison of an ideal and real flow over circular cylinder, D'Alembert's paradox.

Learning Outcomes

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

- Write the governing equation for irrotational, incompressible flow (L1).
- Summarize the general approach to the solution of irrotational, incompressible flows (L2).
- Determine the stream function and velocity potential for basic elementary flows (L3).
- Compute potential flow over 2D bodies 'by superposition of basic elementary flows (L3).
- Compute lift using Kutta-Joukowski theorem (L3).
- Describe the basic philosophy behind source panel method (L2).
- Explain the advantages and limitations of method of superposition and source panel method (L2).
- Summarize the differences between an ideal and real flow over a cylinder (L2).

UNIT IV **10 hours**

Thin Airfoil Theory: Vortex sheet, Kutta condition and Kelvin's circulation theorem. Classical thin airfoil theory: symmetric and cambered airfoil, vortex panel numerical method, experimental characteristics of airfoils and comparison with theoretical results.

Learning Outcomes

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

- Describe the Kutta condition and obtain corresponding expressions for different trailing edge shapes (L3).
- Apply Kelvin circulation theorem to describe the generation of lift over an airfoil (L3).
- Describe the basic philosophy behind thin airfoil theory and vortex panel method (L2).
- Summarize important results of thin airfoil theory for a symmetric and cambered airfoil (L2).
- Estimate lift and moment coefficients using thin airfoil theory and compare them with experimental results (L3).
- Compare the advantages and limitations of thin airfoil theory and vortex panel method (L2).

UNIT **10 hours**

Finite Wing Theory: Downwash, induced drag, Biot-Savart's law and Helmholtz's theorem. Prandtl's classical lifting line theory, Elliptic and general lift distribution over finite unswept wings, effect of aspect ratio, correlation of C_L distribution over other aspect ratios, flow past swept and delta wings, lifting surface theory, drag polar and ground effect.

Learning Outcomes

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

- Explain differences in flow characteristics over an airfoil and wing (L2).
- Apply Biot-Savart law to determine velocity induced at a point by straight vortex filament (L2).
- Explain Helmholtz's vortex theorems (L2).
- Describe basic philosophy behind the Prandtl's lifting line theory (L2).Summarize important results of lifting line theory for an elliptic and general lift distribution (L2).
- Estimate aerodynamic characteristics of a finite wing using lifting line theory (L3).
- Explain the limitations of lifting line theory (L2).
- Summarize the flow characteristics over swept and delta wings (L2).
- Explain differences between Prandtl's lifting line theory and lifting surface theory (L2).
- Describe the effect of ground on aerodynamic characteristics of an aircraft (L2).

Course Outcomes:

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

- Apply the governing equations in both integral and differential form for different flows.
- Compute center of pressure, aerodynamic center, lift, drag and moment coefficients given appropriate information.
- Compute potential flow around two-dimensional bodies.
- Apply appropriate theoretical and numerical methods to estimate aerodynamic characteristics of an airfoil.
- Applying appropriate theoretical and numerical methods to estimate aerodynamic characteristics of a wing.

Text Book(s)

1. J. D. Anderson, Fundamentals of Aerodynamics, 5/e, McGraw Hill, 2010.
2. E. L. Houghton, P. W. Carpenter, S. H. Collicott, D. T. Valentine, Aerodynamics for Engineering Students, 6/e , Elsevier Science, 2012

References

1. L. J. Clancy, Aerodynamics, 1/e, Shroff Publications, 2006
2. J. J. Bertin and R. Cummings, Aerodynamics for Engineers, 6/e, Pearson, 2013.
3. B. W. McCormick, Aerodynamics, Aeronautics and Flight Mechanics, 2/e, John Wiley and Sons, 1995.
4. C. Y. Chow and A. M. Kuethe , Foundations of Aerodynamics, 5/e, Wiley India, 2009

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3

CO1	3	2	1	1	1	1		1	1	1	1	1	3	1	1
CO2	3	2	1	1	1	1	1	1	1	1	1	1	3	1	1
CO3	3	2	1	1	1	1		1	1	1	1	1	3	1	1
CO4	3	2	1	1	1	1	1	1	1	1	1	1	3	1	1
CO5	3	2	1	1	1	1	1	1	1	1	1	1	3	1	1

AERODYNAMICS LABORATORY

Preamble:

This course is designed for Aerospace Engineering undergraduate students. This course aims at imparting practical exposure on various techniques used to measure pressure, velocity, force and visualize the flow. Familiarity with these techniques helps in determining aerodynamic forces and moments.

Course objectives:

- introduce different types of wind tunnels.
- acquaint different pressure, velocity, and force measurement techniques.
- acquaint different flow visualization techniques.

List of Experiments:

1. Study of the pressure distribution over smooth and rough cylinder.
2. Study of the pressure distribution over symmetric and cambered airfoils.
3. Performance of an airfoil with flap, influence of flap angle on lift, drag and stall.
4. Aerodynamic characterization of different wing configurations
5. Aerodynamic characterization of flapping wing.
6. Flow visualization studies in low-speed flow over airfoil with different angle of incidence
7. Pressure distribution around a two- dimensional model in supersonic flow conditions, at different angles of attack.
8. Lift and drag coefficient for aerodynamic models in supersonic flow.
9. Shock waves and expansion patterns around a two - dimensional model in supersonic flow conditions. (Flow visualization with Schlieren apparatus.
10. Measurement of the velocity profile in the boundary layer at on rough and smooth plates
11. Measurement of the velocity profile in the boundary layer at various distances from the leading edge of the plate

Course Outcomes:

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

- classify and explain different types of wind tunnel and their components.
- explain the principle behind the different techniques used for measuring pressure, velocity, force and visualizing the flow.
- measure and analyse pressure/velocity distribution over bodies of practical interest such as cylinder, airfoil, wing and a flat plate
- use various flow visualisation techniques to identify different flow structures in both subsonic and supersonic flows.
- measure and analyse lift, drag and moment coefficients.

PC9: MECHANICS OF AEROSPACE STRUCTURES

L	T	P	S	J	Letter
3	0	2	0	0	4

Preamble:

This course is designed for Aerospace Engineering undergraduate students. It is designed for the students to understand the basics principles of Mechanics of different components of Aerospace Structures. Understanding these principles will help them in the Design and Analysis of Aerospace Structures.

Course Objectives:

- To study and analyze structures using various energy methods.
- To familiarize different methods for statically indeterminate structures.
- To impart knowledge on the principles of the theory of elasticity.
- To educate the behavior of bending of thin plates under different load conditions.
- To identify the behavior of columns and struts with different end conditions.
- To study the principles of thin plates and tension field beams.
- To learn the fundamental principles of mechanical vibrations

UNIT I **12 hours**

Energy Methods: Unit load method for calculating displacement, strain energy method for uniaxial stress, pure bending and shearing stresses, Castigliano's theorem.

Statically Indeterminate Structures: Introduction, methods for indeterminate beams, superposition method, double integration method and moment distribution method, matrix methods for indeterminate trusses and frames.

Learning Outcomes:

After completion of this unit student will be able to

- Apply various energy methods to solve problems. (L3)
- Use different methods in analysing statically indeterminate structures (L2)
- Analyse statically indeterminate structures using different methods (L4)

UNIT II **8 hours**

Theory of Elasticity: Stress - Strain relations, equilibrium and compatibility conditions for elastic solids, 2D elasticity equations for plane stress, plane strain and generalized plane strain cases, stress functions; Airy's stress function, bending of end-loaded cantilever beams.

Learning Outcomes:

After completion of this unit student will be able to

- Explain the importance of equilibrium and compatibility conditions for elastic solids (L2)
- Distinguish between plane stress and plane strain conditions (L4)
- Solve 2-D elastic problems using stress functions (L3)

UNIT III **10 hours**

Bending of Thin Plates: Pure bending of thin plates, plates subjected to bending, twisting and distributed transverse loads, combined bending and in-plane loading of a thin rectangular plate, bending of thin plates having a small initial curvature, energy methods for bending of thin plates.

Learning Outcomes:

After completion of this unit student will be able to

- explain the behavior of bending of thin plates under different types of loadings (L2)
- apply energy methods to solve bending of thin plate problems (L3)

UNIT IV **10 hours**

Columns and Struts: Elastic instability, Euler's buckling of columns - columns with one end free and the other fixed, both ends fixed, one end fixed and other hinged, inelastic buckling, column with initial curvature, column carrying eccentric load, laterally loaded columns, empirical formulae.

Thin Plates: Buckling of thin plates - elastic buckling of isotropic flat plates in compression, elastic buckling of plates due to shear and bending stresses. Instability of stiffened panels, crippling stresses by Needham's and Gerard method.

Learning Outcomes:

After completion of this unit student will be able to

- Compare the behavior of columns with different end conditions (L2)
- Explain the behavior of column carrying eccentric load (L2)
- Explain the elastic buckling of isotropic flat plates under different load conditions (L2)
- Explain the instability of stiffened panels (L2)

UNIT V **12 hours**

Vibrations: Single degree of freedom systems, natural frequency, undamped and damped vibration, vibration of torsional system with single rotor, undamped and damped frequencies.

Learning Outcomes:

After completion of this unit student will be able to

- Explain the concept of mechanical vibrations. (L2)
- Distinguish between damped and undamped vibrations (L4)
- Solve simple problems on vibrations of single degree of freedom systems (L2)

Course Outcomes:

After the completion of this course student will be able to

- Solve problems on statically determinate and indeterminate beams
- Make use of principles of theory of elasticity to solve 2-D elastic solid problems
- Explain the behavior of columns under different load conditions and end conditions
- Analyse buckling of thin plates under different types of loads
- Solve simple problems on mechanical vibrations

CO PO PSO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	1	1	1	1	1	1	1	3	2	1
CO2	3	2	1	1	1	1	1	1	1	1	1	1	3	2	1
CO3	3	2	1	1	1	1	1	1	1	1	1	1	3	1	1
CO4	3	2	1	1	1	1	1	1	1	1	1	1	3	1	1
CO5	3	2	1	1	1	1	1	1	1	1	1	1	3	2	1

Text Book(s)

1. T. H. G. Megson, Aircraft Structures for Engineering Students, 5/e, Elsevier Publications, 2013.

References

1. Timoshenko, Strength of Materials Part - I and II, 3/e, CBS Publishers, 2011.
2. E. P. Popov, Mechanics of Solids, 2/e, Pearson Education, 2003.
3. I. H. Shames and J. M. Pitarres, Introduction to Solid Mechanics, 3/e, Prentice Hall of India, 2009.
4. F. P. Beer, E. R. Johnston, Jr. and J. T. Dewolf, Mechanics of Materials, 6/e, Tata McGraw Hill, 2013.
5. S. S. Rattan, Strength of Materials, 2/e, Tata McGraw Hill, 2011.

AEROSPACE STRUCTURES LABORATORY

List of Experiments:

1. Maxwell's reciprocal theorem verification for beams with different end conditions.
2. Column instability test for different end conditions.
3. Shear tests on riveted joints.
4. Study the behavior of pressurized thin cylinder.
5. Shear centre in open sections beams.
6. Shear centre in closed sections beams.
7. Wagner tension field beam
8. Combined bending and torsion of a circular tube
9. Strength of structural under fatigue or cyclic loading
10. Free vibration of a cantilever beam
11. Forced vibration of beams
12. Forced vibration of rotating unbalance

PC10_AIRCRAFT PROPULSION

L	T	P	S	J	Letter
3	1	0	0	0	4

Preamble

These course projects concepts connected to power plants that are used in aircrafts. It focuses mainly on performance estimation, characterization and analysis of different subsystems used in aircraft engines. Course find appealing and enhances interest on gas turbine-based power plant engineering.

Course Objectives:

- To make learn the principles of the several types of power plants.
- To impart knowledge on performance of Turbojet, Turbo fan, Turbo prop and turbo shaft engines.
- To teach concepts of Ramjet and Scramjet engines.
- To train basic design of Compressors, Combustors, Turbine and Nozzle.
- To propel for Analyze and identify the cause of off design performance.

UNIT I **12 hours**

Thermodynamics of Gas Turbine Engines:

Introduction: Nomenclature and air breathing engines, principle of gas turbine engine, thrust equation and related factors.

Aerothermodynamics of Engines: Turboprop engine, turbojet engine, turbo fan engine, turbo shaft engine, ramjet engine, and their performance characteristics, thermodynamic cycles, thrust, efficiencies, specific fuel consumption(thrust), specific thrust and Numerical.

Learning Outcomes

At the end of unit student will be able to

- Develop concepts related to air breathing gas turbine engines(l2)
- Understand the performance of different aircraft engines(l2)
- Distinguish across various engines and their significance(l5)
- Demonstrate basic knowledge of engine design(l4)
- Enhance critical thinking by practice of numerical(l6)

UNIT II **12 hours**

Axial Flow Compressors:

Introduction: Geometry structure of stage and related terminology, Flow and airfoil angles, stage and multistage, standard airfoil profiles

Energy transfer: components of energy transfer, stage reaction, Rothalpy and total enthalpy, incidence and deviation angles, radial equilibrium, specific speed and its design role, Compressor performance charts, polytropic efficiency, total and static efficiencies. Real flow effects of incidence angle, Mach number, tip clearance. Concepts of rotating stall and surge.

Learning Outcomes

At the end of unit student will be able to

- Understand fundamentals related to turbomachinery (L2)
- Connect rotating flow aerodynamics across different frames of reference(L2)
- Enhance knowledge on rotating flow dynamics and performance (L4)
- Develop critical design skills of axial flow compressors(L4)
- Appreciate the turbomachinery flow sensitivity and significance(L5)

UNIT III **10 hours**

Axial Flow Turbines:

Introduction, geometry, comparison with axial flow compressor, velocity polygons, stage energy analysis- pressure ratio, degree of reaction – impulse, reaction turbines and related flow angles, Study of performance charts, typical blade profiles, Blade cooling, blade and vane materials, turbine-compressor matching, Numerical.

Learning Outcomes

At the end of unit student will be able to

- Differentiate flow dynamics between turbines and compressor(L2)
- Analyses, deduces turbine performance from study of charts(L4)
- Demonstrate various turbine blade cooling methods(L4)
- Judge better choice of materials for different components of turbine(L5)
- Enhance critical design skills of axial flow turbines(L6)

UNIT IV **9 hours**

Combustion System:

Introduction, geometries, primary combustor, afterburner, Flame stability, ignition and engine starting, adiabatic flame temperature thermodynamics, combustion process, pressure losses-Rayleigh, Fanno line flows, combined heat addition and friction. Performance maps, fuel types used.

Learning Outcomes

At the end of unit student will be able to

- Understand combustion process and associated dynamics in a typical jet engine(l2)
- Appreciates the significance and challenges of energy conversion in combustor(l5)
- Demonstrate the knowledge on flame tube cooling(l4)
- Exhibits design knowledge of typical combustor(l3)
- Deploy possible means to contain combustion losses(l6)

UNIT V **7 hours**

Subsonic 1-D Flow:

Inlets: Introduction, geometry structure, subsonic inlets: capture area, low subsonic and high subsonic diffusers, internal flow, external flow decelerations and their implications, area ratio and design criteria.

Learning Outcomes

At the end of unit student will be able to

- Understand internal and external flow modulations for operation of subsonic diffuser(L2)
- Appreciates significance of boundary flow and its role in containing aerodynamic behavior(L6)
- Exhibits subsonic intake design knowledge(L4)
- Enhance interest on learning for high speed subsonic and supersonic intakes(L6)

Course Outcomes

At the end of course student will be able to

- Gain understanding on various gas turbine engines performance.
- Exhibit knowledge on axial flow compressor and turbines working.
- Appreciates combustion mechanism and its sensitivity.
- Exhibit knowledge on working and performance determination of axial flow turbines.
- Demonstrate knowledge of subsonic inlet of gas turbine engine.

Text Book(s)

1. R. D. Flack, Fundamentals of Jet Propulsion with Applications, 2/e, Cambridge University Press, 2010.
2. Erian A Baskharone, Principles of Turbomachinery in air breathing engines.
3. J. D. Mattingly, Elements of Gas Turbine Propulsion, 3/e, McGraw Hill,2011.
4. G. C. Oates, Aerothermodynamics of Aircraft Engine Components, AIAA,2007.

References

1. C. R Peterson and P. G. Hill, Mechanics and Thermodynamics of Propulsion, 2/e, Pearson,2009.
2. Cumpsty, Jet Propulsion, 2/e, Cambridge University Press,2008.
3. A. F. El-Sayed, Aircraft Propulsion and Gas Turbine Engines, 1/e, CRC Press,2008.
4. J. L. Kerrebrock, Aircraft Engines and Gas Turbines, 2/e, MIT Press,1992.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	2	1	1	1	1	1	1	3	1	1
CO2	3	2	2	1	1	1	1	2	1	1	2	1	3	2	1
CO3	2	1	1	1	1	2	1	1	1	1	1	1	2	1	1
CO4	2	2	2	1	1	1	1	1	1	1	2	1	2	1	1
CO5	2	2	1	1	1	1	1	1	1	1	2	1	2	1	1

PC 11: AERODYNAMICS - II

L	T	P	S	J	Letter	P/F
3	0	0	0		3	

Preamble

This course highlights syllabus related to high speed flows. It includes flow theories of normal, oblique and expansion shocks and flow linearization methods. Course find appealing and enhances interest in the area of high speed flows and gas dynamics

Course Objectives:

- Explain behavior of airflow both internal and external in compressible flow regime with particular emphasis on supersonic flows.
- Train principles behind the formation of shocks and expansion fans in supersonic flows.
- Impart the knowledge of flow physics of nozzles and supersonic inlets.
- Familiarize approximation theory and linearization of potential flows.
- Encourage take up design of nozzles and supersonic airfoils

UNIT I **10 hours**

Isentropic Flows: Steady one-dimensional isentropic flow: differential equations for 1D flow, isentropic flow with area variation, area-velocity relation and its application.

Normal Shock Theory: Normal shock concept, normal shock relations, stationary normal shocks.

Learning Outcomes

At the end of unit student will be able to

- Develop conceptual understanding of one-dimensional steady flow(L2)
- Deduce conservation equations from fundamental principles(L3)
- Learn applications of steady flow equations for one dimensional flow(L2)
- Appreciates the dynamics of high-speed flows(L2)
- Express interest in design of one-dimensional flow subsystems(L4)

UNIT II **10 hours**

Oblique Shocks and Shock Reflections: Oblique shocks, concept and theory, oblique shock relations, property variations, detached shocks, shock reflections, numerical examples and shock-shock interactions.

Expansion Theory: Expansions: 1D expansion wave, expansion fan, Prandtl-Meyer function, smooth expansions/compressions and numerical examples. Shock expansion theory: examples and its applications.

Learning Outcomes

At the end of unit student will be able to

- Develop knowledge on various types of shock and their properties(L1)
- Gain profound understanding of Mach number, shock and wedge angle significance(L2)
- Effectively differentiate oblique and expansion waves(L5)
- Put in sufficient applied numerical practice(L3)
- Analyze, interpret supersonic flow behavior for various objects(L6)

UNIT III **12 hours**

Nozzle Flows: Area-Mach number relations, geometric choking, convergent nozzles, divergent nozzles, convergent-divergent nozzles, numerical examples, multiple choking points, and effect of different pressure ratio across nozzle, under and over expanded nozzles.

Supersonic Inlets: Introduction, starting problem, convergent-divergent diffuser, divergent inlet, shock boundary layer problem, external deceleration and performance, flow stability problem with movable spikes.

Learning Outcomes

At the end of unit student will be able to

- Realize the significance of compressibility of high-speed flows(L2)
- Appreciates the aerodynamic performance of nozzles(L2)
- Exhibit knowledge on the design of different types of nozzles(L4)
- Develop understanding on supersonic inlets and their gas dynamic behavior (L2)
- Realize the complexities associated with high response of engine subsystems(L6)

UNIT IV **10 hours**

Linearized Potential flow Theory: Potential equation for 2-dimensionalcompressible flow, linearization of potential equation, perturbation potential, linearised pressure coefficient, linearised subsonic flow, Prandtl-Glauert rule, linearised supersonic flow, and Introduction to method of characteristics.

Learning Outcomes

At the end of unit student will be able to

- Appreciates linearization theory of potential flow of compressible regimes(L2)
- Exhibit enhanced interest in handling compressible nature of fluids over different aerodynamic objects(L6)
- Apply design knowledge of compressible flow to airfoil (L3)

UNIT V **10 hours**

Linearized Supersonic Flows: Critical Mach number, drag divergence Mach number, shock stall, supercritical airfoil sections, transonic area rule, swept wing, airfoils for supersonic flows, lift, drag, pitching moment and centre of pressure for supersonic profiles, wave drag, supersonic wings.

