BHARATH INSTITUTE OF HIGHER EDUCATION AND RESEARCH

CURRICULUM AND SYLLABUS

(R2018)
B - FACT

(Bharath – **F**lexible **A**ccommodative **C**hoice based credit system for **T**echnology)

(Applicable to the batches admitted from July 2018)

B.Tech - AERONAUTICAL ENGINEERING

FULL TIME

I – VIII SEMESTERS

SEMESTER I								
Sl. No.	**Code No.**	**Category**	**Course Title**	**Contact Periods**	**L**	**T**	**P**	**C**
THEORY								
1	U18HSEN101	HS	Communicative English	4	2	0	2	3
2	U18BSMA101	BS	Engineering Mathematics –I	4	4	0	0	4
3	U18BSPH101	BS	Waves and Optics	3	3	0	0	3
4	U18BSCH101	BS	Engineering Chemistry	3	3	0	0	3
5	U18ESCS101	ES	Problem Solving and Python Programming	3	3	0	0	3
6	U18ESME101	ES	Engineering Graphics & Design	5	1	0	4	3
PRACTICAL								
7	*U18BSPH2L1	BS	Wave Optics and Mechanics Lab	3	0	0	3	0
8	*U18BSCH2L4	BS	Chemistry Lab	3	0	0	3	0
9	U18ESCS1L1	ES	Problem Solving and Python Programming Laboratory	3	0	0	3	1.5
ACTIVITY BASED COURSES								
10	U18MCAB101	MC	Physical health – Sports & Games	2	0	0	2	0
11	U18MCAB102	MC	Gardening & Tree Plantation	2	0	0	2	0
TOTAL				**35**	**16**	**0**	**19**	**20.5**

***Laboratory Classes will be conducted on alternative weeks for Physics and Chemistry.**

The Lab Practical Examinations will be held only in the second semester (including the first semester experiments).

SEMESTER II								
Sl. No.	**Code No.**	**Category**	**Course Title**	**Contact Periods**	**L**	**T**	**P**	**C**
THEORY								
1	U18HSEN201	HS	Technical English	3	2	1	0	3
2	U18BSMA201	BS	Engineering Mathematics-II	4	4	0	0	4
3	U18BSPH201	BS	Introduction to Mechanics	3	3	0	0	3
4	U18BSCH201	BS	Environmental Sciences	3	3	0	0	3
5	U18BSBT201	BS	Biology for Engineers	2	2	0	0	2
6	U18ESEE101	ES	Basic Electrical and Electronics Engineering	3	3	0	0	3
PRACTICAL								
7	*U18BSPH2L1	BS	Wave Optics and Mechanics Lab	3	0	0	3	1.5
8	*U18BSCH2L4	BS	Chemistry Lab	3	0	0	3	1.5
9	U18ESME1L2	ES	Workshop / Manufacturing Practices Laboratory	5	1	0	4	3
10	U18ESEE1L3	ES	Basic Electrical and Electronics Engineering Laboratory	3	0	0	3	1.5
ACTIVITY BASED COURSES								
11	18MCAB203	MC	Yoga	2	0	0	2	0
12	18MCAB204	MC	Physical health – NCC	2	0	0	2	0
TOTAL				**36**	**18**	**1**	**17**	**25.5**

***Laboratory Classes will be conducted on alternative weeks for Physics and Chemistry.**

The Lab Practical Examinations will be held only in the second semester (including the first semester experiments).

SEMESTER III								
Sl. No.	**Code No.**	**Category**	**Course Title**	**Contact Periods**	**L**	**T**	**P**	**C**
THEORY								
1	U18BSMA302	BS	Partial Differential Equations, Probability and Statistics	4	3	1	0	4
2	U18PCAE301	PC	Fundamentals of Aeronautics and Astronautics	2	2	0	0	2
3	U18PCAE302	PC	Fundamentals of Mechanics and Machines	3	3	0	0	3
4	U18ESAE301	ES	Fundamentals of Fluid Mechanics	3	3	0	0	3
5	U18ESAE302	ES	Fundamentals of Aero – Thermodynamics	3	3	0	0	3
6	U18ESAE303	ES	Fundamentals of Structural Mechanics	3	3	0	0	3
PRACTICAL								
7	U18PCAE3L1	PC	Strength of Materials Laboratory	3	0	0	3	1.5
8	U18PCAE3L2	PC	Computer Aided Design and Drafting Laboratory	2	0	0	2	1
9	U18ESAE3L1	ES	Fluid Mechanics and Machinery Laboratory	3	0	0	3	1.5
ACTIVITY BASED COURSES								
10	U18MCAB305	MC	Culture- Learning an art form	2	0	0	2	0
11	U18MCAB306	MC	Culture – Intangible Cultural, heritage(festivals, Food ways, Local games)	2	0	0	2	0
TOTAL				**30**	**17**	**01**	**12**	**22**