Learning Outcomes

At the end of unit student will be able to

- Improve knowledge of quantification of supersonic flows(L2)
- Exhibit increased interest in deducing critical high-speed flow response on different aerodynamic objects(L3)
- Compare exact and approximation theories in simplification of high-speed gas dynamic flows(L4)
- Exhibit design knowledge of supersonic wings and other high-speed components(L4)

Course Outcomes

At the end of course student will be able to

- Realize the significance of nature of high speeding flows and their relevance to mach number**(L2)**
- Exhibit knowledge of quantification of supersonic flow shock field concepts **(L4)**
- Ascertain, and design typical supersonic nozzle and inlet**(L6)**
- Understands the importance of linearization of potential flow and its quantification**(L2)**
- Exhibit knowledge of supersonic flow field complexities and quantification methods**(L4)**

Text Book(s)

1. E. Rathakrishnan, Gas Dynamics, 5/e, Prentice Hall of India, 2013.
2. J. D. Anderson, Modern Compressible flow, 3/e, McGraw Hill, 2012.

References

1. C. R Peterson and P. G. Hill, Mechanics and Thermodynamics of Propulsion, 2/e, Pearson, 2009.
2. H. W. Liepmann and A. Roshko, Elements of Gas Dynamics, Dover publications, 2007.
3. A. H. Shapiro, The Dynamics and Thermodynamics of Compressible Fluid Flow, volume I and II, 1/e, John Wiley, 1953.
4. P. H. Oosthuizen and W .E. Carscallen, Compressible Fluid Flow, 1/e, McGraw Hill, 1997.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	1	1	1	1	2	1	1	2	1	3	2	1
CO2	3	2	2	1	1	1	1	2	1	1	2	1	3	2	1
CO3	3	2	1	1	1	1	1	2	1	1	2	1	3	2	1
CO4	2	2	1	1	1	1	1	2	1	1	2	1	2	1	1
CO5	3	2	1	1	1	1	1	2	1	1	2	1	3	1	1

PC12: ANALYSIS OF AEROSPACE STRUCTURES

L	T	P	S	J	Letter
3	0	0	0	0	3

Preamble:

This course is intended to give a insight knowledge on thin walled beams used in aerospace vehicles. Student will gain knowledge on the design of thin-walled beams and will be able to understand the behaviour of beams which undergo different loading conditions in aircrafts.

Course Objectives:

- Provide concepts on bending stresses and deflections for beams.
- Train to compute shear stresses and twist angles in torsion for solid sections, closed thin-walled sections and open thin-walled sections.
- Focus on the application of structural idealization for different aircraft structures.
- Impart skills to design structural joints used in aerospace domain.

UNIT I **10 hours**

Bending of Open and Closed Thin-Walled Beams: Symmetrical and unsymmetrical bending, resolution of bending moments, direct stress distribution, position of neutral axis, deflections due to bending and approximations for thin walled sections.

Learning Outcomes

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

- differentiate between bending of symmetrical and unsymmetrical sections (l1)
- estimate the stress distributions in thin walled sections (l3)
- estimate the deflections due to bending (l3)

UNIT II **10 hours**

Shear of Open and Closed Thin-Walled Beams: General stress, strain and displacement relationships for open and single-cell closed section thin-walled beams, shear of open section beams, shear center, shear of closed section beams.

Learning Outcomes:

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

- understand the concept of shear center in thin walled section beams (l1)
- estimate the shear in open and closed section beams (l3)
- derive the stress, strain and displacement relationships for open and single-cell closed section thin-walled beams (l4)

UNIT III **11 hours**

Torsion of Circular Shafts: Shafts, torsion of shafts, torsion equation, hollow circular shafts, torsional rigidity, power transmitted by the shaft, importance of angle of twist and shear stresses in shafts, shafts in series, shafts in parallel, comparison of solid and hollow shafts, combined bending and torsion.

Torsion of Beams: Torsion of closed section, displacements associated with Bredt-Batho shear flow, torsion of open section beams, warping of cross section, conditions for zero warping.

Learning Outcomes:
At the end of the unit, student will be able to

- understand the importance of angle of twist in beams (l1)
- understand the concept of combined bending and torsion (l1)
- estimate the displacements using bredt-batho theory (l3)
- understand the concept of warping (l1)

UNIT IV **10 hours**

Structural Idealization: Idealization of panel, effect of idealization on the analysis of open and closed section beams. Deflection of open and closed section beams.

Sizing Procedures: Preliminary sizing, production stress analysis, formal stress reports, load path and free body diagrams; Margin of safety and stiffness requirements.

Learning Outcomes:
At the end of the unit, student will be able to

- calculate the deflections in open and closed section beams using idealization (l3)
- do stress analysis and draw free body diagrams (l4)
- understand the importance of margin of safety in the structural aspect (l1)

UNIT V **9 hours**

Joints and Fittings: Introduction to bolted and riveted joints, standard parts, splices, eccentrically loaded connections, gusset joints, welded joints, bonded joints, lug analysis (bolt in shear), tension fittings (bolt in tension) and tension clips.

Learning Outcomes:
At the end of the unit, student will be able to

- importance of bolts and riveted joints in aircraft structures (l1)
- do shear analysis in joints (l3)
- understand and apply the concept of different joints (l3)

Course Outcomes:
At the end of the course the student will be able to:

- understand fundamental principles relating to the bending analysis of thin-walled structures (l1).
- compute stresses, deflections and shear centers in asymmetric beams in bending. (l3)
- analyze the circular and non circular sections subjected to torsion (l4)
- develop ability to size practical aerospace structures given representative loads (l4)
- analyze different types of joints (l3)

Text Book(s)

1. T. H. G., Megson, Aircraft Structures for Engineering Students, 5/e, Elsevier, 2013.
2. M. C. Niu, Airframe Stress Analysis and Sizing, 3/e, 2011.

References

1. D. J. Peery, Aircraft Structures, 2/e, Dover publications, 2012.
2. B. K. Donaldson, Analysis of Aircraft Structures: An Introduction, 2/e, Cambridge University Press, 2012.

3. D. William, E. Arnold, An Introduction to the Theory of Aircraft Structures, Elsevier, 2013.
4. J. Cutler, Understanding Aircraft Structures, 3/e, Aditya Books, 2002.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	1	0	1	2	2	1	2	3	2	1
CO2	3	2	1	1	1	1	0	1	2	2	1	2	3	2	1
CO3	3	2	1	1	1	1	0	1	2	2	1	2	3	2	1
CO4	2	2	1	1	1	1	0	1	2	2	1	2	3	2	1
CO5	3	2	1	1	1	1	0	1	2	2	1	2	3	2	1

PC13 :FLIGHT MECHANICS

L	T	P	S	J	Letter	P/F
3	0	0	0	0	3	

Preamble:

This course is designed for aerospace engineering students. It introduces the fundamentals of mechanics of flight. This course is designed to acquaint the learners with governing equations of motion of flight, flow physics during mission profile and stability of the aircraft.

Course Objectives

- To introduce the science of predicting and controlling the motion of flight that results from Aerodynamic forces and moments.
- To familiarize the students about the complete picture of atmosphere and its physical properties.
- To analyze the flow physics of high lift devices.
- To Introduce basic concepts of stability and control.
- To describe the main principles of aircraft motion and the governing equation.

UNIT I **8 hours**

Principles of Flight: Physical properties and structure of the atmosphere,international standard atmosphere, temperature, pressure and density variations with altitude, measurement of speed: true, indicated and equivalent air speed; Streamlined and bluff bodies, various types of drag in airplanes, drag polar, methods of drag reduction of airplanes,infinite vs finite wings, critical Mach number, drag divergence Mach number.

Learning Outcomes

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

- Learn the influence of atmosphere, airplane weight and airplane configuration on aircraft performance (l1)
- Apply basic aerodynamic principles to analyze the aerodynamic characteristics (l3)
- Understand aerodynamic and control forces acting on aircraft (l2)

UNIT II **9 hours**

Aircraft Performance in Level, Climbing and Gliding Flight: Straight and level flight, thrust required and available, power required and available, effect of altitude on thrust and power, conditions for minimum drag and minimum power required, gliding and climbing flight, maximum rate of climb, numericals, Breguet range and endurance equation for jet and propeller engine aircraft, effect of tail and head wind on range and endurance.

Learning Outcomes

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

- Learn airplane performance limitations such as airspeed, load factor (l1)
- Calculate and analyze airspeed-drag and power curve (l4)
- Calculate fuel consumption, flight range and endurance of an airplane (l3)

UNIT III **6 hours**

High Lift Devices: Introduction , trailing edge flap, plain flap, split flap,slotted flap, fowler flap, comparison of different types of flap, general comments on trailing edge flaps, leading edge slot, leading edge flap, boundary layer control, boundary layer blowing, boundary layer suction and jet flap.

Learning Outcomes

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

- Learn different types of high lift devices and their performance (l1)
- Understand the flow physics of flaps slats and slots (l2)

UNIT IV **8 hours**

Accelerating Flight: Take off and landing performance, turning performance, horizontal and vertical turn, pull up and pull down, control in a turn, maximum turn rate, numericals, V-n diagram.

Learning Outcomes

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

- Calculate and analyze the landing and take-off distance (**l4)**
- Understand the performance condition during turning flight **(l2)**
- Analyze velocity and load factor curve**(l3)**

UNITV **8 hours**

Introduction to Stability and Control: Introduction, static stability,dynamic stability, aircraft control, axes of reference and notation, longitudinal stability, wing alone, wing and horizontal tail, factors affecting tail contribution, neutral point and static margin.

Learning Outcomes

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

- Describe the influence of forces and moments on the static and dynamic stability of aircraft (l2)
- Apply the aircraft flight mechanics equations to analyze the flight stability performance of aircraft in different situations (l3)

Course Outcomes

After completion of the course the student will be able to

- Predict the influence of atmosphere and airplane configuration on aircraft performance.
- Understand the factors that influence aircraft design and limit aircraft performance.
- Apply knowledge of basic aerodynamics necessary for understanding mechanics of flight.
- Apply control system and maneuvering methodologies to solve flight control problems
- Identify limitations of the aircraft stability principles and equations as applied to aircraft.

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO 12	PSO 1	PSO2	PSO 3
CO1	3	3	1	1	1	1	1	1	1	1	1	1	3	2	1
CO2	2	2	2	1	1	1	1	1	1	1	1	1	2	2	2
CO3	2	2	1	1	1	1	1	1	0	1	1	1	2	2	2
CO4	2	2	2	1	1	1	1	1	1	1	0	1	2	2	2
CO5	3	2	1	1	1	1	1	1	0	1	1	1	2	1	3

Text Book(s)

1. J. D. Anderson, Introduction to Flight, 7/e, McGraw Hill, 2011.
2. E. L. Houghton, P. W. Carpenter, S. H. Collicott and D. T. Valentine, Aerodynamics for Engineering Students, 6/e , Elsevier, 2012.

References

1. L. J. Clancy, Aerodynamics, Shroff Publications, 2006.
2. J. J. Bertin and R. Cummings, Aerodynamics for Engineers, 6/e, Pearson, 2013.
3. A.W. Babister, Aircraft Stability and Response, Pergamon Press, 1980.
4. R. C. Nelson, Flight Stability and Automatic Control, 2/e, McGraw Hill, 1998.
5. M. V. Cook, Flight Dynamics Principles, 2/e, Elsevier Publications, 2012

PC14: AEROSPACE PROPULSION

L	T	P	S	J	Letter
3	0	0	0	0	3

Preamble

This course intends to train students on aspects connected to power plants that are used in rockets and missiles. It focuses mainly on the design of the rocket and thrust chamber. It as well projects different aspects connected with fuels, fuel systems and nozzle aerodynamics. Course find appealing and enhances interest on rocket power plant engineering

Course Objectives:

- Explain principles of the several types of rocket power plants.
- Impart knowledge on performance evaluation of different types of rocket engines.
- Familiarize concepts of turbo pump, feed systems, nozzle and thrust chamber.
- Facilitate basic design of different typical rocket engines.
- Provide exposure to a variety of fuels used across different rocket engines.

UNIT I **8 hours**

Elements of Rocket Propulsion: Introduction to rocketry, classification and applications of rocket propulsion, Newton laws, rocket equation for gravity and drag free condition, vehicle velocity, mass ratio, mass fraction. Multi-staging of rocket and strap on boosters. Exhaust velocity, thrust at sea level and vacuum, energy and efficiencies, total impulse, specific impulse, effect of propulsion system on vehicle performance.

Learning Outcomes

At the end of chapter student will be able to

- obtain basic understanding on principles of rocketry(L2)
- study and analysis the performance of various rockets(L3)
- show knowledge of orbits, launching of rockets, and related velocities(L4)
- exhibit skills of launch vehicle trajectory design and dynamics(L4)
- optimize payload design and vehicle mass distribution(L4)

UNIT II **9 hours**

Rocket Nozzle dynamics: Aerothermodynamics of nozzle, review of thermodynamic relations, mass flow rate, Isentropic flow through nozzle and different types of expansions, design parameters. Performance measures of chemical rocket nozzle - thrust coefficient, specific impulse, engine parameters, thrust chamber pressure, temperature, characteristic and jet exhaust velocity. Nozzle configuration: Cone and bell-shaped nozzles. Nozzle alignment

Learning Outcomes

At the end of chapter student will be able to

- understand significance of inclined rocket motion under influence of earth's gravity(L2)
- exercise strong command on various parameters guiding nozzle thrust(L4)
- distinguish working of nozzle for various expansions (L4
- attempt the design and detailing of rocket nozzle(L4)
- characterize performance of typical rocket nozzle (L5)

UNIT III **9 hours**

Solid Propellant Rocket Motor: Rocket motor and components, applications, classification of motors, **propellant burning rate**-effect of temperature, pressure and burn rate modifiers, erosive burning, basic performance relations. **Grain -** propellant grain and grain configurations, grain stress and strain. **Propellants:** Solid propellants, classification, propellant characteristic, propellant ingredients, and hazards. **Other propellants -** gas generator, smoke, smokeless and igniter propellants

Learning Outcomes

At the end of chapter student will be able to

- appreciate working of solid rocket motor(L2)
- understand combustion of grain and sensitivity associated ballistics (L1)
- analyze suitability of propellant pertaining to a mission(L4)
- gain knowledge on different types of rocket motors, solid propellants, and grain design(L2)
- study the working of Solid propellant combustor (L3)

UNIT IV **10 hours**

Liquid Rocket Engines: Liquid rocket engines, propellants, **propellant feed systems** – gas and pressure feed, propellant tanks, tank pressurization, flow and pressure balance, **Liquid engines** – RCS & OMS. **Propellants:** Propellant properties, liquid oxidizers, liquid fuels, monopropellants, gaseous propellants, **Thrust chamber:** Injector, combustion chamber, and Combustion of liquid propellants.

Learning Outcomes

At the end of chapter student will be able to

- differentiate the working of solid and liquid rocket engines(L5)
- exhibit strong knowledge on various liquid engines and different fuels used(L3)
- exercise choice of feed systems, propellants, and structural materials suiting to specific need(L4)
- gain knowledge on combinations and combustion of various liquid propellants(L2)
- assess the significance of different subsystems of thrusters(L6)

UNIT V **12 hours**

Combustion Instabilities: Introduction to instabilities, Modes of instabilities: constant, increasing, and decaying amplitude, bulk mode in liquid engines, suppression, and control of instability.

Electric propulsion systems: Electro-thermal: resisto jet and arc jet, magneto plasma dynamic (MPD) electric thruster, Electro-static types of Ion, hall, field emission thrusters

Learning Outcomes

At the end of chapter student will be able to

- gain basic understanding of causes for combustion related vibrations(L2)
- exhibit the knowledge of various combustion instabilities(L4)
- assess systems ability to control and suppress the instability (L6)
- show strong understanding on using electric energy source for thrusting devices(L4)
- appreciate the beauty and significance of these advanced electric propulsion concepts (L2)

Course Outcomes

At the end of course student will be able to

- Develops knowledge on working of rockets, missiles and space crafts (L6)
- Exhibit desire to design and develop solid motor rockets systems(L4)
- Exercises better choice across different engines and propellants(L3)
- Understand, interpret and assess the performance of different rocket systems combustion instabilities(L2)
- Appreciate the availability and usage of alternate advanced propulsion concepts(L5)

Text Book(s)

1. G. P. Sutton and D. M. Ross, Rocket Propulsion Elements, 8/e, John Wiley, 2010.
2. M. J. L. Turner, Rocket and Spacecraft Propulsion, 3/e, Springer Praxis, 2008

References

1. H. S. Mukunda, Understanding Aerospace Chemical Propulsion, 1/e, Interline Publishing, 2004.
2. K. Ramamurthi, Rocket Propulsion, 2/e, Mach Millan, 2012.
3. H. G. Ang, P. Sreekumar, High Energetic Polymers, 1/e, Wiley, 2011.
4. Champak Jyoti Bora, Fundamentals of Rocket and Spacecraft Propulsion, 1/e, Lulu Publications, 2014.
5. Kubota, Propellants and Explosives: Thermo Chemical Aspects of combustion, 2/e, Wiley, 2008

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	2	2	1	1	1	2	1	2	2	1
CO2	2	1	3	2	1	2	2	1	2	1	1	1	2	2	1
CO3	2	2	2	1	1	2	1	1	1	1	2	1	2	1	1
CO4	2	2	1	1	1	1	2	1	2	1	2	1	2	1	1
CO5	2	1	1	1	1	2	2	1	1	1	1	1	1	1	1

PC15: COMPUTATIONAL METHODS

L	T	P	S	J	Letter	P/F
3	0	3	0	0	4.5	

Preamble:

This course is designed for Aerospace Engineering undergraduate students. It is designed for the students for the basic understanding of techniques for numerical solution of algebraic equations, differentiation, integration used to solve aerospace 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 exercises for code development:
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 2nd and 4th 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.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	2	1	1	1	1	1	1	3	2	1
CO2	3	3	2	2	2	1	1	1	1	1	1	1	3	2	1
CO3	3	3	2	3	2	1	1	1	1	1	1	1	3	2	1
CO4	3	3	2	3	3	1	1	1	1	1	2	2	3	2	1
CO5	3	3	2	3	3	1	1	1	1	1	2	2	3	2	1

PC 16- Design Practice for Aerospace Engineering

L	T	P	S	J	Letter	P/F
2	0	2	0	0	3	

This course is designed for aerospace engineering students. It introduces the basic principles of aircraft design practice.

Course Objectives:

- Familiarize students with the important issues and methodologies of aircraft design.
- Instruct the process of aircraft synthesis as an outcome of the integration of the disciplines of aerodynamics, performance, stability and control, propulsion, structures and aero elasticity.
- Provide the ability to function as a member of a team in a design setting; including the ability to conduct a peer review of the other team members.
- Impart the students with Federal Aviation Regulations as a means for ensuring passenger safety.
- Explain enhance and develop technical design skills.

UNIT I

7 hours

Design Preliminaries: Aircraft design requirements, specifications, androle of users, aerodynamic and structural consideration, and importance of weight. Classification of airplanes, special features of modern airplane, air loads in flight.

Learning Outcomes

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

- Complete conceptual design of different types of aircraft. (l2)
- Choose the required decisions during the total design cycle of an aircraft including conceptual, preliminary and detail design. (l2)
- Discuss performance and stability analysis of different types of aircraft. (l3)

UNIT II

7 hours

Airplane Weight Estimation: Weight estimation based on type of airplane,trends in wing loading, weight-estimation based on mission requirements, iterative approach. Basics of wing design: selection of airfoil selection, influencing factors.

Learning Outcomes

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

- Explain the hierarchical models in aircraft design as a multi-disciplinary design objective and utilize a system approach to design and operational performance; (l2)
- Discuss the design phases of an aircraft; (l2)
- Calculate total weight and weight fractures of an aircraft(l3)
- Understand the wing design and calculations. (l3)

UNIT III

8hours

Fuselage and Empennage design: Volume considerations, aerodynamic considerations, drag estimation, spread sheet for fuselage design. Horizontal and vertical tail design: tail arrangement, horizontal and vertical tail sizing, tail plan form shape, airfoil section type, tail placement, spread sheet for tail design.Learning Outcomes

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

- Evaluate sensitivity analysis of design parameters (l2)
- Perform and understand sizing of an aircraft(l3)
- Explain layout design of different aircraft (l2)

UNIT IV

7 hours

Landing Gears: Different kinds of landing gears and associate darrangement for civil and military airplanes. Preliminary calculations for locating main and nose landing gears, landing gear arrangements, tire sizing, shock absorbers, castoring, wheel geometry, gear-retraction geometry, seaplanes and subsystems. Landing gear design and integration.

Learning Outcomes

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

- Preliminary calculations for position and location of landing gear (l2)
- Landing gear sizing and disposition (l2)
- Sizing to takeoff distance requirements (l4)
- Sizing to landing distance requirements (l3)
- Geometry of landing gear system or wheel geometry(l4)

UNIT V

6 hours

Engine selection

Propulsion selection, number of engines, Engine ratings, turbojet engine sizing, propulsion system.

Learning Outcomes

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

- Understand fundamentals of aircraft engine configuration selection. (l3)
- Know how to choose engine/s and locate them. (l3)
- Understand the propulsion design system. (l2)

Course Outcomes:

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

- Explain the design requirements for an aircraft based on fundamental principles and statistical data.
- Evaluate the design specifications and discuss an aircraft design to meet the necessary requirements
- Apply engineering knowledge and applied skills to a design problem
- Analyze design issues considering aerodynamics, propulsion, structure, weights, stability, cost, and performance
- Design to a specified mission and generate a layout.

List of Experiments:

1. Comparative configuration study of different types of airplanes
2. Comparative study on specification and performance details of aircraft
3. Preliminary weight estimations, selection of main parameters,
4. Power plant selection, aerofoil selection, wing tail and control surfaces
5. Preparation of layouts of balance diagram and three view drawings
6. Aircraft conceptual sketch and its gross weight estimation algorithm
7. V- n diagram for the design study
8. Gust and maneuverability envelopes
9. Preliminary weight estimation (rubber sizing)
10. Load or induced drag estimation
11. Airfoil and geometry selection, determination of thrust to weight ratio, wing loading.
12. Balancing and maneuvering loads on tail plane, aileron and rudder loads.

Text Book(s)

1. D. P. Raymer, Aircraft Design: A conceptual approach, 5/e, AIAA 2013.
2. T. D. Stinton, The Design of Airplane, 2/e, AIAA, 2001.
3. J. D. Anderson,, Airplane Performance and Design, International Edition, Tata McGraw Hill, 1999.

References

1. L. M. Nicolai, G. E. Carichner, Fundamentals of Aircraft and Airship Design, AIAA Education Series, 2010.
2. J. Bertin, Aerodynamics for Engineers, 4/e, Pearson Education, 2002.
3. E. E. Scheler and L.G. Dunn, Airplane Structural Analysis and Design, John Wiley and Sons, 1963.

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO3
CO1	3	1	3	1	1	1	1	1	1	1	1	1	3	1	1
CO2	2	2	2	2	1	1	1	1	1	1	1	1	2	1	1
CO3	3	1	2	2	1	1	1	1	1	1	1	1	3	1	1
CO4	2	2	2	2	1	1	1	1	1	1	1	1	2	1	1
CO5	2	1	2	1	1	1	1	1	2	1	1	1	2	1	1

PE1: COMPUTATIONAL AERODYNAMICS

L	T	P	S	J	Letter	P/F
3	0	0	0	0	3	

Preamble:

This course is give introduction to computational fluid dynamics and applications of CFD in various branches of engineering along with emphasis on finite difference approach in solving Navier-Stokes equations in solving different flow field problems.

Course objectives:

To make the student to:

1. understand the forms of governing equations of fluid flow particularly best suited for CFD.
2. classify the given system of partial differential equations and find the characteristics.
3. understand basic aspects of finite difference and finite volume discretization.
4. understand the various types of grid generation methods.
5. understand various numerical schemes used in solving incompressible as well as compressible flow problems

UNIT I **7 hours**

Introduction: Applications of CFD in various branches of Engineering, models of fluid flow: finite control volume and infinitesimal fluid element.

Governing Equations and Physical Boundary Conditions: Derivation of continuity, momentum and energy equations, physical boundary conditions, significance of conservation and non-conservation forms and their implication on CFD applications - strong and weak conservation forms

- shock capturing and shock fitting approaches.

UNIT II **7 hours**

Mathematical Behavior of Partial Differential Equations and Their Impact on Computational Fluid Dynamics: Classification of quasi-linear partial differential equations by Cramer's rule and Eigen value method; General behavior of different classes of partial differential equations and their importance in understanding physical and CFD aspects of aerodynamic problems at different Mach numbers involving hyperbolic, parabolic and elliptic equations; Domain of dependence and range of

influence for hyperbolic equations - wellposed problems.

UNIT III **12 hours**

Basic Aspects of Discretization: Introduction to finite differences, finite difference approximation for first order, second order and mixed derivatives. Difference equations: explicit and implicit approaches, truncation and round-off errors, consistency, stability, accuracy, convergence, efficiency of numerical solutions; Von-Neumann stability analysis and physical significance of CFL stability condition.

Finite Volume Methods: Basis of finite volume method, conditions on the finite volume selections, cell-centered and cell-vertex approaches, definition of finite volume discretization, general formulation of a numerical scheme, two-dimensional finite volume methods with example.

UNIT IV **10 hours**

CFD Technique's: Lax-Fredrich's technique, Lax-Wendroff technique, Mac Cormack's technique, Crank Nicholson technique, Relaxation technique, ADI technique, aspects of numerical dissipation and dispersion. Pressure correction technique: application to incompressible viscous flow; Need for staggered grid. Numerical procedures: SIMPLE, SIMPLER algorithms, boundary conditions for pressure correction method.

UNIT V **7 hours**

Grid Types and Characteristics: Need for grid generation, structured grids, cartesian grids, stretched (compressed) grids, body fitted structured grids, H-mesh, C-mesh, O-mesh, I-mesh, multi block grids, C-H mesh, H-O-H mesh, overset grids, adaptive grids. Unstructured grids, triangular cells, tetrahedral cells, hybrid grids, quadrilateral cells and hexahedra cells.

Text Book(s)

1. J. D. Anderson, Computational Fluid Dynamics: The Basics with Applications, 1/e, McGraw Hill, 2012.
2. R. H. Pletcher , J. C. Tannehill , D. A. Anderson, Computational Fluid Mechanics and Heat Transfer, 3/e, Taylor and Francis, 2011.

References

1. S. V. Patankar, Numerical Heat Transfer and Fluid Flow, 1/e, ANE Books, 1980.
2. C. Hirsch, Numerical Computation of Internal and External Flows: Fundamentals of Computational Fluid Dynamics, 2/e, Elsevier, 2007.
3. H. K. Versteeg, and W. Malalasekra, An Introduction to Computational Fluid Dynamics: The Finite Volume Method, 2/e, Pearson Education, 2010.
4. K. Muralidhar, and T. Sundararajan, Computational Fluid Flow and Heat Transfer, Narosa Publishing House, 1995.
5. T. K. Bose, Computation Fluid Dynamics, Wiley Eastern Limited, 1988.

<u>Course Outcomes (CO):</u>

Students will be able to

1. identify the type of any partial differential equation whether it is parabolic, elliptic and hyperbolic.
2. write the canonical form of solution using the characteristics.
3. write the difference equations of the given partial differential equation.
4. formulate the finite difference and finite volume discretization for a given problem.
5. find the stability restrictions and convergence of a given numerical scheme.
6. identify the type of grid to be selected for a particular flow problem.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	3	2	1	1	1	1	1	1	1	3	3	2
CO2	3	3	2	2	2	1	1	1	1	1	1	1	3	2	1
CO3	3	3	3	3	3	1	1	1	1	1	2	2	3	3	2
CO4	3	3	2	1	1	1	1	1	1	1	2	2	3	2	1
CO5	3	3	3	1	1	1	1	1	1	1	2	2	3	2	1

PE2: WIND TUNNEL TECHNIQUES

L	T	P	S	J	Letter	P/F
3	0	0	0	0	0	

Preamble: This course is designed for Aerospace Engineering undergraduate students. This course aims to introduce fundamental aspects of wind tunnel testing.

Course Objectives:

- Introduce different types of wind tunnels.
- Acquaint different pressure, velocity and force measurement techniques.
- Familiarize different aspects of wind tunnel calibration.
- Acquaint different flow visualization techniques.
- Familiarize different aspects in testing of aircraft and its various components.

UNIT I **8 hours**

Wind Tunnels Testing: Review of dimensional analysis, similitude, classification of wind tunnels and testing, different flow regime testing - subsonic, transonic, supersonic and hypersonic speed regions, layouts: sizing and design parameters.

Learning Outcomes

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

- Classify wind tunnels based on the path followed by air and the maximum speed, (L1).
- Discuss the advantages and limitations of open return and closed return wind tunnels (L2).
- Illustrate and explain the general layout of different types of wind tunnels (L2).
- Describe the basic aspects of wind tunnel design (L2).

UNIT II **9 hours**

Wind Tunnel Measurements: Pressure and velocity measurements, force measurements, three component and six component balances, internal balances.

Learning Outcomes

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

- List different ways of measuring pressure and velocity in a wind tunnel and explain the principle behind them (L2).
- Explain the basic principle behind three-component and six-component balances (L2).
- Classify and explain different types of external balances (L2).
- Explain the working of an internal balance (L2).

UNIT III **8 hours**

Calibration of Wind Tunnels: Test section speed, horizontal buoyancy, flow angularities, turbulence measurements, associated instrumentation, and calibration of supersonic tunnels.

Learning Outcomes

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

- Discuss important parameters that need to be considered during the calibration of the wind tunnel (L2).
- Classify different types of turbulence measurements (L3)
- Discuss and understand the calibration of supersonic wind tunnels(L2)

UNIT IV **9 hours**

Flow Visualization: Smoke and tuft grid techniques, dye injection special techniques, optical methods of flow visualization.
Non-Intrusive Flow Diagnostics: Laser-doppler anemometry, particle image velocimetry, laser induced fluorescence.

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

- Describe various intrusive and non-intrusive techniques used for visualizing flow in a wind tunnel (L2).
- Discuss the advantages and limitations of different visualization techniques (L2).
- Identify the various non-intrusive flow diagnostics

UNIT V **9 hours**
Aircraft and Component Testing: General test procedures, components, complete configuration, power effects, propeller aircraft, jet aircraft and V/STOL vehicles.

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

- Describe the general test procedure of an aircraft and its various components (L2).
- Discuss important parameters that are evaluated when testing the aircraft and its various components (L2).
- Determine aerodynamic characteristics given appropriate information (L3).

Course Outcomes:
After the completion of this course the student will be able to

- Classify and explain different types of wind tunnels and its components.
- Explain the principle behind the different techniques used for measuring pressure, velocity and force in a wind tunnel.
- Explain the various parameters that need to be considered during the calibration of the wind tunnel.
- Explain the principle behind the different intrusive and non-intrusive flow visualization techniques used in wind tunnels.
- Explain the general test procedure of an aircraft and its various components.

Text Book(s)

1. A. Pope and L Goin, High Speed Wind Tunnel Testing, John Wiley, 1985.
2. J. B. Barlow, W. H. Rae, A. Pope, Low Speed wind Tunnel Testing, 3/e, John Wiley, 2010.

References

1. E. Rathakrishnan, Instrumentation, Measurements, and Experiments in Fluids, CRC Press, 2007.
2. Bradsaw "Experimental Fluid Mechanics", Pergamon Press, 2nd Revised edition,1970, ISBN-13: 978-0080069814
3. Short term course on Flow visualization techniques, NAL, 2009
4. Lecture course on Advanced Flow diagnostic techniques 17-19 September 2008 NAL, Bangalore

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	1	1	1	1	1	1	1	1	1	2	1	1
CO2	3	2	1	1	2	1	1	1	1	1	1	1	2	1	1
CO3	2	1	1	1	1			1	1	1	1	1	2	1	1
CO4	3	2	1	1	2	1	1	1	1	1	1	1	2	1	1
CO5	3	1	1	1	1	1	1	1	1	1	1	1	2	1	1

PE3: BOUNDARY LAYER THEORY

L	T	P	S	J	Letter	P/F
3	0	0	0	0	3	

Preamble:

This course is designed for Aerospace Engineering undergraduate students. This course aims to introduce and explain the fundamental concepts of laminar and turbulent boundary layers.

Course Objectives:

- Provide an insight into development of boundary layer in various flow situations.
- Introduce Navier-Stokes equations and some of its exact solutions.
- Familiarize governing equations of laminar and turbulent flows.
- Familiarize exact and approximate methods to solve laminar boundary layer equations.
- Acquaint the basic concepts of compressible boundary layer.

UNIT I **8 hours**

Introduction: Description of flow along a solid surface, development of boundary layer along a flat plate, different measures of boundary layer thickness, boundary layer with pressure gradient, flow separation, boundary layer at inlet of pipe, flow through diffuser, flow over symmetrical and bluff bodies, form drag and skin friction drag, dependence of drag coefficient on Reynolds number.

Learning Outcomes

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

- Illustrate And Describe The Development Of Boundary Layers In Various Internal And External Flow Situations (L2).
- Discuss The Characteristics Of Laminar, Transitional And Turbulent Boundary Layer (L2).
- Describe Different Measures Of Boundary Layer Thickness (L2).
- Explain The Reason For Boundary Layer Separation (L2).
- Discuss The Effect Of Pressure Gradient On The Boundary Layer (L2).
- Explain The Variation Of Drag Coefficient With Reynolds Number Over Bodies Of Practical Interest Such As Flat Plate, Airfoil, Cylinder, And Sphere (L2).

UNIT II **10 hours**

Navier-Stokes Equation: Relation between stress and strain system in a solid body (Hooke's law), relation between stress and strain rate system in liquids and gases (Stokes law), Navier-Stokes equations - general properties of Navier-Stokes equation.

Exact Solution of Navier-Stokes Equation: Two-dimensional flowthrough a straight channel, Hagen-Poiseuille flow, suddenly accelerated plane wall, flow near a rotating disk, and parallel flow past a sphere.

Learning Outcomes

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

- Explain Stoke's Hypothesis (L2).
- Write Navier-Stokes Equation (L1).
- Interpret The Physical Meaning Of Various Terms In Navier-Stokes Equation (L2).
- Describe The General Properties Of Navier-Stokes Equation (L2).
- Apply Navier-Stokes Equation To Analyse Various Internal And External Flows (L3).

UNIT III **12 hours**

Laminar Boundary Layer: Simplified form of boundary layer equations, Blasius solution for flat plate, thermal boundary layer over an isothermal plate, Falkner-Skan wedge flow, momentum and energy integral equations for the boundary layers, one parameter integral methods: Pohlhausen method and Thwaites method. Application of integral methods to flow past a flat plate and a circular cylinder.

Learning Outcomes

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

- Write The Governing Equations Of Mass, Momentum And Energy Within The Boundary Layer (L1).
- List The Assumptions Made In Deriving The Governing Equations Of Boundary Layer (L1).
- Develop A Similarity Solution For Velocity And Thermal Boundary Layer Over A Flat Plate (L3).
- Discuss Falkner-Skan Similarity Solutions (L2).
- Write The Energy And Momentum Integral Equations Of The Laminar Boundary Layer (L1).
- Compare Exact And Approximate Solutions In Case Of A Flat Plate And Cylinder (L2).
- Estimate Boundary Layer Thickness, Skin Friction And Heat Transfer Rates Given Appropriate Information (L3).

UNIT IV **10 hours**

Turbulent Boundary Layer: Two-dimensional turbulent boundary layer equations, eddy viscosity, integral relations, turbulent boundary layer on a flat plate, velocity profiles: law of the wall, logarithmic law and law of the wake, turbulent flow in pipes and channels.

Learning Outcomes

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

- Explain The Concept Of Reynolds Decomposition (L2).
- Write Reynolds Averaged Equations Of Motion (L1).
- Explain The Physical Meaning Of Different Terms In Reynolds Averaged Equations (L2).
- Modify Reynolds Averaged Equations To Obtain Boundary Layer Equations (L3).
- Discuss Differences Between Laminar And Turbulent Boundary Layer Equations (L2).
- Explain Why The Average Product Of Velocity Fluctuations Is Not Zero (L2).
- Explain The Concept Of Eddy Viscosity (L2).
- Compare The Integral Relations Of Laminar And Turbulent Boundary Layer (L2).
- Classify And Explain The Characteristics Of Different Regions In Turbulent Boundary Layer (L2).
- Compare The Turbulent Velocity Profiles In Pipes, Channels And Flat Plate (L2).
- Estimate Skin Friction Given Appropriate Information (L3).

UNIT V **6 hours**

Compressible Boundary Layer: Compressible boundary layer equation, recovery factor, similarity solutions, laminar supersonic cone rule and shock-boundary layer interaction.

Learning Outcomes

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

- Discuss Differences Between Governing Equations Of Incompressible And Compressible Laminar Boundary Layer (L2).
- Write And Explain Crocco Busemann Relations (L1).
- Develop Similarity Solution For Compressible Laminar Flow Using Illingworth Transformation For A Flat Plate And Stagnation Point Flow (L3).
- Describe Supersonic Cone Rule For Laminar Compressible Flow (L2).
- Discuss Interaction Of Shock Waves With A Laminar Boundary Layer On A Flat Plate (L2).

Course Outcomes:

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

- Illustrate And Explain The Development Of Boundary Layer In Various Flow Situations.
- Apply Navier-Stokes Equation To Analyse Various Internal And External Flow Problems.
- Develop Similarity Solutions For Velocity And Thermal Boundary Layer Over A Flat Plate And Also Apply Integral Methods.
- Explain The Differences Between The Governing Equations Of Laminar And Turbulent Boundary Layers And Also Compare The Velocity Profiles In Pipes, Channel And Flat Plate In These Flows.
- Explain The Differences Between The Governing Equation Of Compressible And Incompressible Boundary Layer And The Interaction Of A Shock Wave With The Boundary Layer.

Text Book(s)

1. H. Schlichting, Boundary Layer Theory, 7/e., McGraw-Hill, 1979.
2. F. M. White, Viscous Fluid Flow, 2/e, McGraw Hill, New York, 1991.

References

1. A. J. Reynolds, Turbulent Flows in Engineering, John Wiley, 1980.
2. R. L. Panton., Incompressible Flow, John Wiley, 1984.
3. L. Rosenhead., Laminar boundary layers, Dover Publications, 1963.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	1	1	1	1	1	1	1	3	1	1
CO2	3	2	1	1	1	1	1	1	1	1	1	1	3	1	1
CO3	3	2	1	1	1	1	1	1	1	1	1	1	3	1	1
CO4	3	2	1	1	1	1	1	1	1	1	1	1	3	1	1
CO5	3	2	1	1	1	1	1	1	1	1	1	1	3	1	1

PE4: INDUSTRIAL AERODYNAMICS

L	T	P	S	J	Letter
3	0	0	0	0	3

Preamble:

This course is intended for graduate students in the area of fluid dynamics, wind engineering, and Aerodynamics

Course Objectives:

- Familiarize the learner with non-aeronautical uses of aerodynamics such as road vehicle, building aerodynamics and problems of flow induced vibrations
- Impart this course offers an introduction to industrial aerodynamics and wind engineering with the main characteristics of natural winds.
- Support the characteristics of velocity profiles and atmospheric turbulence are described along with the effects of upstream exposure.
- Develop wind speed and turbulence models for inhomogeneous upstream exposures are presented in comparison with atmospheric measurements and wind-tunnel simulations.
- Explain basic elements of wind-building interaction in the time-averaged mode for uniform and boundary layer flows are described, external and internal pressures and forces on buildings with emphasis on design significance are discussed.

UNIT I **8 hours**

Atmospheric Boundary Layer: Atmospheric circulation, local winds, terrain types, mean velocity profiles, power law and logarithm law. Wind speeds, turbulence profiles, roughness parameters and simulation techniques in wind tunnels.

Learning Outcomes:

At the end of the unit, the learners will be able to

- Basic understanding of the wind environment in atmosphere and flow structure in the atmospheric boundary layer. (l2)
- Understand the parameters of wind speeds (l2)
- Understand the simulation techniques in wind tunnels (l3)

UNIT II **9 hours**

Wind Energy Collectors: Horizontal and vertical axis machines, energy density of different rotors, power coefficient, Betz coefficient by momentum theory.

Learning Outcomes:

At the end of the unit, the learners will be able to:

- Gain knowledge on wing energy collectors like wind turbine machines. (l2)
- Comprehend the energy and energy types. (l2)
- Understand the production of electricity from wind energy. (l2)

UNIT III **9 hours**

Bluff Body Aerodynamics: Boundary layers and separation, two dimensional wake and vortex formation. Strouhal and Reynolds number, separation and reattachments, power requirements and drag coefficients of automobiles, effects of cut back angle, aerodynamics of trains.

Learning Outcomes:

At the end of the unit, the learners will be able to:

- Understand and describe bluff body aerodynamics (l2)
- Understand the difference in aerodynamics of streamlined and bluff objects (l3)
- Understand the effect of reynolds number on bluff body aerodynamics (l2)
- Explain how vortex shedding occurs and the effect it may have on structures. (l3)

UNIT IV **8 hours**

Building Aerodynamics: Pressure distribution on low rise buildings, wind forces on buildings, environmental winds in city blocks and special problems of tall buildings. Basic information about the wind flow around isolated buildings and generic building groups.

Learning Outcomes:

At the end of the unit, the learners will be able to:

- Basic knowledge how to solve problems on wind loading of structures, crosswinds (l2)
- Understand the wind forces on buildings (l2)
- Understand how to write building codes and ventilation process(l3)
- Learn the process of architectural aerodynamics. (l3)

UNIT V **7 hours**

Flow Induced Vibrations: Effect of Reynolds number on wake formation of bluff shapes, vortex induced vibrations, vortex shedding, galloping - wind galloping of circular cables, oscillation of tall structure and launch vehicles under wind loads and stall flutter.