SEMESTER IV								
Sl. No.	**Code No.**	**Category**	**Course Title**	**Contact Periods**	**L**	**T**	**P**	**C**
THEORY								
1	U18BSMA401	BS	Numerical Methods	3	3	0	0	3
2	U18PCAE401	PC	Elements of Aerospace Structures	3	3	0	0	3
3	U18PCAE402	PC	Low Speed Aerodynamics	3	3	0	0	3
4	U18PCAE403	PC	Aircraft Propulsion	3	3	0	0	3
5	U18PCAE404	PC	Aircraft Systems and Instrumentation	2	2	0	0	2
6	U18PCAE405	PC	Manufacturing Technology	2	2	0	0	2
7	U18MCTH401	MC	Constitution of India	2	2	0	0	0
PRACTICAL								
8	U18PCAE4L1	PC	Aerodynamics Laboratory	2	0	0	2	1
9	U18PCAE4L2	PC	Manufacturing Technology Laboratory	2	0	0	2	1
10	U18PCAE4L3	PC	Aero Design and Modeling Laboratory	2	0	0	2	1
ACTIVITY BASED COURSES								
11	U18MCAB407	MC	Literature & Media –Literature, Cinema & Media	2	0	0	2	0
12	U18MCAB408	MC	Literature & Media – Group Reading of Classics	2	0	0	2	0
TOTAL				**28**	**18**	**0**	**10**	**19**

SEMESTER V								
Sl. No.	**Code No.**	**Category**	**Course Title**	**Contact Periods**	**L**	**T**	**P**	**C**
THEORY								
1	U18PCAE501	PC	Aircraft Structural Mechanics	3	3	0	0	3
2	U18PCAE502	PC	Gas Dynamics	3	3	0	0	3
3	U18PCAE503	PC	Advanced Aerospace Propulsion	3	3	0	0	3
4	U18PCAE504	PC	Aircraft Performance	3	3	0	0	3
5	U18PCAE505	PC	Control Systems	3	3	0	0	3
6	-	PE	Professional Elective – I	3	3	0	0	3
7	U18MCTH502	MC	Universal Human Values	2	2	0	0	0
PRACTICAL								
8	U18PCAE5L1	PC	Aircraft Structures Laboratory	2	0	0	2	1
9	U18PCAE5L2	PC	Aircraft Maintenance Laboratory	2	0	0	2	1
10	U18PCAE5L3	PC	Flight Simulation Laboratory	2	0	0	2	1
11	U18PCAS5L4	PC	Simulation tool for Aerospace Applications	2	0	0	2	1
ACTIVITY BASED COURSES								
11	U18MCAB611	MC	Self Development – Spiritual, Mindfulness & Meditation	2	0	0	2	0
12	U18MCAB612	MC	Self Development - religion and Inter-faith	2	0	0	2	0
TOTAL				**32**	**20**	**0**	**12**	**22**

SEMESTER VI								
Sl. No.	**Code No.**	**Category**	**Course Title**	**Contact Periods**	**L**	**T**	**P**	**C**
THEORY								
1	U18HSBA601	HS	Organizational Behavior of Engineer	3	3	0	0	3
2	U18PCAE601	PC	Finite Element Analysis	3	3	0	0	3
3	U18PCAE602	PC	Aircraft Stability and Control	3	3	0	0	3
4	-	PE	Professional Elective – II	3	3	0	0	3
5	-	OE	Open Elective – I	3	3	0	0	3
6	U18MCTH603	MC	Essence of Indian Knowledge Tradition	2	2	0	0	0
PRACTICAL								
7	U18PCAE6L1	PC	Computer Aided Analysis Laboratory	2	0	0	2	1
8	U18PCAE6L2	PC	Propulsion Laboratory	2	0	0	2	1
9	U18EEAE6L1	EE	Aircraft Design Project – I	4	0	0	4	2
ACTIVITY BASED COURSES								
12	U18MCAB509	MC	Social Services – Social Awareness	2	0	0	2	0
13	U18MCAB510	MC	Social Services – NSS	2	0	0	2	0
TOTAL				**29**	**17**	**0**	**12**	**19**