Learning Outcomes:

At the end of the unit, the learners will be able to:

- Solve the problems and able to analyze vibrations during flow. (l3)
- Classify the mechanisms for flow-induced vibration and explain the qualitative (l2) differences between these mechanisms (l2)
- Explain the problems that coupling with a fluid (both quiescent and flowing) can pose for structural mechanics (l3)

Course Outcomes:

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

- To understand the concepts of industrial aerodynamics and wind engineering with the main characteristics of natural winds.(l2)
- To impart knowledge of external and internal pressures and forces on buildings and vehicles with emphasis on design significance (l3)
- use of aerodynamics for non- aerodynamics such as vehicle building.(l2)
- Solve the problems and be able to analyze vibrations during flow.(l3)
- Apply the problems on effect of Reynolds number on wake formations (l3)

Text Book(s)

1. M. Sovran, Aerodynamics and Drag Mechanisms of Bluff Bodies and Road Vehicles, Plenum press, 1978.
2. P. Sachs, Winds Forces in Engineering, Pergamon Press, 1978
3. R. D. Blevins, Flow Induced Vibrations, Van Nostrand, 1990.

References

1. R. S. Scorer, Environmental Aerodynamics, Ellis Harwood, 1978.
2. R. McAllen, F. Browand, J. Rose, The Aerodynamics of Heavy Vehicles: Trucks, Buses and Trains, Springer Berlin, 2004.
3. R. D. Blevins, Flow Induced Vibrations, Van Nostrand, 1990.
4. N. G. Calvert, Wind Power Principle, Charles Griffin and Co, 1997.

CO PO PSO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	1	1	1	1	1	2	1	2	1	2
CO2	2	3	1	1	1	1	1	1	1	1	1	1	3	1	1
CO3	3	2	1	1	1	1	1	1	1	1	2	1	2	1	2
CO4	2	3	1	1	1	1	1	1	1	1	2	1	2	1	1
CO5	3	2	1	1	1	1	1	1	1	1	1	1	1	1	2

PE5: FLAPPING WING AERODYNAMICS

L	T	P	S	J	Letter	P/F
3	0	0	0	0	3	

Preamble:

This course is designed for aerospace engineering students. It introduces about the fundamentals flapping wing aerodynamics. This course is designed to acquaint the learners with aerodynamics of birds, insect and low Reynolds number flyer which is useful for understanding the mechanism of Bio- inspired MAVs and UAVs.

Course Objectives

- To impart the various aspects of aerodynamics of natural flyers such as birds, bat, and micro aerial vehicle.
- To familiarize the role of structural flexibility of low Reynolds number wing aerodynamics.
- To acquaint the flight stability for flapping wing and also the passive control.
- To exhibit the insight into low Reynolds number flight science while providing guidelines for vehicle development

UNIT I **6 hours**

Introduction: Flapping flight in nature, scaling, geometrical similarity,wing span, wing area, wing loading, aspect ratio, wing - beat frequency. Mechanics of gliding, forward and hovering flight - gliding and soaring, powered flight flapping - power implication of flapping wings.

Learning Outcomes

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

- Apply flow similarity, non-dimensional coefficients such as the lift and drag coefficient, and non-dimensional parameters such as Reynolds number in aerodynamic modeling of flapping wings (L3)
- Contribute substantially as an individual to the design and execution of a computational and experimental aerodynamic analysis of flapping wings (L4)

UNIT II **8 hours**

Rigid Fixed-Wing Aerodynamics: Laminar separation and transition to turbulence - Navier-Stokes equation and the transition model, factors effecting low Reynolds number aerodynamics, 3D wing aerodynamics.

Learning Outcomes

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

- Differentiate the characteristics of rigid fixed and flexible wing (L4)
- Understand the unsteady aerodynamics of flexible 3-d wings (L2)
- Understand the behaviour of the low Reynolds number flyer (L1)

UNIT III **8 hours**

Rigid Flapping Wing Aerodynamics: Flapping wing and body kinematics,governing equations and non-dimensional parameters - Reynolds number, Strouhal number and reduced frequency. Unsteady aerodynamics mechanism in flapping wings - leading edge vortices, wake capture, tip vortices, clap and fling mechanism.

Learning Outcomes

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

- Understand the rigid wing aerodynamics (L2)
- Analyze the flow physics of flapping wing mavs (L4)
- Make use of different non dimensional performance parameter for low Reynolds number flyers (L3)

UNIT IV **8 hours**

Flow Physics at Low Reynolds Numbers: Flow physics at in 'O' regime, effects of kinematics on hovering airfoil performance, effects of wing gust on hovering aerodynamics. Flow around a flat plate in shallow and deep stall, airfoil shape effects; force prediction for pitching and plunging.

Learning Outcomes

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

- Differentiate the aerodynamic flow behavior of rigid, flexible and hovering wings(L4)
- Classify the scaling and aerodynamic models for low Reynolds number flyers (L3)
- Differentiate between pitching , plunging and gliding mode of natural flyers (L3)

UNIT V

8 hours

Flexible Wing Aerodynamics: Introduction, governing equations for wing structures, linear membrane model, hyperelastic membrane model, flat plate and shell models, flapping flexible wings, non-dimensional wing tip deformation parameters, scaling and lift generation of hovering flexible wing of insect size, power input efficiency.

Learning Outcomes

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

- Understand the governing equations of motion for different flexible wing model (L2)
- Categorize the plunging and pitching motion of the insects (L3)
- Calculate the efficiency and power input of flexible wing birds (L4)

Course Outcomes:

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

- Apply the knowledge of low Reynolds number for natural flyer and manmade flyer.
- Demonstrate the aerodynamics of fixed, rigid and flapping wings
- Analyze the implications of laminar-turbulent transition, multiple time scale,
- Exhibit aerofoil shapes and Time-dependent structural and fluid dynamics of flapping wing body.
- Differentiate the aerodynamic flow behavior of rigid, flexible and hovering wings

Text Book(s)

1. W. Shyy, H. Aono, C. K. Kang, H. Liu, An Introduction to Flapping Wing Aerodynamics, Cambridge University Press, 2015.

References

1. Muller and Thomas, Fixed and Flapping Wing Aerodynamics for Micro Air Vehicle Applications, AIAA, 2002.
2. J. E. Toomey, Proquest, Numerical and Experimental Studies of flexibility in Flapping Wing Aerodynamics, Umi Dissertation Publishing, 2011.
3. Wei Shyy, YongshengLian,Jian Tang, Dragos vileru,HaoLiu,Aerosynamics of low reynold number flyers, Cambridge Aerospace Series, 2008

CO PO PSO MAPPING

	P O 1	P O 2	P O 3	P O 4	P O 5	P O 6	PO 7	P O 8	P O 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	2	1	1	1	1	1	1	1	1	2	1	3	1	2
CO2	3	2	1	1	1	1	1	1	1	1	2	1	2	1	2
CO3	2	2	1	1	1	1		1	1	1	1	1	3	1	1
CO4	2	2	1	1	1	1	1	1	1	1	2	1	2	1	2
CO5	2	2	1	1	1	1	1	1	1	1	1	1	2	1	1

PE6: EXPERIMENTAL TECHNIQUES

L	T	P	S	J	Letter
3	0	0	0	0	3

Preamble: This course is designed for Aerospace Engineering undergraduate students. It is designed for the students to understand the basics principles of Measurements, Instrumentation and Experimental Methods of Stress Analysis. Understanding these principles will help them in the Design, Analysis and Testing of Aerospace Structures.

Course Objectives:

- To explain different principles of measurement.
- To familiarize various instruments required for measurement
- To focus on electrical resistance strain gauges
- To impart knowledge on optical methods for stress analysis
- To help the students to understand Non-destructive testing techniques.

UNIT I **9 hours**

Measurements and Extensometers: Principles of measurements, accuracy, sensitivity and range of measurements, extensometers – type sand uses of acoustic, mechanical, electrical, electronic, optical and laser,basic electrical components, Kirchhoff 's circuit laws, resistance

thermometers, thermocouples, dynamic response of temperature sensors, flow velocity, flow rates in closed systems by pressure variation measurements.

Learning Outcomes:

After completion of this unit student will be able to

- classify the types of measurement (L2)
- explain the function of basic electrical components involved in measurement (L2)
- summarize the temperature sensors and their response (L2)

UNIT II **8 hours**

Instrumentation for Engineering Measurements: Applications of electronic instrument systems, engineering analysis, experimental error, general characteristics of recording instruments, voltmeters for slowly and rapidly varying signals, eddy-current sensors, signal conditioning circuits, data acquisition system.

Learning Outcomes:

After completion of this unit student will be able to

- compare various electronic instrument systems (L2)
- summarize general characteristics of recording instruments (L2)
- select proper electronic instrument for a particular application (L3)

UNIT III **8 hours**

Strain Measurement Methods and Strain Gauges: Introduction to strain measurements and strain gauges, electrical resistance strain gages, strain gage circuits and instrumentation, strain sensitivity of a strain gage, bridge sensitivity, Rosettes, strain gauge alloys, carriers and adhesives, performance of strain gauge system, temperature compensation, two-wire and three-wire circuits, strain gauge selection, bonding of a strain gauge, soldering, accounting for transverse sensitivity effects.

Learning Outcomes:

After completion of this unit student will be able to

- explain the construction and working of electrical resistance strain gauges (L2)
- select appropriate strain gauge for a given application (L3)
- build strain gauge circuits (L3)

UNIT IV **8 hours**

Optical methods of Stress analysis: Introduction to optics, photoelasticity, applied photoelasticity, two dimensional and three-dimensional photoelasticity, interferometry and holography, Moiré method, Moiré interferometry, polariscope - circular and plane, speckle methods -subjective, objective, digital image correlation, optical methods for determining fracture parameters.

Learning Outcomes:

After completion of this unit student will be able to

- explain the usage of photoelasticity for stress analysis (L2)
- compare the function of different polariscopes (L2)
- outline the interferometry and holography technique (L2)
- apply the optical methods for determining fracture parameters (L3)

UNIT V **9 hours**

Coatings and Non-Destructive Testing: Introduction to brittle coatings, coating materials, selection of coating thickness, industrial application of photoelastic coatings, calibration of photoelastic coatings, introduction to brittle coatings, analysis of brittle coatings.

Non-Destructive Testing: Fundamentals of non-destructive testing, radiography, ultrasonics, holography, laser holography magnetic particle inspection, fluorescent penetrant technique, eddy current testing, acoustic emission technique, X-ray applications, ultrasonic C-scan, thermograph, fiber- optic sensors.

Learning Outcomes:

After completion of this unit student will be able to

- select proper brittle coating material and thickness of coating based on application (L3)
- explain the calibration procedure of photo elastic coatings (L2)
- identify the relative advantages and disadvantages of various Non-destructive testing techniques (L3)
- choose proper Non-destructive testing technique based on the requirement (L2)

Course Outcomes:

After the completion of this course student will be able to

- summarize the function of basic electrical components involved in measurement
- select proper electronic and recording instruments for a given application
- build strain gauge circuits and use them for strain measurements
- apply the optical methods for determining fracture parameters
- choose and make use of proper Non-destructive testing technique based on the requirement

CO PO PSO MAPPING

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	2	2	1	0	1	0	0	1	1	1	0	2	1	2	1
CO2	2	1	1	1	2	1	0	1	1	1	0	2	2	2	1
CO3	2	2	2	1	2	1	0	1	1	1	1	2	2	1	1
CO4	2	2	2	2	2	1	1	1	1	1	1	2	2	3	1
CO5	2	2	2	2	2	1	1	1	1	1	1	2	2	3	1

Text Book(s)

1. J. W. Dally, W. F. Riley, K. G. McConnell, Instrumentation For Engineering measurements, 2/e, John Wiley and Sons, 1984.
2. P. Fordham, Non-Destructive Testing Techniques, Business PublicationsLimited, 1988.

References

1. J. W. Dally and M. F. Riley, Experimental Stress Analysis, 3/e, McGraw Hill,1988.

3. L. S. Srinath, M. R. Raghavan, K. Lingaiah, G. Gargesa, B. Pant, And K.Ramachandra, Experimental Stress Analysis, Tata McGraw Hill, 1984.
4. M. Hetenyi, Handbook of Experimental Stress Analysis, John Wiley and Sons,1980.
5. G. S. Holister, Experimental Stress Analysis, Principles and Methods,Cambridge University Press, 1987.

PE 7: Hypersonic Aerodynamics

L	T	P	S	J	Letter
3	0	0	0	0	3

Preamble:

This course is designed for aerospace engineering students. It introduces about the fundamentals on hypersonic flows and their characteristics. This course is designed to acquaint the learners with methods used for hypersonic flows and different experimental facilities available to understand the hypersonic flow behavior.

Course Objectives:

- Explain the flow behavior at hypersonic flows.
- Impart knowledge on the physics of shock-interactions under different conditions.
- Explain the theory used for predicting the flow characteristics at hypersonic speeds.
- Familiarize about the experimental test facilities available for hypersonic flows.
- Explain the concept of boundary layers in hypersonic flows.

UNIT I **8 hours**

Basics of Hypersonic Aerodynamics: Introduction to hypersonic aerodynamics, thin shock layers, entropy layers, low density and high-density flows, hypersonic flight paths, hypersonic flight similarity parameters, shock wave and expansion wave relations of inviscid hypersonic flows.

Learning Outcomes:

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

- understand the characteristics of hypersonic flows (l1)
- use the similarity parameters in hypersonic flight (l3)
- derive the shock and expansion relations for hypersonic flows (l4)

UNIT II **9 hours**

Surface Inclination Methods for Hypersonic Inviscid Flows: Local surface inclination methods and modified Newtonian law. Newtonian theory, tangent wedge/ tangent cone and shock expansion methods, calculation of surface flow properties.

Learning Outcomes:

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

- understand the Newtonian theory used for hypersonic flows. (l1)
- apply the knowledge of Newtonian theory in the design of various models in hypersonic flows. (l3)
- apply the knowledge of shock-expansion methods for wedge/cone models and calculate the flow properties. (l3)

UNIT III **9 hours**

Approximate Methods for Inviscid Hypersonic Flows: Approximate methods hypersonic small disturbance equation and theory. Thin shock layer theory, blast wave theory, entropy effects, rotational method of characteristics, hypersonic shock wave shapes and correlations.

Learning Outcomes:
At the end of the unit, student will be able to:

- understand the concept of small disturbance theory used in hypersonic flows. (l1)
- understand the concept of blast wave theory and shock layer theory. (l1)
- differentiate the blast wave and shock wave concepts. (l4)
- use the correlations used in hypersonic flows. (l5)

UNIT IV **9 hours**
Viscous Hypersonic Flow Theory: Navier-Stokes equations, boundary layer equations for hypersonic flow, hypersonic boundary layer theory and non-similar hypersonic boundary layers, hypersonic aerodynamic heating and entropy layers effects on aerodynamic heating.

Learning Outcomes:
At the end of the unit, student will be able to:
- derive the navier-stokes equations used in high speed flows (l3)
- understand the concept of hypersonic boundary layer(l1)
- apply concepts about aerodynamic heating at high speed flows (l3)

UNIT V **10 hours**
Viscous Interactions in Hypersonic Flows: Strong and weak viscous interactions, hypersonic shockwaves and boundary layer interactions, role of similarity parameter for laminar viscous interactions in hypersonic viscous flow.

Shock Tube Based Experimental Facilities: Impulse facilities, hypersonic wind tunnels, shock tunnels, gun tunnels, and heat transfer measurements.

Learning Outcomes:
At the end of the unit, student will be able to:

- understand about shock-boundary layer interactions in hypersonic flows (l1)
- apply the similarity parameters for hypersonic viscous flows. (l3)
- learn about the different test facilities used to test various models in high speed flows (l1)
- learn about application of heat transfer measurements in high speed experimental test facilities. (l3)

Course Outcomes:
At the end of the course, the student will be able to:
- apply the knowledge of hypersonic flow conditions for various configurations.
- apply the knowledge of shock-boundary layer interactions in the design of supersonic combustion engines.
- apply the knowledge of shock-shock interactions in the design of missile body or re-entry vehicle design.
- design and test any model in shock tunnels in order to understand the high temperature effects in hypersonic flows.
- obtain knowledge about the application of heat transfer measurements in high speed experimental test facilities.

Text Book(s)

1. J. D. Anderson, Hypersonic and High Temperature Gas Dynamics, 2/e, McGraw Hill, 2002.
2. P. Curtis, The Shock tube, Kindle edition, Dream Engine Interactive limited, 2014.
3. J. J. Bertin, Hypersonic Aerothermodynamics, AIAA Education series, 1994.
4. Y. Burtschell, R. Brun, and D. Zeitoun, Shock Waves, 1/e, Springer Verlag, 1992.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	1	2	2	0	1	1	2	2	1	2
CO2	3	2	1	0	1	2	1	1	1	2	0	2	1	2	1
CO3	3	1	1	2	0	0	1	0	1	1	2	1	3	1	2
CO4	3	1	0	1	3	1	2	1	1	1	2	2	2	1	3
CO5	2	1	1	1	1	0	1	1	0	1	0	1	3	1	2

PE8: FINITE ELEMENT ANALYSIS

L	T	P	S	J	Letter	P/F
3	0	0	0	0	3	

Preamble:

This course is designed for aerospace engineering students. It introduces the basic principles of finite element procedure. This course is designed to acquaint the learners with finite element solutions to structural and thermal problems and deals with the realistic engineering problems.

Course Objectives:

- To impart the basic principles of finite element analysis procedure.
- To develop the ability to generate the governing FE equations for systems governed by partial differential equations.
- To familiarize and apply finite element solutions to structural, thermal, dynamic problem to develop the knowledge and skills needed to effectively evaluate finite element analyses performed by others.
- To develop proficiency in the application of the finite element method (modeling, analysis, and interpretation of results) to realistic engineering problems

UNIT I **8 hours**

Fundamental Concepts: Stresses and equilibrium, strain – displacement relations, stress-strain relations, plane stress, plane strain, temperature effects, potential energy and equilibrium. Rayleigh- Ritz method, Galerkin's method, Saint Venant's principle.

Learning Outcomes

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

- Understand the concepts behind variational methods and weighted residual methods in FEM (L2)
- Identify the application and characteristics of FEA elements (L3)
- Develop the ability to generate the governing FE equations for systems governed by partial differential equations (L5)

UNIT II **8 hours**

One-dimensional Problems: Finite element modeling, shape functions, 1-D bar element, Potential energy approach, Galerkin's approach, assembly of the global stiffness matrix and load vector, quadratic shape functions, temperature effects. Plane trusses, local and global co-ordinate system, element stiffness matrix, stress calculations.

Learning Outcomes

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

- Demonstrate the ability to evaluate and interpret FEA analysis results for design and evaluation purposes (L3)
- Develop a basic understanding of the limitations of the FE method and understand the possible error sources in its use (L5)
- Formulate and Solve axially loaded bar Problem and analyze truss problem (L4)

UNIT III **8 hours**

Two-dimensional Problems using Constant Strain Triangles: Finite element modeling, constant strain triangle, isoparametric representation, potential energy approach, element stiffness, force terms, stress calculations.

Axisymmetric Solids Subjected to Axisymmetric Loading: Axisymmetric formulation, axisymmetric triangular element, strain displacement relations, stiffness matrix,Stress and strain calculation

Learning Outcomes

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

- Implement the formulation techniques to solve two-dimensional problems using triangle and quadrilateral elements (L5)
- Formulate and solve axi-symmetric problems and understand the formulation of three-dimensional elements (tetrahedral and brick elements). (L4)
- Classify the finite element modeling techniques (L3)

UNIT IV **8 hours**

Beams and Frames

Finite element formulation, load vector, boundary considerations, shears force and bending moment.**Two-dimensional Isoparametric Elements and Numerical Integration:** Four-node quadrilateral element, shape functions, element stiffness matrix, element force vector. Numerical integration, Gauss quadrature, one dimension and two-dimensional integrals.

Learning Outcomes

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

- Demonstrate the ability to evaluate and interpret FEA analysis results for design and evaluation purposes (L3)
- Create models for beams and frames, plate structures, machine parts, and components.
- Understand the role and significance of shape functions in finite element formulations and use linear, quadratic, and cubic shape functions for interpolation (L2)

UNIT V **8 hours**

Scalar Field Problems: Steady state heat transfer, one dimensional heat conduction, one dimensional heat transfer in thin fins.

Dynamic Considerations: Formulation,element mass matrices, evaluation of eigen-values and eigen-vectors.

Learning Outcomes

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

- Understand the application of FEA in heat transfer problem (L2)
- Apply the techniques, skills, and modern engineering tools necessary for engineering practice. (L3)

Course Outcomes:
At the end of this course, the student will be able to

- Understand the numerical methods involved in Finite Element Theory
- Apply the role and significance of shape functions in finite element formulations and use linear, quadratic, and cubic shape functions for interpolation
- Understand global, local, and natural coordinates and formulation of one-dimensional elements (truss and beam)
- Formulate two-dimensional elements, three dimensional and axisymmetric elements.
- Identify how the finite element method expands beyond the structural domain, for problems involving dynamics, heat transfer, and fluid flow.

Text Book(s)

1. Tirupathi R. Chandrupatla, Ashok D. Belegundu, Introduction to Finite Elements in Engineering, 3/e, Pearson Education, 2009.
2. Reddy. J.N., "An Introduction to the Finite Element Method", 3rd Edition, Tata McGraw-Hill, 2005

References

1. S.S.Rao, Finite Element Method in Engineering, Elsevier Butterworth-Heinemann Publications, 2013.
2. J.N. Reddy, An Introduction to the Finite Element Method, 3/e, McGraw-Hill Publications, 2006. 3.Robert D. Cook, David S. Malkus, Michael E. Plesha, Rober J. Witt, Concepts and Applications of
Finite Element Analysis, 4/e, Wiley India 2001.

4. Logan, D.L., "A first course in Finite Element Method", Thomson Asia Pvt. Ltd., 2002

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	1	1	1	1	1	2	1	3	2	2
CO2	2	2	2	1	1	0	1	1	1	1	2	1	2	1	2
CO3	2	2	2	1	2	1	1	1	0	1	2	1	2	1	2
CO4	2	2	1	1	1	0	1	1	1	1	2	0	2	3	2
CO5	3	2	1	1	1	2	1	1	0	1	2	1	2	2	2

PE9: ADVANCED AEROSPACE STRUCTURES

L	T	P	S	J	Letter	P/F
3	0	0	0	0	3	

Preamble:

This course is designed for Aerospace Engineering undergraduate students. It is designed to understand the advanced principles of mechanics of different components of aircraft structures. Understanding these principles will help them in the Design and Analysis of Aerospace Structures.

Course Objectives:

- Provide basic concepts to size practical aerospace structures given representative loads and other parameters.
- Learn to compute stresses for different aerospace structural components.
- Develop skills to design simple aerospace structures to support mechanical loads.
- Develop a mind set to understand the advanced aircraft structures.

UNIT I **8 hours**

Stress Analysis of Wing Spars and Box Beams: Tapered beams of single web, open and closed section beams and beams having variable stinger areas.

Stress Analysis of Fuselages: Bending, shear and torsion of fuselage, cutouts in fuselages.

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

- Analyse tapered beams of different sections
- Analyse fuselages under bending, shear and torsion

UNIT II **8 hours**
Stress Analysis of Wings: Bending, shear and torsion of wings, shear centre, tapered wings, deflections and cut-outs in wings.

Stress Analysis of Fuselage Frames and Wing Ribs: Principles of stiffener/ web construction, fuselage frames, wing ribs.

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

- Analyse wings under different loading conditions

- Analyse fuselage frames and wing ribs

UNIT III **10 hours**

Structural and Loading Discontinuities in Thin Walled Beams: Closed section beams: shear stress distribution of a closed section beam built in at one end under bending, shear and torsion loads, semi monocoque. Open section beams: I section beam subjected to torsion, torsion of beam of arbitrary section, torsion bending constant and shear lag.

Learning outcomes:

After completion of this unit student will be able to

- Understand the effect of structural and loading discontinuities and analyse shear stress distribution in closed section beams with discontinuities
- Distinguish between the shear stress distribution in open and closed section beams with discontinuities under different loading conditions

UNIT IV **8 hours**

Fatigue: Safe life and fail-safe structures, designing against fatigue, fatigue strength of components, prediction of aircraft fatigue life, crack propagation.

Learning outcomes:

After completion of this unit student will be able to

- understand the basic principles of fatigue
- apply the principles to predict the fatigue strength and fatigue life

UNIT V **8 hours**

Fracture Mechanics: Strength of cracked bodies, potential energy and surface energy; Griffith's theory, Irwin-Orwin extension of Griffith's theory to ductile materials, stress analysis of cracked bodies, effect of thickness on fracture toughness, stress intensity factors for typical geometries.

Learning outcomes:

After completion of this unit student will be able to

- Understand the basic principles of fracture mechanics
- Apply different theories for the analysis of components made of ductile materials
- Explain the effect of thickness on different parameters

Course Outcomes:

After the completion of this course student will be able to

- Perform the stress analysis of wing spars, box beams and fuselages subjected to mechanical loads. (L3)
- Analyse aircraft wings, wing ribs and fuselage frames under loading (L2)
- Analyse the effect of structural and loading discontinuities on thin walled beams (L2)

- solve problems of fatigue damage and calculate fatigue-crack growth under aircraft spectrum loading.(L3)
- Apply the principles of fracture mechanics to analyse aircraft structures (L3)

CO PO PSO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	1	1	1	1	1	1	1	2	1	1
CO2	3	2	1	1	1	1	1	1	1	1	1	1	2	2	1
CO3	3	2	1	1	1	1	1	1	1	1	1	1	2	2	1
CO4	3	2	1	1	1	1	1	1	1	1	1	1	2	1	1
CO5	3	2	1	1	1	1	1	1	1	1	1	1	2	2	1

Text Book(s)

1. T. H. G. Megson, Aircraft Structures for Engineering Students, 5/e, Elsevier, 2013.
2. J. F. Knott, Fundamentals of Fracture Mechanics, Butterworth and Co., 1983.

References

1. E. F. Bruhn, R. J. H. Bollard, Analysis and Design of Flight Vehicles Structures, Jacob Publishing, 1973.
2. B. K. Donaldson, Analysis of Aircraft Structures an Introduction, 2/e, Cambridge University Press, 2012.
3. D. William, E. Arnold, An Introduction to the Theory of Aircraft Structures, Elsevier, 2013.
4. E. H. Dowell, A Modern course in Aeroelasticity, 5/e, Springer International Publishing, 2014.

PE10: VIBRATIONS AND ACOUSTICS

L	T	P	S	J	Letter
3	0	0	0	0	3

Preamble: This course is designed for aerospace engineering students. It introduces about the fundamentals on vibration and acoustics. This course is designed to acquaint the learners with vibration theory involved in mechanical system, dynamic behavior of the system and sound and wave propagation.

Course Objectives:

- To impart the fundamental concepts of vibration theory and dynamic modeling methods
- To acquaint to mathematically model real-world mechanical vibration problems
- To assess fluctuations and acoustic processes in nature in different forms.
- To understand the role of damping, stiffness and inertia in mechanical systems.
- Develops methods and understanding of analyzing vibrations in mechanical systems, which are closely related to acoustics engineering problems.

UNIT I **8 hours**

Free Vibration of Single Degree of Freedom Systems: Introduction, free vibration of an undamped translational system, free vibration of an undamped torsional system, stability conditions, Rayleigh's energy method, free vibration with viscous damping, Coulomb damping and hysteretic damping.

Learning Outcomes

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

- describe the causes and effects of vibration in mechanical systems (L3)
- understand the different types of vibration (L2)
- develop schematic models for physical systems and formulate governing equations of motion (L6)

UNIT II **9 hours**

Harmonically Excited Vibrations: Introduction, equations of motion, response of undamped and damped systems under harmonic excitation, harmonic motion of the base and rotating unbalance.

Two Degree of Freedom System: Equations of motion for forced vibration, free vibration analysis of an undamped system, torsional system.

Learning Outcomes

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

- analyze rotating and reciprocating systems and compute critical speeds. (l4)
- apply newton's equation of motion and energy methods to model free and

harmonically forced vibrations.(l3)

UNIT III **10 hours**

Multi Degree of Freedom Systems: Introduction, modeling of continuous systems as multi degree of freedom systems, Newton's second law to derive equations of motion, influence coefficients, generalized coordinates and generalized forces, Lagrange's equation to derive the equation of motion, Eigen value problem and solution.

Determination of Natural Frequencies and Mode Shapes: Introduction, Dunkerley's formula, Rayleigh's method.

Learning Outcomes

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

- develop single- and multi-degree of freedom systems (L6)
- perform and verify computer simulations employing time integration and modal analysis of discrete vibrating systems (L5)
- determine the natural frequency and mode shapes of a given system (L4)

UNIT IV **8 hours**

Introduction to Acoustics: Introduction, derivation of the wave equation, traveling wave solutions, acoustic energy corollary, impedance and admittance, standing wave solutions.

Learning Outcomes

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

- assess fluctuations and acoustic processes in nature in different forms (L5)
- provide examples of variations and acoustic objects (L3)
- analyze sound propagation and reflections in space (L4)

UNIT V **8 hours**

Propagation and Noise Reduction: Effect of area and temperature variation on wave propagation, wave equation in cylindrical co-ordinates and its applications, Rayleigh's criteria, noise reduction techniques.

Learning Outcomes

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

- analyze sound propagation and reflections in space (L4)
- understand the fluctuations in the interaction with acoustic audio distribution systems(L2)
- evaluate different acoustic system designs and formulate the design of acoustic targets(L5)

Course Outcomes:

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

- understand complex system behavior including interactions between components and with other systems.
- develop schematic models for physical systems and formulate governing equations of

motion

- analyze rotating and reciprocating systems and compute critical speeds
- develop models using appropriate tools such as computer software, laboratory equipment and other devices.
- evaluate different acoustic system designs and formulate the design of acoustic targets.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	2	1	1	1	1	1	1	3	1	1
CO2	3	2	1	1	1	1	1	1	1	1	1	1	2	1	1
CO3	2	2	1	1	1	1	1	1	1	1	1	1	2	1	1
CO4	2	2	1	1	1	1	1	1	1	1	1	1	2	1	0
CO5	2	2	1	1	1	1	1	1	1	1	1	1	2	1	0

Text Book(s)

1. S. S. Rao, Mechanical Vibrations, 4/e, Pearson Education Inc., 2009.
2. F. Fahy and P. Gardonio, Sound and Structural Vibration: Radiation, Transmission and Response, 2/e, 2007.

Reference

1. L. Meirovich, Elements of Vibration Analysis, 2/e, Tata McGraw Hill 2007.
2. L. E. Kinsler, A. R. Frey, A. B. Coppens and J. V. Sanders, Fundamentals of Acoustics, 4/e, Wiley, 2000.
3. L. Cremer, M. Heckl and B. A. T. Peterson, Structure Borne Sound, 3/e, Springer-Verlag, 2005
4. G. K. Grover, Mechanical Vibrations, 8/e, NemChand and Brothers, 2009

PE11: THEORY OF ELASTICITY

L	T	P	S	J	Letter
3	0	0	0	0	3

Preamble:

This course is designed for Aerospace Engineering undergraduate students. It is designed to understand the basics principles of Theory of Elasticity. Understanding these principles will help them in the Design and Analysis of Aerospace Structures.

Course Objectives:

- To familiarize notations and sign conventions for stress and strain
- To impart knowledge on basic equations of elasticity
- To help to understand plane stress and plane strain conditions
- To explain the elasticity problems using polar coordinates
- To focus on torsion of prismatic bars

UNIT I **4 hours**

Introduction: Definitions, notations and sign conventions for stress and strain, equations of equilibrium.

Learning Outcomes:

After completion of this unit student will be able to

- Apply proper sign conventions for stress and strain in analysing the problems (L3)
- Explain about equations of equilibrium (L2)

UNIT II **12 hours**

Basic Equations of Elasticity: Strain-displacement relations, stress-strain relations, Lame's constant cubical dilation, compressibility of material, bulk modulus, shear modulus, Compatibility equations for stresses and strains, principal stresses and principal strains, Mohr's circle, Saint-Venant's principle.

Learning Outcomes:

After completion of this unit student will be able to

- Develop relations between stresses and strains in a given problems (L3)
- Explain different elastic constants (L2)
- Determine principal stresses and strains in a given problem (L5)
- Determine stresses using St. Venant's principle (L2)

UNIT III **8 hours**

Plane Stress and Plane Strain Problems: Airy's stress function, biharmonic equations, polynomial solutions, simple two-dimensional problems in Cartesian coordinates like bending of cantilever and simply supported beams, etc.

Learning Outcomes:

After completion of this unit student will be able to

- distinguish between plane stress and plane strain conditions (L4)

- make use of Airy's stress functions and biharmonic equations (L3)
- solve two-dimensional problems in Cartesian coordinates (L3)

UNIT IV **10 hours**

Polar Coordinates: Equations of equilibrium, strain-displacement relations, stress-strain relations, axi-symmetric problems, Kirsch, Michell'sand Boussinesque problems.

Learning Outcomes:

After completion of this unit student will be able to

- develop equations of elasticity in polar coordinates (L3)
- apply these equations to solve axi-symmetric problems (L3)

UNIT V **8 hours**

Torsion of Prismatic Bars: Navier's theory, St. Venant's theory, Prandtl's theory on torsion, the semi- inverse method and applications to shafts of circular, elliptical, equilateral triangular and rectangular sections.

Learning Outcomes:

After completion of this unit student will be able to

- distinguish the behaviour of circular and prismatic bars under torsion (L4)
- make use of different theories to solve problems on torsion of prismatic bars (L3)

Course Outcomes:

After the completion of this course student will be able to

- Apply proper sign conventions in the given problems (L3)
- Develop basic equations of elasticity (L3)
- Solve two dimensional problems in Cartesian and polar coordinates (L3)
- Apply equations of elasticity in polar coordinates to solve axi-symmetric problems (L3)
- Analyse prismatic bars under torsion (L4)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	1	1	1	1	1	1	1	3	2	1
CO2	3	2	1	1	1	1	1	1	1	1	1	1	3	2	1
CO3	3	2	1	1	1	1	1	1	1	1	1	1	3	1	1
CO4	3	2	1	1	1	1	1	1	1	1	1	1	3	1	1
CO5	3	3	1	1	1	1	2	1	1	2	1	1	3	2	1

Text Book(s)

1. S. Timoshenko and T. N. Goodier, Theory of Elasticity, 3/e, Tata McGrawHill, 2010.

References

1. E. Volterra and J. H. Caines, Advanced Strength of Materials, Prentice Hall, 1991.
2. C. T. Wang, Applied Elasticity, McGraw Hill, 1993.

3. R. B. Hetnaarski and J. Ignaczak, Mathematical Theory of Elasticity, CRCPress, 2011.
4. J. R. Barber, Elasticity, Springer, 2010.

PE12: INTRODUCTION TO MECHANICS OF COMPOSITE MATERIALS

L	T	P	S	J	Letter
3	0	0	0	0	3

Preamble:

This course is designed for Aerospace Engineering undergraduate students. It is designed for the students to understand the basics principles of Mechanics of Composite Materials. Understanding these principles will help them in the Design of Aerospace Structures.

Course Objectives:

- To familiarize the terminology and materials used for composite materials
- To impart knowledge on macro mechanical behavior of lamina
- To focus on micro mechanics of lamina
- To support them to understand the stress strain behavior of different types of laminates
- To instruct the strength criteria of orthotropic lamina
- To explain the design of composite structures

UNIT I **8 hours**

Composite Materials: Composite materials terminology.

Classifications: Polymer matrix, metal matrix, ceramic matrix, carbon-carbon matrix composites.
Fabrication of Fibers: Glass fibers, carbon/graphite fibers, aramid fibers, boron fibers, banana and bamboo fibers.

Application of Composite Materials: Automotive, space, marine and aircraft application.

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

- explain the terms related to composite materials (L2)
- classify the composite materials (L2)
- summarize the fabrication procedures of fibers (L2)

UNIT II **9 hours**

Macro Mechanical Behavior of Lamina: Hooke's Law, stiffness and compliance matrix for generally anisotropic materials, orthotropic materials, transversely isotropic materials and isotropic materials. Relations between engineering constants and elements of stiffness and compliance matrix.

Stress strain relations for plane stress in a unidirectional orthotropic material and arbitrary oriented orthotropic material.

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

- outline the procedure to obtain stiffness and compliance matrices for different materials (L2)

- develop stress strain relations for a unidirectional orthotropic material under plane stress (L3)
- determine stress strain relations for an arbitrary oriented orthotropic material under plane stress (L5)

UNIT III **8 hours**

Micro Mechanical Behavior of Lamina: Introduction, Mechanics of materials approach to stiffness to determine Young's modulus, Poisson's ratio and rigidity modulus. Elasticity approach to stiffness by bounding techniques of elasticity.

Learning Outcomes:

After completion of this unit student will be able to

- apply mechanics of materials approach to stiffness to determine elastic constants (L3)
- explain elasticity approach to stiffness by bounding techniques of elasticity to determine elastic constants (L2)

UNIT IV **9 hours**

Macro Mechanical Behavior of Laminate:

Classical Lamination Theory: Lamina stress-strain behavior, stress and strain variation in a laminate, resultant laminate forces and moments.

Special Cases of Laminate Stiffness: Single-layered, symmetrical laminates, anti-symmetrical laminates, unsymmetrical laminates.

Learning Outcomes:

After completion of this unit student will be able to

- make use of classical lamination theory to obtain forces and moments in a laminate (L3)
- outline various special cases of laminates ((L2)

UNIT V **8 hours**

Performance of Composite Materials:

Strength Criteria of Orthotropic Lamina: Maximum stress failure criterion, maximum strain failure criterion, Tsai-Hill failure criterion, Hoffman failure criterion and Tsai-Wu failure criterion.

Design of Composite Structures: Elements of design, structural design process, design objectives and design drivers, design analysis stages. Material selection factors, fiber selection factors, matrix selection factors.

Learning Outcomes:

After completion of this unit student will be able to

- determine strength of orthotropic lamina using different theories (L3)
- explain the elements and process of design of composite structures (L2)
- select proper materials for a given application (L3)

Course Outcomes:

After the completion of this course student will be able to

- summarize on the terminology and classification of composite materials and outline The procedure for fabrication of fibers
- develop relations for orthotropic materials under plane stress
- apply various approaches to determine elastic constants of composite materials
- analyze the macro mechanical behavior of laminates
- make use of various strength criteria in the design of composite structuresCO PO PSO Mapping

1	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	2	1	1	0	0	2	2	1	1	2	0	2	0	0	1
CO2	3	2	2	1	1	1	0	1	2	2	1	2	2	2	1
CO3	3	2	2	1	1	1	0	1	2	2	1	2	2	2	1
CO4	3	2	2	1	1	1	0	1	2	2	1	2	2	2	1
CO5	3	2	3	2	1	1	0	1	2	2	1	2	2	3	1

Text Book(s)

1. R M Jones, Mechanics of Composite Materials, 2/e, Taylor and Francis, 1999.

References

1. Nicholas J. Pagano, Reddy J.N, Mechanics of Composite Materials, Kluwer Academic Publishers, 1994.
2. Agarwal. B. D, Boatman. L. J, Chandrasekhar K, Analysis and Performance of Fiber Composites, 3/e, John Wiley and Sons, 2006.
3. Malik P.K, Fiber Reinforced Composites, 3/e, CRC Press, 2013.
4. Aurar K Kaw, Mechanics of Composite Materials, 2/e, Taylor and Francis,2013.

PE13: AEROELASTICITY

L	T	P	S	J	Letter
3	0	0	0	0	3

Preamble:

This course is designed for aerospace engineering students. It introduces about the fundamentals of aeroelastic effect during flight. This course is designed to Emphasize on the analysis of aeroelastic deformation, divergence, flutter and control surface efficiency, based on finite element analysis and potential flow methods.

Course Objectives:

- Model aeroelastic aero-structure interactions that create phenomena such as divergence, lift effectiveness and control effectiveness.
- Predict structural instabilities such as flutter and divergence.
- Calculate unsteady aerodynamic forces for elementary wings.
- Model and analyze discrete, vibrating mechanical systems

UNIT I **8 hours**

Introduction: Aeroelastic problems, Collar's triangle, static and dynamicaeroelasticity, deformation of structures and influence coefficients, energy method, classification and solution of aeroelastic problems.

Learning Outcomes:

After completion of this unit the student will be able to

- Formulate aeroelastic equations of motion (L1)
- Formulate mathematical models for some simple problems in aeroelasticity.(L1)
- Apply knowledge of science and engineering fundamentals.(L2)

UNIT II **10 hours**

Static Aero elasticity: Divergence of 2-D airfoil and finite wing, aileron reversal, control effectiveness for 2D and finite wing, wing loading and deformations, swept wing divergence.

Learning Outcomes:

After completion of this unit the student will be able to

- Appreciate the significance of load redistribution in the response of aerospace vehicle(L2)
- Realize the effect of unsteady aerodynamics on the behavior of aero elastic system(L2)
- Perform static aero elastic instabilities such as divergence, control surface (L3)

UNIT III **8 hours**

Dynamic Aero elasticity: Dynamic flutter model of 2-D airfoil, aero elasticity problems in rotary wing vehicles, coupling, prevention of flutter, experimental determination of flutter speed, control surface flutter.

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

- Calculate the divergence dynamic pressure(L1)
- Determine the stress distribution under aero elastic air load distribution from Structural engineer's perspective(L2)
- Analyze these systems using suitable tools both in the time domain and in the frequency domain (L3)

UNIT IV **8 hours**

Unsteady Aerodynamics: Introduction, 2-D and 3-D supersonic flow, subsonic flow - Kernel function approach, Theodore theory, finite state model.

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

- Perform a preliminary aero elastic analysis of a slender wing structure in low-speed airflow(L2)
- Explain under what circumstances an aero elastic analysis can be expected to produce useful result(L2)
- Realize the effect of unsteady aerodynamics on the behavior of aero elastic system(L3)

UNIT V **9 hours**

Flutter Analysis: Flutter calculation, p-k method, exact treatment of bending, torsion flutter of uniform wing, and flutter analysis by assumed mode method, panel flutter.

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

- Incorporate the aero elastic constraints into the design aerospace structure (L2)
- Execute set up of aero elastic models in MSC Flight loads and perform static (divergence) and dynamic aero elastic (flutter) solutions (L3)
- Generate Flight loads, flat plate aero modeling, aero-structural coupling, splining aero and structural meshes (L4)

Course Outcomes:
At the end of the course the student will be able to:

- Explain how the aero elastic phenomena flutter, divergence and aileron reversal arise and how they affect aircraft performance
- Formulate aero elastic equations of motion and use there to derive fundamental relations for aero elastic analysis
- Perform a preliminary aero elastic analysis of a slender wing structure in low-speed airflow
- Explain under what circumstances an aero elastic analysis can be expected to produce useful results
- Demonstrate the flutter analysis phenomenon of wing and elevator

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	1		1		1	1	1	3	1	1
CO2	2	2	1	1	1	1	1	1	1	1	1	1	2	1	
CO3	2	2	1	1	1	1		1		1	1	1	2	1	1
CO4	2	2	1	1	1	1		1		1	1	1	2	1	
CO5	2	2	1	1	1	1	1	1	1	1	1	1	2	1	1

Text Book(s)

1. R. L. Bisplinghoff, H. Ashley and R. L Halfmann, Aeroelasticity, Addison Wesley, 2/e, 1987.
2. D. H. Hodges and G. A. Pierce, Introduction to Structural Dynamics and Aeroelasticity, 2/e, Cambridge Aerospace Series, 2011.

References

1. T. H. G. Megson, Aircraft Structures for Engineering Students, 5/e, Elsevier, 2013.
2. Y. C. Fung, An Introduction to the Theory of Aeroelasticity, John Wiley, 1985.
3. E. G. Broadbent, Elementary Theory of Aeroelasticity, Bun Hill Publications, 1986

PE14: AERODYNAMICS OF TURBOMACHINERY

L	T	P	S	J	Letter
3	0	0	0	0	3

Preamble

This course projects contents that include different types of turbomachinery aerodynamics. It focuses mainly on working of turbo machines and performance characterization and design philosophies. Course find appealing and enhances interest in the area of compressor and turbines

Course Objectives:

- Impart knowledge on principles of turbo machinery and various subsystems within.
- Train students on performance characterization of different turbo machines.
- Impart design knowledge of axial and centrifugal compressors and turbines.
- Familiarize to analyzing various types of losses rotating machines could undergo.
- Explain fundamentals of matching different turbo machine components.

UNIT I 9 hours

Axial Flow Compressors: Geometry structure of stage and related terminology, velocity triangles, flow behavior, thermodynamic cycle, single and multistage, degree of reaction, stage pressure ratio and other performance characteristics, compressor pressure curve. Losses - causes, primary and secondary losses, stall, surge. Efficiencies - polytropic, stage and adiabatic. Cascade aerodynamics - nomenclature, analysis of cascade forces, numericals and study of performance charts.

Learning Outcomes

At the end of unit student will be able to

- Understand rotating flow physics and its interpretation (L2)
- Appreciates the significance of velocity triangles and energy exchange, conversion processes (L4)
- Calculate and characterize the performance of axial flow compressors (L4)
- Quantify different types of losses of rotating machines (L3)
- Exhibit interest in enhancing deeper understanding of cascade flows (L5)

UNIT II 9 hours

Centrifugal Compressors: Introduction, elements of centrifugal compressor, inlet and impeller slip factor, concept of rothalpy. Incidence and lag angles, forward lean, backward lean, velocity triangles, diffuser - vane and vaneless, volute casing centrifugal compressor characteristics, stage loses

Learning Outcomes

At the end of unit student will be able to

- Appreciates the difference between axial and centrifugal compressors (L4)
- Understand the significance of inducer at inlet and volute at the exit of compressor (L2)
- Exhibit design knowledge of different components of centrifugal compressors (L3)
- Characterize the performance of centrifugal compressors (L4)

UNIT III **9 hours**

Axial Flow Turbines: Velocity diagrams for rotors and stators,performance computations, degree of reaction, impulse and reaction turbines, flow losses and causes, efficiencies - total to total and total to static, blade spacing, blade and disk stress - centrifugal, bending and thermal. Typical blade profiles, study of performance charts. Limitations: Materials used for blades and disks, cooling - internal, external cooling. Numericals

Learning Outcomes

At the end of unit student will be able to

- Appreciates the difference between axial flow turbines and compressors (L4)
- Understand the significance of position of stators and its importance in axial flow machines (L2)
- Exhibit design knowledge of different types of axial flow turbine like impulse and reaction machines (L2)
- Get exposure on different types of turbine cooling techniques (L1)
- Understands the limitation of turbine working (L2)

UNIT IV **8 hours**

Radial Flow Turbines: Elements of radial turbines stage, stage velocity triangles, enthalpy - entropy diagrams, stage losses and efficiency, performance characteristics.

Learning Outcomes

At the end of unit student will be able to

- Appreciates the difference between axial and radial flow turbines (L4)
- Understand the significance of radial movement of flow in generation of shaft work (L2)
- Exhibit design capabilities of radial flow turbine and its aerodynamic components (L4)
- Characterize the performance of centrifugal compressors (L3)

UNIT V **8 hours**

Dimensional Analysis and Matching: Geometric similarity, dynamic similarity, Buckingham's PI theorem for turbo machines, compressor and turbine maps, choking of compressor and turbines, specific speed and its design role, turbine and compressor matching.

Learning Outcomes

At the end of unit student will be able to

- Appreciates the significance of matching mechanical and aerodynamic behaviour of turbomachines (L4)
- Understand the role of performance maps, specific speeds and choking concept of turbomachine (L2)
- Exhibit knowledge of matching the performance of turbomachines in a typical engine (L4)
- Enhance understanding of similarity concepts (L2)

Course Outcomes

At the end of course student will be able to

- Appreciate working of axial flow compressor for fluid pressurization(L2)
- Understands and distinguishes the working and performance of centrifugal and axial compression systems(L4)
- Comprehend thermodynamic working of axial flow turbines(L3)
- Ascertain and design typical radial inflow turbine(L4)
- Determine best matching combinations across compressors and turbine (L4)

Text Book(s)

1. Baskharone, Principles of Turbomachinery in Air Breathing Engines, 2/e, Cambridge University Press, 2006.
2. R. D. Flack, Fundamentals of Jet Propulsion with Applications, 2/e, Cambridge University Press, 2010.

References

1. E. Logan Jr., Turbomachinery: Basic Theory and Applications, 2/e, Taylor and Francis limited, 1993.
2. S. A. Korpela, Principles of Turbomachinery, 2/e, John Wiley, 2012.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	1	2	1	2	1	1	2	1	3	2	1
CO2	3	2	2	2	1	2	1	2	2	1	2	1	3	2	1
CO3	3	2	1	1	1	2	1	2	1	1	2	1	3	1	1
CO4	3	2	1	1	1	2	1	1	2	1	2	1	3	1	1
CO5	3	2	2	1	1	2	1	1	1	1	1	1	3	1	1

PE15: THEORY OF CRYOGENICS

L	T	P	S	J	Letter
3	0	0	0	0	3

Preamble

This course highlights syllabus related to cryogen zing of propellants. It includes different theories liquefaction, refrigeration, separation and purification. Course find appealing and enhances interest in the area of very low temperature liquid production

Course Objectives:

1. Explain importance of cryogenics and very low temperature processes.
2. Train different principles behind gas liquefaction and refrigeration systems
3. Impart the knowledge of gas separation and purification process.
4. Familiarize different properties of materials at very low temperature.
5. Provide exposure on challenges, design of cryogenic fluid process, materials and storage

UNIT I **8 hours**

Introduction: Properties of engineering materials at cryogenic temperatures, mechanical properties thermal properties, electric and magnetic properties, super conducting materials, thermo electric materials, properties of cryogenic fluids, super fluidity of He3 and He4.

Learning Outcomes

At the end of unit student will be able to

- Understand properties of various applied cryogenic materials (L2)
- Exhibit interest in advanced material processes of superconducting and thermo electric (L3)
- Compare compatibility of materials and appropriate processes(L4)
- Gain knowledge of super fluidity of helium variants(L4)

UNIT II **9 hours**

Low Temperature Processes: Importance and applications,thermodynamic minimum work, cooling duty and COP, isobaric cooling minimum work, production of low temperatures, Joule-Thomson expansion, adiabatic reversible turbine expansion, discontinuous sudden expansion, Philips refrigerator, Gifford McMahan refrigerator, pulse tube refrigerator.

Learning Outcomes

At the end of unit student will be able to

- Learn importance of low temperature processes of different applications (L2)
- Exhibit interest on different refrigerators used for low temperature processes (L3)
- Appreciates thermodynamic working of different processes involved (L4)
- Apply principles for quantification of different parameters of refrigeration cycle (L4)

UNIT III **9 hours**

Gas Liquefaction and Refrigeration Systems: Thermodynamically idealsystem for liquefaction, liquefaction for nitrogen, oxygen, and argon by Linde-Hampson process and simple Claude process. Neon, hydrogen, helium liquefaction by pre-cooled Linde-Hampson, Collins helium liquefaction process, natural gas by pure component refrigeration.

Learning Outcomes

At the end of unit student will be able to

- Learn concepts of gas liquefaction and refrigeration (L2)
- Apply knowledge of material liquefaction using different process (L3)
- Compare different method of refrigeration and liquefaction suitable to material (L4)
- Exhibit design knowledge refrigeration systems (L4)

UNIT IV **8 hours**

Gas Separation and Purification: Gas separation and purification,principles, cryogenic and non-cryogenic for air, hydrogen and helium separation systems.

Learning Outcomes

At the end of unit student will be able to

- Improve knowledge of gas separation and purification (L2)
- Exhibit increased interest in cryogenic separation systems (L3)
- Apply cryogenic principles for air, hydrogen and helium materials (L4)
- Design of purification processes for other materials (L4)

UNIT V **9 hours**

Cryogenics in Aerospace Applications: Challenges for cryogenic propellants, design concept for cryogenic propellant, boil off rate, storage and transportation of cryogenic fluids, storage vessel, thermal shields and insulation, effect of size shape on heat in-leak transfer and draining of liquid, transportation issues - nitrogen, helium and hydrogen.

Learning Outcomes

At the end of unit student will be able to

- Impart knowledge on different challenges of cryogenic propellants (L2)
- Exhibit interest in resolving issues of storage, evaporation and transportation (L3)
- Compare different parameters for preserving and storing of cryogenic propellants (L4)
- Exhibit design knowledge of cryogenic propellants (L4)

Course Outcomes

At the end of course student will be able to

- Understands properties of various materials that take part in cryogenisation process
- Realize the significance of low temperature processes
- Exhibit knowledge on gas liquefaction and refrigeration systems
- Apply principles of gas separation and purification for air, hydrogen and helium
- Appreciates challenges and design issues with regard to materials and processes

Text Book(s)

1. R. F. Barron, Cryogenic Systems, 2/e, McGraw Hill, 2008.
2. M. Mamata, Fundamentals of Cryogenic engineering, 1/e, PHI, 2010.

References

1. T. M. Flynn, Cryogenic Engineering, 2/e , CRC press, 2005.
2. T. Flynn, Cryogenic Process Engineering, 1/e, Plenum press, 1989.
3. G. Haseldom, Cryogenic Fundamentals, 1/e, Academic Press, 1971.
4.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	1	1	2	1	1	1	1	3	1	1
CO2	3	2	1	1	1	1	1	2	1	1	1	1	3	1	1
CO3	2	1	1	1	1	1	1	2	1	1	1	1	2	1	1
CO4	3	2	1	1	1	1	1	2	1	1	1	1	3	1	1
CO5	2	1	1	1	1	1	1	2	1	1	1	1	2	1	1

PE16: ROCKETS AND MISSILES

L	T	P	S	J	Letter
3	0	0	0	0	3

Preamble

This course projects contents that involve fundamental of rocket and missile systems. It focuses mainly on rocket aerodynamic, typical engines used, trajectory design and rocket optimization. Course find appealing and enhances interest on rocketry

Course Objectives:

- Impart knowledge on aerodynamics of rocketry.
- Train students on rocket propulsion systems solid and liquid engines.
- Impart design knowledge of different types of trajectories.
- Explain fundamentals of multi-staging and optimization of rocket design.
- Familiarize different types of materials used for rockets and missile applications.

UNIT I **10 hours**

Aerodynamics of Rockets and Missiles: Airframe components of rocketsand missiles, forces acting on a missile while passing through the atmosphere, classification of missiles, methods of describing aerodynamic forces and moments, lateral aerodynamic moment, lateral damping moment and longitudinal moment of a rocket, lift and drag forces.

Learning Outcomes

At the end of unit student will be able to

- Gain sound knowledge on different components and their significance in rockets(L2)
- Appreciates working and aerodynamic forces and moments in sustaining the flight(L4)
- Calculate and characterize the basic static performance rocket(L3)
- Quantify different types aerodynamic loads on rockets(L3)

UNIT II **9 hours**

Solid Rocket Systems: Basic concepts and design, solid propellants,casing, nozzle and its performance.

Liquid Rocket Systems: Ignition system in rockets, types of igniters andigniter design considerations, injection system and propellant feed systems of liquid rockets and their design considerations, design considerations of liquid rocket thrust chambers, combustion mechanisms.

Learning Outcomes

At the end of unit student will be able to

- Understand anatomy of solid rocket motor(L2)
- Appreciates the significance of injection, ignition, and combustion systems(L4)
- Carryout basic design calculation of motor grain(L3)
- Quantify various types of design considerations of thrust chamber(L3)
- Exhibit interest in enhancing deeper understanding combustion mechanism(L4)

UNIT III **9 hours**

Rocket Motion in Free Space and Gravitational Field: One dimensionaland two-dimensional rocket motions in free space and homogeneous gravitational fields, description of vertical, inclined and gravity turn trajectories, determination of range and altitude, simple approximations to burn out velocity and altitude, estimation of culmination time and altitude.

Learning Outcomes

At the end of unit student will be able to Understand one- and two-dimensional rocket dynamics(L2)

- Appreciates the dynamics in gravity and free space environments(L4)
- Calculate kinematic and kinetic parameters that specify the trajectory(L3)
- Exhibit interest in studying different types of maneuvers and trajectory turns(L2)
- Develop trajectory design for a typical rocket(L4)

UNIT IV **8 hours**

Multi-Stage Rocket and Attitude Control

Nomenclature of the multi-stage rocket, ideal velocity of the multi-stage rocket, vertical ascent in a homogeneous gravitational field and in vacuum (burnout velocity, culmination altitude, vertical ascent of a two-stage rocket). Rocket thrust vector control, methods of thrust vector control, thrust magnitude control, and thrust termination.

Learning Outcomes

At the end of unit student will be able to

- Gain knowledge of multi staging of rocket and its significance (L2)
- Appreciates the priority of different mass ratios and burnout velocity (L4)
- Calculate and characterize multi-stage rocket performance (L3)
- Realize the role of thrust vector control and different methods of thrust vectoring(L2)
- Quantify different thrust vectoring terms to control and guide the vehicle(L3)

UNIT V **8 hours**

Separation Systems for Rockets and Missiles: Stage separationdynamics, separation techniques.
Materials for Rockets and Missiles: Criteria for selection of materialsfor rockets and missiles, choice of materials at cryogenic temperatures, extremely high temperatures, requirement of materials for thermal protection and pressure vessels.

Learning Outcomes

At the end of unit student will be able to

- Understand the importance of materials and their limitations(L2)
- Select different materials as demanded by situation(L5)
- Appreciates the working of high temperature materials(L4)
- Realize the role of thermal protection and materials for pressure vessels(L2)

Course Outcomes

At the end of Course student will be able to

- Appreciates working of aerodynamic forces and moments in sustaining the flight
- Realize suitability and capacity of matching propulsive engines
- Calculate kinematic and kinetic parameters that specify the trajectory

- Gain knowledge of multi staging of rocket and its design
- Select suitable high temperature materials

Text Book(s)

1. J. W. Cornelisse, H. F. R. Schoy, K. F. Wakker, Rocket propulsion and Space Dynamics, Pitman Publishing, 1979.
2. G. P. Sutton, Rocket Propulsion Elements, John Wiley, 2000.

References

1. Barrere et al, Rocket Propulsion, Elsevier, 1960.
2. M. J. L. Turner, Rocket and Spacecraft propulsion: Principles, Practice and New Developments, Springer Praxis, 2004.
3. N. Nielsen, Missile Aerodynamics, Mountain View, 1998.
4. S. S. Chin, Missile configuration Design, McGraw Hill, 1961.
5. E. R. Parker, Material for Missiles and Spacecraft, McGraw Hill, 1982.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	2	1	1	1	2	1	1	2	1	3	2	1
CO2	2	1	1	1	1	1	1	2	1	1	2	1	2	1	1
CO3	2	2	1	1	1	1	1	2	1	1	1	1	2	2	1
CO4	3	2	1	1	1	1	1	2	1	1	2	1	3	1	1
CO5	3	2	1	1	1	1	1	2	1	1	1	1	3	1	1

PE17: FLIGHT DYNAMICS

L	T	P	S	J	Letter	P/F
3	0	0	0	0	3	

Preamble:

This course is designed for aerospace engineering students. It introduces about the fundamentals of flight dynamics. This course is designed to acquaint the learners with different types of operating conditions and various controls and maneuvering dynamics.

Course Objectives

- To acquaint the students about the performance of airplanes under various operating conditions
- To familiarize them about the performance of control surfaces and their characteristics.
- To impart the knowledge about the purpose of elevator and ailerons in various operating condition.
- To learn the various maneuvering criteria and their stability.
- To familiarize the students with the concepts of dynamic stability in aircraft.

UNIT I **8 hours**

Stick Fixed Static Longitudinal Stability: Introduction to stability of airplane, wing alone configuration, wing and tail configuration, effect of tail on static stability, stick fixed longitudinal stability, neutral point, centre of gravity limits. In-flight measurement of stick fixed neutral point.

Learning Outcomes

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

- Describe the influence of forces and moments on the static and dynamic stability of aircraft (L2)
- Apply the aircraft flight mechanics equations to analyze the flight stability performance of aircraft in different situations (L3)
- Determine the practical approach of flight measurement of stick- fixed neutral point (L5)

UNIT II **8 hours**

Control Surfaces and Aerodynamic Balancing: Control surface hinge moments, floating and restoring tendencies, different types of tabs used on airplanes, mass balancing, frise aileron, the sealed nose balance, spoiler controls, aeroelastic effects.

Learning Outcomes

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

- Understand performance of various control surfaces and tab (L2)
- Demonstrate the advanced control concepts to design stabilization systems and autopilots (L3)
- Classify the aerodynamic balancing methods (L6)

UNIT III **8 hours**

Stick Free Static Longitudinal Stability: Effect of free elevator on airplane stability, elevator control force, stick force gradients, neutral point and controls free center of gravity limit. In-flight measurement of stick free neutral point.

Learning Outcomes

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

- Understand the stick free and trim condition (L2)
- Apply the practical approach of flight measurement of neutral point (L3)

UNIT IV **8 hours**

Maneuvering Flight, Directional and Lateral Control: Maneuver margins. Asymmetric flight, weather cock stability, contribution of different parts of the airplane, rudder fixed and rudder free static directional stability, dihedral effect. Contribution of different parts of airplane controls in roll, cross coupling of lateral and directional effects.

Learning Outcomes

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

- Design tools for aircraft stability augmentation systems (L6)
- Demonstrate computational flight simulation systems based on the established dynamic models and airplane controls (L2)
- Linearized the non-linear equations of motion, and express them in state space form (L3)

UNIT V **8 hours**

Dynamic Stability: Introduction to dynamics, spring-mass system.Equations of motion without derivation, phugoid modes, Routh's criteria (b) lateral and directional dynamic stability and control - approximate analysis of roll subsidence spiral mode and Dutch roll.

Learning Outcomes

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

- Determine the physical and mathematical significance of aerodynamic derivatives (L2)
- Explain the natural modes of motion of a fixed wing aircraft (L2)
- Analyze the dynamic stability of aircraft based on a state space representation of its equations of motion. (L4)
- Derive transfer functions from the state space representation and hence calculate the response of fixed wing aircraft to control inputs. (L4)

Course Outcomes

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

- Apply the knowledge of performance characteristics under various operating.
- Implement the role of primary and secondary control surface in stability of aircraft.
- Apply the knowledge of elevator lock and unlock conditions.
- Implement the concept of various maneuvering conditions and their stability.
- Characterize and explain relevant flight and handling qualities and the disturbances acting on an aircraft.

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO11	PO1 2	PSO 1	PSO2	PSO 3
CO1	3	2	1	1	1	1	1	1	1	1	1	1	3	2	1
CO2	2	2	2	1	1	0	1	1	1	1	1	1	2	1	1
CO3	2	2	2	1	2	1	1	1	0	1	1	1	2	1	1
CO4	2	2	1	1	1	0	1	1	1	1	0	0	2	3	0
CO5	3	2	1	1	1	2	1	1	0	1	1	1	2	2	0

Text Book(s)

1. B. N. Pamadi, Performance, Stability, Dynamics, and Control of Airplane; 2/e, AIAA, 2004.
2. T. R. Yechout, S. L. Morris, D. E. Bossert and W. F. Hallgren, Introduction to Aircraft Flight Mechanics, AIAA, 2009.

References

1. J. D. Anderson, Aircraft Performance and Design, 1/e, McGraw Hill, 2011.
2. J. J. Bertin and R. Cummings, Aerodynamics for Engineers, 6/e, Pearson, 2013.
3. A.W. Babister, Aircraft Stability and Response, Pergamon Press, 1980.
4. R. C. Nelson, Flight Stability and Automatic Control, 2/e, McGraw Hill, 199

PE 18: SPACE TECHNOLOGY

L	T	P	S	J	Letter	P/F
3	0	0	0	0	0	

Preamble:

This course is designed for aerospace engineering students. It introduces the basic introduction of Space Technology

Course Objectives

- Explain basic knowledge on fundamentals of Rocketry and space technology applications;
- Impart the awareness of the universality of use and multiplicity of space applications;
- Explain basic knowledge on space missions and national programs;
- Demonstrate and explain basic principles of rocket propulsion
- Focus and apply physical and mathematical methods used in analyzing engineering applications involving rocket

UNIT I **9 hours**

Fundamentals of Rocketry: Space mission, types, space environment, launch vehicle selection, types of orbits. Two-dimensional trajectories of rockets and missiles, vehicle sizing, two stage, multi-stage rockets; Trade-off ratios, single stage to orbit, sounding rocket, aerospace plane, gravity turn trajectories.

Learning Outcomes:

At the completion of this unit, students will be able to:

- Understand of basic physics of rockets and space missions. (l2)
- Understand rocket propulsion systems for both launch and orbital control missions (l3)
- Understand the concept of two-dimensional trajectories of rockets and missiles. (l3)
- Understand the multistage of rockets and missiles. (l2)

UNIT II **7 hours**

Atmospheric Re-entry: Introduction, steep ballistic re-entry, ballistic orbital re-entry, skip re-entry, double dip reentry, aero braking, lifting body re-entry.

Learning Outcomes:

At the completion of this unit, students will be able to:

- Understand Re-entry of space vehicle (L2)
- Get knowledge on different re-entry paths or maneuvers (L2)
- Understand the how to reduce the velocity of bodies while Re-entry of vehicles (L3)

UNIT III **8 hours**

Fundamentals of Orbit Mechanics: Orbit maneuvers, two body motion- circular, elliptic, hyperbolic, and parabolic orbits; Basic orbital elements, ground trace in-plane orbit changes, Hofmann transfer, bi-elliptical transfer, plane changes, combined maneuvers, propulsion for maneuvers.

Learning Outcomes:
At the completion of this unit, students will be able to:

- Understand and get the knowledge of fundamentals of mathematics and physics of Keplerian laws. (L3)
- Understand the orbital motions of planets (L2)
- Have knowledge on orbital transfer mechanics in space environment.

UNIT IV 8 hours

Satellite Attitude Dynamics: Torque free axi-symmetric rigid body,attitude control for spinning spacecraft, attitude control for non-spinning spacecraft, Yo-Yo mechanism, gravity - gradient satellite, dual spin spacecraft and attitude determination.

Learning Outcomes:
At the completion of this unit, students will be able to:

- Understand satellite attitude dynamics of axisymmetric rigid body (l2)
- Know the attitude control for spinning and non-spinning spacecraft. (l2)
- Understand the mechanisms of satellite attitude dynamics. (l3)

UNIT V **9 hours**

Space Mission Operations: Supporting ground systems, architecture and team interfaces, mission phases and core operations, team responsibilities, mission diversity, standard operations practices, impact point calculation, injection conditions, flight dispersions.

Learning Outcomes:
At the completion of this unit, students will be able to:

- Space mission operation like ground systems, architecture and team interfaces (l3)
- Understand standard operation of space mission (l2)
- Understand space impact point calculation, flight dispersions(l3)

Course Outcomes:
At the completion of this course, students will be able to:

- The candidate has broad knowledge on satellite orbits and multidisciplinary knowledge in space technology.
- Possess the basic knowledge on rocketry and related combustion
- Analyze and understand the spacecraft launch, space environment
- Exercise strong knowledge on working of spacecraft in different environment conditions.
- Good knowledge on space applications such as earth observation, navigation and communication.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	1	1	1	1	1	1	1	1	1	3	1	1
CO2	2	2	2	1	1	1	1	1	1	1	1	1	2	1	1
CO3	2	2	3	2	1	1	1	1	1	1	1	1	2	1	1
CO4	2	2	2	2	1	1	1	1	1	1	1	1	2	1	1
CO5	2	1	2	1	1	1	1	1	2	1	1	1	2	1	1

Text Book(s)

1. W. E. Wiesel, Spaceflight Dynamics, 2/e, McGraw Hill, 2014.
2. F. J. Hale, Introduction to Space Flight, 1/e, Prentice Hall, 1993.

References

1. Cornelisse, H. F. R Schoyer and K. F. Wakker, Rocket Propulsion and Spaceflight Dynamics, Pitman, 1984.
2. V. L. Pisacane, Fundamentals of Space Systems, Oxford University Press, 2005.
3. J. Sellers, Understanding Space: An Introduction to Astronautics, McGraw Hill, 2000.
4. C. D. Brown, Spacecraft Mission Design, AIAA Education Series, 1998.
5. M. Rudolph, Elements of Space Technology for Aerospace Engineers, Academic Press, 1999.
6. C. Sivaram, Rocket Dynamics and Space Flight, 1/e, Ane Books Pvt. Limited, 2009.

PE19: SPACE MECHANICS

L	T	P	S	J	Letter
3	0	0	0	0	3

Course Objectives:

- Explain the basic concepts of orbital Mechanics with particular emphasis on interplanetary trajectories.
- Focus the general N-Body problems related to satellite orbits in relation with space and time.
- Impart the concepts of Satellite Injection and orbit perturbation.
- Encourage the concepts of interplanetary trajectories of Spacecraft and Launch vehicles.
- Instruct about Ballistic Missiles trajectory and Materials used for launch vehicles.

UNIT I **6 hours**

Basic Concepts

The Solar System – References Frames and Coordinate Systems – The Celestial Sphere – The Ecliptic – Motion of Vernal Equinox – Sidereal Time – Solar Time – Standard Time – The Earth's Atmosphere.

Learning Outcomes:

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

- gain an awareness of dynamical system theory for space mission design (L4)
- understand the fundamentals of spacecraft rotational dynamics (L2)
- analyze and linearize the orbital dynamics and rotational dynamics (L3)

UNIT II **10 hours**

The General N-Body Problem

The many body Problem – Lagrange – Jacobian Identity –The Circular Restricted Three Body Problem – Libration Points- Relative Motion in the N-body Problem –Two –Body Problem – Satellite Orbits- Relations Between Position and Time – Orbital Elements.

Learning Outcomes:

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

- understand the fundamentals of two-body orbits; are familiar with multi-body orbits (L2)
- mathematically describe the mechanics of orbital motion including perturbations(L3)
- understand and use the relationships between position, velocity, energy, angular momentum, and the classical orbital elements. (L2)
- exploit three-body problem dynamics for mission design and analysis(L4)

UNIT III **8 hours**

Satellite Injection and Satellite Orbit Perturbation

General Aspects of satellite Injections – Satellite Orbit Transfer –Various Cases – Orbit Deviations Due to Injection Errors – Special and General Perturbations –

Cowell's Method– Encke's Method – Method of vibrations of Orbital Elements – General Perturbations Approach.

Learning Outcomes:

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

- learn the dynamics of the satellite. (L2)
- accomplish through problems from orbital mechanics such as finding characteristics of desired transfer trajectories and the corresponding specific impulses(L3)
- able to understand the communication satellite design. (L2)
- analyse spacecraft orbits and their perturbations, and recognise commonly employed satellite orbits(L4)

UNIT IV **8 hours**

Interplanetary Trajectories

Two Dimensional Interplanetary Trajectories –Fast Interplanetary Trajectories – Three Dimensional Interplanetary Trajectories – Launch if Interplanetary Spacecraft –Trajectory about the Target Planet.

Learning Outcomes:

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

- identify, formulates, and solves engineering problems. (L2)
- design and calculate inter-orbit transfers(L2)
- design and perform preliminary analysis of interplanetary trajectories (L3)
- accomplish through problems requiring the design of interplanetary trajectories(L4)

UNIT V **9 hours**

Ballistic Missile Trajectories and Material

The Boost Phase – The Ballistic Phase –Trajectory Geometry- Optimal Flights – Time of Flight – Re– entry Phase – The Position of the Impact Point – Influence Coefficients. Space Environment – Peculiarities – Effect of Space Environment on the Selection of Spacecraft Material.

Learning Outcomes:

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

- design a system, component or process to meet desired needs for a space mission. (L2)
- gain an awareness of computer-aided trajectory design and optimisation for space mission design(L3)
- compute delta-V and fuel requirements for various orbital manoeuvres, interplanetary transfers, and launches. (L4)

Course Outcomes:

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

- apply the basic concepts of orbital Mechanics with particular emphasis on interplanetary trajectories.
- apply the general N-Body problems related to satellite orbits in relation with space and time.
- formulate mathematical model for the Satellite Injection and orbit perturbation.
- apply mathematical model on interplanetary trajectories of Spacecraft and Launch vehicles.
- follow methods used for the Ballistic Missiles trajectory and Materials used for launch vehicles.

Text Book

1. Cornelisse, J.W., "Rocket Propulsion and Space Dynamic", W.H. Freeman & Co., 1984.

References

1.Sutton, G.P., "Rocket Propulsion Elements", John Wiley, 1993.
2. Van de Kamp, P. "Elements of Astro-mechanics", Pitman, 1979.
3.Parker E.R., "Materials for Missiles and Spacecraft", McGraw-Hill Book Co. Inc., 1982.

CO-PO-PSO-MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2	2	1	1	1	1	1	1	1	1	2	1	1
CO2	2	2	1	3	1	1	1	1	1	1	1	1	2	1	1
CO3	3	2	3	2	1	1	1	1	1	1	1	0	3	1	1
CO4	2	2	2	2	1	1	1	1	1	1	1	1	2	1	1
CO5	2	2	3	1	1	1	1	1	1	1	1	1	2	1	1

PE20: SATELLITE ATTITUDE AND CONTROL

L	T	P	S	J	Letter
3	0	0	0	0	3

Preamble:
This course provides an introduction to the basic concepts of satellites and its control systems of space missions.

Course Objectives:
- Focus on developing mathematical models of spacecraft attitude dynamics
- Analyzing the response to external disturbances and control torques
- Demonstrate Multiplexing schemes and multiple access techniques
- Impart rigorously develop the concepts, mathematical procedures, and methods associated with defining, determining, and controlling the attitude of a spacecraft.
- Encourage, the student will develop the theoretical background necessary to purse advanced courses in the field of Spacecraft Attitude Dynamics.

UNIT I Elements of Satellite Communication: 6 hours
Satellite systems, orbital description and orbital mechanics of LEO, MEO and GSO, placement of a satellite in a GSO, satellite, description of different communication subsystems, bandwidth allocation.

Learning Outcomes:
After completion of this unit students are able to
- analyse Keplerian motion and non-Keplerian perturbation effects; (L4)
- compute and analyze optimum impulsive maneuvers and orbit transfers; (L3)
- demonstrate knowledge of preliminary (two-body) orbit determination techniques. (L2)

UNIT II 10 hours
Transmission, Multiplexing, Multiple Access and Coding: Differentmodulation and multiplexing schemes, multiple access techniques FDMA, TDMA, CDMA and DAMA, coding schemes, satellite packet communications.

Learning Outcomes:
After completion of this unit students are able to
- understand about codes of satellite attitude dynamics for different techniques(L2)
- understand multiple techniques of FDMA,TDMA, CDMA and DAMA(L2)
- learn to write coding schemes for Transmission multiple access, (L3)

UNITIII **8 hours**

Attitude and Orbit Control System: Coordinate system, AOCS requirements, environment effects, attitude stabilization, attitude sensors, actuators, design of control algorithms.

Learning Outcomes:

After completion of this unit students are able to

- understand attitude control systems – 2-dimensional coordinate system of orbit (L2)
- understand actuators, attitude sensors and attitude stabilization of satellite (L2)
- understand environmental effects and its requirements AOCS (L2)

UNIT IV **12 hours**

Propulsion Systems, Structures and Thermal Control: Systems trade-off, mono propellant systems, thermal consideration, system integration design factors, pre-flight test requirements, system reliability configuration design of spacecraft structure, structural elements, material selection. Environmental loads, vibrations, structural fabrication, orbital environments, average temperature in space, transient temperature evaluation, thermal control techniques, temperature calculation for a spacecraft, thermal design and analysis program structure, thermal design verification, active thermal control techniques.

Learning Outcomes:

After completion of this unit students are able to

- learn about mono-propellants systems, thermal consideration of its systems (L3)
- understand basic knowledge of spacecraft structures and its thermals control techniques (L2)
- acquire knowledge on thermal design and analysis program. (L2)

UNIT V **6 hours**

Telemetry Systems: Base band telemetry system, modulation, TT and CRF system, telecommand system, ground control systems.

Learning Outcomes:

After completion of this unit students are able to

- understand telemetry system in space environment (L2)
- get knowledge about TCS and GCS tracking systems (L3)
- create basics ideas on writing programs for control systems (L3)

Course Outcomes:

After completion of this course students are able to

➢ learn the subject of spacecraft attitude dynamics, determination and control.

➢ analyze the free and forced rotational dynamics of rigid bodies.

➢ apply rigid body dynamic equations and basic control concepts to the modeling of orbiting spacecraft maneuvers

Text Book(s)

1. K. V. B. Narayana, Satellite Architecture, 2/e, ISRO Satellite Center, 2011.
2. V. V. Beletsky and E. M. Levin, Dynamics of Space Tether Systems, 1/e, Amer Astronautical Society 1993.

References

1. P. C. Hughes, Spacecraft Attitude Dynamics, 1/e, Dover Publications, 2004.
2. V. A. Chobotov, Spacecraft Attitude Dynamics and Control, 1/e, Orbit Books,1991

CO-PO-PSO-MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	3	1	1	1	1	1	1	1	3	1	2	1	1
CO2	2	2	2	1	1	1	1	1	1	1	2	1	1	1	1
CO3	2	1	2	1	1	1	1	1	1	1	1	1	3	2	1
CO4	2	2	1	1	2	1	1	1	1	1	2	1	1	1	1
CO5	2	1	2	1	2	1	1	1	1	1	1	1	2	1	1

PE21: GUIDANCE AND CONTROL

L	T	P	S	J	Letter
3	0	0	0	0	3

Unit I **6 hours**

Introduction: Introduction to navigation, guidance and control – definition and historical background.

Unit II **10 hours**

Missile and Launch Vehicle Guidance: Operating principles and design of guidance laws, homing guidance laws - short range, medium range and beyond visual range missiles, launch vehicle - introduction, mission requirements, implicit guidance schemes, explicit guidance, Q- guidance of missile.

Unit -III **8 hours**

Augmentation Systems: Need for automatic flight control systems, stability augmentation systems, control augmentation systems, gain scheduling concepts.

Unit IV **10 hours**

Longitudinal Autopilot: Displacement autopilot - pitch orientation control system, acceleration control system, glide slope coupler and automatic flare control and flight path stabilization, longitudinal control law design using back stepping algorithm.

Unit V **8 hours**

Lateral Auto Pilot: Damping of the Dutch roll, methods of obtaining coordination, yaw orientation control system, turn compensation, automatic lateral beam guidance. Introduction to fly-by-wire flight control systems, lateral control law design using back stepping logarithm.

Textbook(s)

1. J. H. Blakelock, Automatic Control of Aircraft and Missiles, John Wiley, 1990.

2. B. L Stevens and F. L. Lewis, Aircraft Control and Simulation, John Wiley, 1992.

References

1. R. P. G. Collinson, Introduction to Avionics, Chapman and Hall, 1996.

2. P. Garnel and D. J. East, Guided Weapon Control Systems, Pergamon Press, 1977.

3. B. Etkin, Dynamics of Flight Stability and Control, John Wiley, 1972.

4. J. Strickland, Missile Flight Simulation, Lulu Inc, 2012.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	3	1	1	1	1	1	1	1	2	1	1	1	1
CO2	2	2	2	2	1	1	1	1	1	1	2	1	2	1	1
CO3	2	2	3	3	1	1	1	1	1	1	2	1	2	1	1
CO4	2	2	2	2	1	1	1	1	1	1	2	1	2	1	1
CO5	1	2	3	2	1	1	1	1	1	1	2	1	1	1	1

PE22: AIRCRAFT SYSTEMS AND INSTRUMENTS

L	T	P	S	J	Letter
3	0	0	0	0	3

Preamble:

This course work is designed specifically for the undergraduate students of Aerospace Engineering as an elective. This course work is mainly aimed for the students, who are very interested in obtaining the knowledge of instrumentation and system components of the Aircraft. In the view of the outline, this course will provide knowledge to the students in the areas of control surfaces, Engine and fuel systems, Hydraulic and Pneumatic systems, Environmental Control Systems and Aircraft Instruments of flying machine.

Course Objectives:

- Introduction to various aircraft systems, integration and overview of the functions of the same.
- To impart knowledge of the hydraulic and pneumatic systems components
- To obtain knowledge of aircraft system and instrumentation's failures and analysis.

UNIT I **8 hours**

FLIGHT CONTROL SYSTEMS

Principles of flight control, flight control surfaces, flight control linkage systems, trim and feel, flight control actuation, fly by wire system, Airbus and Boeing implementations, interrelationship of flight control, guidance and vehicle management systems.

Learning Outcomes

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

- Obtain the knowledge and over view of flight instruments and components (l2)
- Understand the industrial design criteria for the flying machines (l4)
- Know the flights control and management systems(l2)

UNITII **10 hours**

ENGINE CONTROL AND FUEL SYSTEMS

Engine control problem, fuel flow control, air flow control, control system parameters, engine starting and ignition systems, lubricating systems for aircraft piston and jet/propeller engines.

Fuel systems: Characteristics of aircraft fuel systems, fuel systems components, fuel transfer pumps, fuel booster pumps, fuel transfer valves, and fuel quantity measurement systems

Learning Outcomes

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

- Achieve deep knowledge of flight power plant systems and solutions for raised problems in the same (l2)
- Possess knowledge of aircraft fuels systems, working mechanism and components (l4)
- Debug and cross checking in various components of power plant (l5)

UNITIII **10 hours**
HYDRAULIC&PNEUMATIC SYSTEMS

Hydraulic systems: Hydraulic circuit design, hydraulic actuation, hydraulic fluid, hydraulic pumps. Types of hydraulic systems, landing gear systems - retraction, steering, braking and antiskid **Pneumatic systems**: Basic working principle of pneumatic systems, pneumatic power system - components, use of pneumatic power in aircraft, sources of pneumatic power, the engine bleed air, engine bleed air control,

Learning Outcomes

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

- Know the definition and applications of hydraulic and pneumatic systems which are used in flying machines (l2)
- Acquire knowledge of various hydraulic systems and maintenance systems of the same (l2, l3)
- Exhibit knowledge on various pneumatic systems and uses of pneumatic power in flights controls (l2, l3)

UNIT IV **9 hours**
ENVIRONMENTAL CONTROL SYSTEMS

The need for a controlled environment in aircraft, Refrigeration systems - vapour cycle systems, boost

- strap air cycle system, humidity control, aircraft anti-icing and de-icing systems, air distribution systems, cabin pressurization, g-tolerance, rain dispersal, anti-misting and demisting.

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

- Have knowledge of various environmental conditions for flights, cycles and cooling systems (l2)
- Understand the role of humidity control, aircraft anti-icing and de-icing systems of aircrafts.(l3, l4)
- Illustrate the requirements of air distribution systems, cabin pressurization systems (l2)

UNITV **8 hours**
AIRCRAFT INSTRUMENTS

Flight instruments and navigation instruments, gyroscope, accelerometers, air speed indicators – TAS and EAS; Machmeters, altimeters, principles and operation, study of various types of engine instruments, tachometers, temperature gauges, pressure gauges – operation and principles.

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

- Understand the roles of flight instruments and navigation instruments (l2)
- Have knowledge of various components of flights for navigation applications (l2, l3)
- Clear explanation of aircraft maintenance instruments and principal operations (l3, l4)

Course Outcomes

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

- Develop a mind set to implement instrumentation requirements and describe instrumentation elements, mechanism, error sources. (l3)
- Understand the aircraft classical and state of art control systems, engine control system fuel systems and its components for both civil and military aircrafts.(l2)
- Learn the significance of hydraulic system; pneumatic systems and emergency power sources used in aircraft.(l3)
- Increase the understanding of electrical systems (both a.c and d.c) utilizing as an auxiliary power sources in aircrafts. (l2)
- Develop effective skills for the operation of flight instruments incorporating gyroscopes, basic flight indicators, sensors and its operating principles. (l2)

Text Book(s)

1. A. Seabridge, I. Moir, Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration, 2/e, John Wiley and Sons, 2008.
2. E. H. J. Pallett, Aircraft Instruments and Integrated Systems, 1/e, Pearson Education, 1992.
3. Mekinley, J.L. and R.D. Bent, "Aircraft Power Plants", McGraw Hill 1993

Reference Books

1. Moir, I. and Seabridge, A., Design and development of aircraft systems-an introduction, AIAA education series, AIAA,2004.
2. Aircraft systems by David A Lambro tata Mc Graw Hill. Ed;2009.

	P O 1	P O 2	P O 3	P O 4	P O 5	P O 6	P O 7	P O 8	P O 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	2	2	2	2	1	1	1	1	1	3	1	2	1	1
CO2	2	2	3	1	1	1	1	1		1	2	1	1		1
CO3	1	1	2	2	2	1			1		1	1	3	2	1
CO4	2	2	2	1	2		1	1	1	1	2		1	1	1
CO5	2	1	1	2	1	1	1	1	1	1	1	1	2	1	1

PE23: AIRPORT PLANNING AND MANAGEMENT

L	T	P	S	J	Letter
3	0	0	0	0	3

Preamble:

This course is designed for Aerospace Engineering undergraduate students. This course aims in basic understanding of airport operations, planning and management.

Course Objectives:

- Impart knowledge on administration and organization of airport systems.
- Familiarize about the components of the airport such as airfield, airspace and control, terminal, and ground access.
- Understand the concepts of airport security and financial management.
- Focus on the economic role that airports play within local communities.
- Describe the different types of airfield pavements and their potential failures

UNIT I **8 hours**

Airports and airport systems: An introduction, organization and administration, a historical and legislative perspective.

Learning Outcomes:

After completion of this unit the student will be able to

- Identify federal regulations and advisory circulars that influence airport operations.(l3)
- Demonstrate the ownership characteristics of airports in the united states and internationally. (l2)
- Understand the public relations issues that are associated with airport management.(l2)
- Describe the development of national administrations that have regulated civil aviation throughout its history.(l1)
- Describe the various funding programs that have existed to support airports over the course of history.(l1)

Unit ii **9 hours**

The components of airport: the airfield, airspace and air traffic control, airport terminals and ground access.

Learning outcomes:

After completion of this unit the student will be able to

- Identify the various facilities located on an airport's airfield.(l3)
- Interpret the specifications and types of airport runways.(l2)
- Understand the importance of runway orientation.(l2)
- Identify an airport's reference code.(l3)
- Be familiar with airfield lighting, signage, and markings.(l1)
- Describe the various navigational aids that exist on airfields.(l1)

UNIT III **9 hours**

Airport Operations and Financial Management: Airport operations management under FAR 139, airport security,airport financial management

Learning Outcomes:

After completion of this unit the student will be able to

- Understand the requirements under FAR Part 139 to operate airports serving commercial air carrier operations. (L2)
- Describe the different types of airfield pavements, their potential failures, and various types of maintenance programs. (L1)
- Identify the areas of concern with respect to safety inspection programs.(L3)
- Understand the difference between O&M and capital improvement expenses.(L2)
- Be familiar with the process of airport financial accounting.(L1)
- Explain the need for liability insurance at airports.(L2)

UNIT IV **9 hours**

Airport public administration and planning: The economic, political, and social role of airports, airport system and master planning.

Learning Outcomes:

After completion of this unit the student will be able to

- Understand the important economic role airports play within local communities.(L2)
- Examine how airport activity stimulates economic growth in a metropolitan region.(l2)
- Appreciate the complex relationships between airport management and the airlines that serve their airports.(l2)
- Define the various measures used to determine the impact of noise around airports.(l1)
- Describe various noise abatement programs employed at airports.(l1)

UNIT V **7 hours**

Future of Airport management:

Airport capacity and delay, the future of airport management.

Learning Outcomes:

After completion of this unit the student will be able to

- Define the concepts of capacity, particularly as it relates to airport activity.(l1)
- Identify the factors of the airport environment that affect capacity and delay.(l3)
- Be familiar with the various runway configurations and their rules of operation that affect capacity.(l2)
- Describe the concept of lahso, as it relates to airport capacity.(l3)
- Estimate the capacity of an airfield on the basis of faa approximation charts.(l2)

After successful completion of this course the students will be able to:

- Gain knowledge on the development of national administrations that have regulated civil aviation throughout its history.
- Identify various components of the airport and be familiar with airfield lighting.
- Be familiar with the process of airport financial accounting
- Appreciate the complex relationships between airport management and the airlines that serve their airports
- Understand the challenges for future airport management.

Text Book(s)

1. Seth Young and Alexander T. Wells, Airport Planning and Management, 7/e, McGraw Hill, 2019.
2. P.C.K. Ravindran, Airport Management, 1/e by, Asian Law House, 2013.

Reference(s):

1. Richard de Neufville and Amedeo Odoni, Airport Systems: Planning, Design and Management, 2/e, McGraw Hill, 2016.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1		1	1	1	1	1	1	1	1	2	1	1
CO2	2	2	1		1	1	1	1	1	1	1	1	2	1	1
CO3	2	1	1		1	1		1	1	1	2	1	2	1	1
CO4	2	1	1	1	1	1	1	1	1	1	1	1	2	1	1
CO5	2	1	1	1	1	1	1	1	1	1	1	1	2	1	1

PE24: AIR TRANSPORTATION SYSTEMS

L	T	P	S	J	Letter
3	0	0	0	0	3

Preamble:

This course is designed for Aerospace Engineering undergraduate students. This course aims in basic understanding of elements of air transportation systems.

Course Objectives:

- Facilitate the basic knowledge on aviation Industry and regulations,
- Develop perspective on airspace category, and understand the evolution ATC System
- Impart conceptual skills to understand the management procedures related to Aircraft, Airport and Airlines.
- Create an interest towards the field of air transportation.

UNIT I **8 hours**

Aviation Industry and its Regulatory Authorities: Introduction, history of aviation, evolution, development, growth and challenges. The breadth of regulation: ICAO, IATA, DGCA, and FAA. Safety regulations, risk assessment, human factors and safety, security regulations and environmental regulations.

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

- Recall the history of aviation and its evolution. (l1)
- Outline the breadth of regulatory authorities. (l2)
- Understand the safety, security and environmental regulations. (l2)

UNIT II **9 hours**

Airspace: Categories of airspace, separation minima, airspace sector, capacity demand and delay. Evolution of air traffic control system, procedural ATC system, procedural ATC with radar assistance, first generation automated ATC system, current generation radar and computer-based ATC systems, aerodrome air traffic control equipment and operation, ICAO future air-navigation systems, FANS.

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

- Define the airspace and separation minima. (l1)
- Understand the evolution of air traffic control system (l2)
- Interpret relation between capacity, demand and delay(l2)

UNIT III **9 hours**

Aircraft: Costs, project cash-flow, aircraft price, compatibility with the operational infrastructure, direct and indirect operating costs, balancing efficiency and effectiveness, payload, range, fuel efficiency, technical contribution to performance, operating speed and altitude, aircraft field length performance, typical operating costs, effectiveness, wake-vortices, cabin dimensions and flight deck.

Learning outcomes:

After completion of this unit the student will be able to

- Classify the types of costs. (l2)
- Interpret the concepts of efficiency and effectiveness with respect to payload-range, fuel efficiency. (l2)
- Understand the aircraft field length performance(l2)

UNIT IV **8 hours**

Airports: Airport demand, airport siting, runway characteristics, length, declared distances, aerodrome areas, obstacle safeguarding. Runway capacity, evaluating runway capacity, sustainable runway capacity, runway pavement length, maneuvering area, airfield lighting, aprons, passenger terminals, terminal sizing and configuration, airport demand, capacity and delay.

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

- Identify ideal conditions for an airport siting.(l3)
- Define various runway declared distances(l1)
- Gain knowledge on airfield lighting and other maneuvering aerodrome areas.(l1)

UNIT V **8 hours**

Airlines: Modern airline objectives, route selection and development, airline fleet planning, annual utilization and aircraft size, seating arrangements. Indirect operating costs, aircraft - buy or lease. Revenue generation, computerized reservation systems, yield management, integrating service quality into the revenue-generation process, airline scheduling, evaluating success - financial viability, regulatory compliance, efficient use of resources and effective service.

Course outcomes:

After completion of this unit the student will be able to

- Recall the history of aviation and the breadth of regulatory authorities.
- Define the airspace and learn the technologies used for navigating within the defined airspaces.
- Understand the various costs attributing to total aircraft cost.
- Understand the need for airport demand and interpret the concepts of runway and other areas of aerodrome.
- Learn the advanced technologies for understanding airline management.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1			1	2	1	2	1	1	1	1	2	1	1
CO2	2	1	1		1	1		1	1	1	1	1	2	1	1
CO3	2	2	1	1	2	2	1	1	1	1	1	1	2	1	1
CO4	2	1	1		1	1		1	1	1	1	1	2	1	1
CO5	3	2	1	1	1	1	1	1	1	1	1	1	2	1	1

TextBooks:

1. Hirst. M, The Air Transport System, 3/e, Woodhood Publishing Ltd.,Cambridge, 2008.
2. G. W. John, Specification of Air Transportation: A management, 7/e, Ashgate Publishing, 2011.

Reference(s)

1. J. G. Wensven, Air Transportation: A Management Perspective, 7/e, Ashgate Publishing 2007.
2. M. Bazargan, Airline Operations and Scheduling, 1/e, Ashgate Publishing, 2004.
3. Dieter Shmitt, and Valker Gollnick, Air Transport System, Springer 2016.
4. A. Wells and S. Young, Airport Planning and Management, 5/e, McGraw Hill, 1986.

PE25: HELICOPTER ENGINEERING

L	T	P	S	J	Letter	P/F
3	0	0	0	0	3	

Preamble:

This course is intended to introduce helicopters to aerospace engineering students. This course will help student to gain knowledge on different types of helicopters and working principle and the design of helicopters considering various aspects.

Course Objectives:

- Familiarize different configurations of helicopters based on rotors.
- Explain the basic concepts of helicopter basic aerodynamics.
- Explain blade element theory of helicopter rotors and help to find aerodynamic force and moments generation using BET.
- Explain helicopter rotor using vertical and forward motion of helicopter.
- Explain the concept of auto-rotation, gliding and powered flight of helicopter.

UNIT I **8 hours**

Elements of Helicopter Aerodynamics: Introduction, helicopters, configurations: jet rotors and compound helicopters, methods of control, collective and cyclic pitch, lead-lag, flapping hinges and lift dissymmetry, helicopters - tandem and tail rotor configuration and their advantages and disadvantages, auto rotation of helicopter.

Learning Outcomes:

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

- Gain knowledge on different types of helicopters (l1)
- Understand the concept on methods of controls (l1)
- Learn about the advantages and disadvantages of different of types of helicopters and their applications (l1)

UNIT II **9 hours**

Momentum Theory and Wake Analysis: Momentum theory for hover, non-dimensionalization, figure of merit, axial flight, momentum theory of vertical climb.

Blade Element Theory: Basic method - thrust grading, torque grading, non-uniform flow, ideal twist, blade mean lift coefficient, power approximations, tip loss, hover characteristics.

Learning Outcomes:

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

- Understand the hovering and apply the momentum theory for hovering (l3)
- Understand blade element theory (l2)
- Estimate power approximations and losses (l4)

UNIT III **8 hours**

Rotor Mechanism and Aerodynamics: The edgewise rotor, flapping motion, rotor control, equivalence of flapping and feathering, blade sailing, lagging motion, Coriolis acceleration, lag frequency, blade flexibility, ground resonance.Descending forward flight, wake analysis, In-plane H-Force, flapping coefficients.

Learning Outcomes:
At the end of the unit, student will be able to

- Understand the concepts ofrotor mechanism (l1)
- Estimate the flapping coefficients under different phases of flight. (l3)
- Estimate the power in forward flight (l4)
- Analyze the wake in forward flight. (l4)

UNIT IV **8 hours**

Configuration and Power Estimates: Tilt wing and vectored thrust, performance of VTOL and STOL aircraft in hover, transition and forward motion. Induced, profile and parasite power requirements in hover and forward flight, performance curves with effects of altitude, in-ground and out of ground effects of helicopter.

Learning Outcomes:
At the end of the unit, student will be able to

- Estimate the performance of vtol and stol aircrafts (l4)
- Plot the performance curves considering the effects of altitude (l4)
- Evaluate in-ground and out of ground effects of helicopter (l4)

UNIT V **8 hours**

Rotor Aerodynamic Design: Blade section design, blade tip shapes - rectangular, swept, and advanced planforms, tail rotors - propeller moment, precession, yaw agility, calculation of downwash, yaw acceleration, and parasite drag, rear fuselage upsweep and aerodynamic design process.

Learning Outcomes:
At the end of the unit, student will be able to

- Design the rotor blade considering aerodynamic parameters (l4)
- Understand the aerodynamic design process in rear fuselage of helicopter (l1)
- Calculate the drag of blade tip (l4)

Course Outcomes:
At the end of the course the student will be able to:

- Design helicopter blades using blade element theory for modern helicopters based on the requirement.
- Approximate the power calculations for hover, vertical and forward flight of a helicopter.
- Adapt the design of blades in different applications such as windmills for energy generation.
- Apply the knowledge of helicopter aerodynamics for autorotation and normal flying conditions.
- Exhibit the aerodynamic design process in rear fuselage of helicopter

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	1	1	2	1	0	1	1	2	0	2
CO2	3	2	1	0	1	2	2	1	2	2	0	2	1	2	0
CO3	2	2	2	2	1	2	1	2	1	1	1	1	3	2	2
CO4	3	1	1	1	1	2	2	2	2	2	1	2	2	1	2
CO5	3	2	2	1	1	0	1	1	1	1	2	1	3	1	2

Text Book(s)

1. J. Seddon and S. Newman, Basic Helicopter Aerodynamics, 3/e, John Wiley, 2011.
2. W. Johnson, Helicopter Theory, Dover Publications, 1994.

References

1. A. Gessow and G. C. Myers, Aerodynamics of Helicopter, Macmillan and Co., 1987.
2. B.W. McCormick, Aerodynamics of V/STOL Flight, Academics Press, 1987.
3. J. G. Leishman, Principles of Helicopter Aerodynamics, 2/e, Cambridge University Press, 2006.
4. L. Gupta, Helicopter Engineering, Himalayan Books, 1996

PE26: AVIONICS

L	T	P	S	J	Letter	P/F
3	0	0	0	0	3	

Preamble:

This course work is mainly aimed for the students, who are very interested in obtaining the knowledge of Avionics and avionics systems. From the outline of this course, it can be observed that, after completion of this course work, students are able to obtain knowledge in the areas of basics and working with of Avionic systems, over view of flight desks and cockpits, radio navigation systems, Autopilots configurations and, needs and operations of surveillance systems which are also green areas of research works in aircraft research and manufacturing organizations.

Course Objectives:

- Introduce the students to functioning and principle of operation of various avionics systems namely, flight sensors installed on a modern passenger and fighter aircraft.
- Introduce the students to guidance, landing, the concepts of auto pilots and surveillance systems of UAV's, and MAV's,
- To introduce various digital electronic principles and working operations of digital circuit.
- To integrate the digital electronics with cockpit equipment's
- To understand the various principles in flight disk and cockpit panels.
- To study the communication and navigation equipment

UNIT I **8 hours**

Introduction to Avionics: Importance and role of avionics, basic principles of avionics, typical avionics sub system in civil/ military aircraft and space vehicles need for avionics in civil and military aircraft and space systems, traffic collision avoidance system - TCAS-I and TCAS-II, ground proximity warning system.

Learning Outcomes

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

- Understand the role of avionics, and c principles of avionics in flying machines (L2)
- Knowledge of avionics sub system in civil/ military aircraft and space vehicles (L2, L3)
- Explanation about the integrated avionics, weapon systems TCAS-I and TCAS-II(L2, L6)

UNIT II **8 hours**

Flight Decks and Cockpits: Control and display technologies: CRT, LED, LCD, EL, plasma panel, touch screen, direct voice input (DVI). Civil and military cockpits: MFDS, MFK, HUD, HMD, HOTAS

Learning Outcomes
At the end of the unit, student will be able to:

- Understand the concepts of Control and display technologies (L2)
- Knowledge and working principal of plasma panel, touch screen, direct voice input (DVI) (L2, L4).
- Discuss types of instruments in aircraft cockpit (L2)

UNIT III **10 hours**

Radio Navigation Systems: Aircraft audio systems, basic audio transmitter and receiver principles, types of frequency bands - HF, VHF, UHF, Tautomeric direction finder (ADF) - transmitter and receiver principles

of operation.

Ranging and Landing Systems: Very high frequency Omni direction range(VOR), transmitter receiver principles of operation, distance measuring equipment (DME), transmitter and receiver principles of operation, instrument landing system (ILS), localizer and glideslope.

Learning Outcomes
At the end of the unit, student will be able to:

- Understand the concepts of Aircraft audio systems, working of basic audio transmitter and various frequency band width (L2)
- Knowledge and working principal of (ADF) - transmitter and receiver principles of operation. (L2, L3).
- Importance of Ranging and Landing Systems of the flying machines.(L2)
- Know about the various distance measuring systems in avionics. (L2)

UNIT IV **8 hours**

Fly-By-Wire Flight Control and Navigation Systems: FBW flight control features, basic concept, advantages of FBW control, fly-by-wire control laws, redundancy, and failure Survival.

Navigation Systems: Types, inertial navigation, GPS basic principles, integration of GPS and INS, differential GPS.

Learning Outcomes
At the end of the unit, student will be able to:

- Understand the basic concepts of FBW flight control features (L2)
- Deep knowledge of fly-by-wire control laws, redundancy and failure Survival. (L2, L3).
- Get to know about the various types of navigation systems. (L2)

UNIT V **10 hours**

Surveillance and Auto Flight Systems: Basic principles, height control, heading control, ILS/ML Scoupled control, automatic landing, and speed control and auto-throttle control system.

Flight Management Systems: Introduction, radio navigation tuning, navigation, flight planning, performance prediction and flight path optimization, control of vertical flight path profile.

Learning Outcomes

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

- Understand the basic concepts Basic principles, height control, heading control, ILS/MLS coupled control (L2)
- Deep knowledge of Automatic landing, speed control and auto-throttle control system.(L2)
- Flight Management Systems which can help to control features such as maneuvering, integrated data management systems.(L2, L6)

Course Outcomes

Upon completion of the course, students will be able to:

- Describe the hardware required for aircraft
- Explain the communication and navigation techniques used in aircrafts
- Discuss about the autopilot and cockpit display related concepts
- Apply the algorithm for an aircraft actuation system, servo-components, inertial sensors, modelling, design and testing of sensors.
- Deploy these skills effectively in the solution of problems in avionics engineering.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	2	2	1	1	1	1	1	3	1	2	1	1
CO2	1	2	2	2	1	1	1	1	1	1	2	1	1	1	1
CO3	2	2	3	2	1	1	1	1	1	1	2	1	2	1	1
CO4	2	1	2	2	2	1	1	1	1	1	1	1	2	1	1
CO5	1	2	1	3	2	1	1	1	1	1	2	1	1	1	1

Text Book(s)

1. R. P. G Collinson, Introduction to Avionics System, 3/e, Springer, 2011.
2. C. R. Spitzer, Digital Avionics Systems: Principles and Practice, 2/e, TheBlackburn Press, 2001.

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2. I. Moir, A. Seabridge, M. Jukes, Civil Avionics Systems, 2/e, John Wiley,2013.
3. R. P. G. Collinson, Introduction to Avionics, 3/e, Springer, 2011.
4. 1. Kayton, M., & Fried, W.R, Avionics Navigation Systems, Wiley, 1997,ISBN 0-471-54795-6Z