SEMESTER VII								
Sl. No.	**Code No.**	**Category**	**Course Title**	**Contact Periods**	**L**	**T**	**P**	**C**
THEORY								
1	U18PCAE701	PC	Computational Fluid Dynamics for Aerospace Engineering	3	3	0	0	3
2	U18PCAE702	PC	Introduction to Avionics	3	3	0	0	3
3	-	PE	Professional Elective – III	3	3	0	0	3
4	-	PE	Professional Elective – IV	3	3	0	0	3
5	-	PE	Professional Elective – V	3	3	0	0	3
6	-	OE	Open Elective – II	3	3	0	0	3
PRACTICAL								
7	U18PCAE7L1	PC	Avionics Laboratory	2	0	0	2	1
8	U18EEAE7L1	EE	Aircraft Design Project – II	4	0	0	4	2
9	U18EEAE7P1	EE	Project Phase I	4	0	0	6	3
ACTIVITY BASED COURSES								
10	U18MCAB713	MC	Behavioral and Interpersonal Skills	2	0	0	2	0
11	U18MCAB714	MC	Nature – Nature club	2	0	0	2	0
TOTAL				**32**	**18**	**0**	**14**	**24**

SEMESTER VIII								
Sl. No.	**Code No.**	**Category**	**Course Title**	**Contact Periods**	**L**	**T**	**P**	**C**
THEORY								
1	-	PE	Professional Elective – VI	3	3	0	0	3
2	-	OE	Open Elective – III (MOOC)	2	2	0	0	2
3	-	OE	Open Elective – IV	3	3	0	0	3
PRACTICAL								
4	U18EEAE8P2	EE	Project Phase II	18	0	0	18	9
5	U18EEAE8C1	EE	Comprehension	0	0	0	2	0
ACTIVITY BASED COURSES								
6	U18MCAB815	MC	Innovation – Project based – Sc., Tech, Social, Design & Innovation	2	0	0	2	0
TOTAL				**28**	**08**	**0**	**22**	**17**

Total No. of Contact Hours : 250 Hours

Total No. of Credits : 169

SUMMARY OF CURRICULUM STRUCTURE AND CREDIT & CONTACT HOUR DISTRIBUTION

Sl. No.	Category of Courses	Semester wise Credits								No. of Credits	% of Credits
		I	II	III	IV	V	VI	VII	VIII		
1	Humanities and Social Sciences (HS)	3	3	-	-	-	3	-	-	09	5.32
2	Basic Sciences (BS)	10	15	4	3	-	-	-	-	32	18.93
3	Engineering Sciences (ES)	7.5	7.5	10.5	-	-	-	-	-	25.5	15.08
4	Professional Core (PC)	-	-	7.5	16	19	8	7	-	57.5	34.02
5	Professional Electives (PE)	-	-	-	-	3	3	9	3	18	10.65
6	Open Electives (OE)	-	-	-	-	-	3	3	5	11	6.5
7	Employability Enhancement (EE) Courses: Project Work, Technical Seminar, Internship, Term Paper, Comprehension, etc.	-	-	-	-	-	2	5	9	16	9.47
8	Mandatory Courses (MC)	-	-	-	-	-	-	-	-	-	-
Total Credit		20.5	25.5	22	19	22	19	24	17	169	100
Total Contact Hours		35	36	30	28	32	29	32	28	250 Hours	

LIST OF ELECTIVES

List of Professional Elective(PE) I:

Code No.	Specialization	Course Title	L	T	P	C
U18PEAE011	Maintenance	Aircraft General Engineering and Maintenance Practices	3	0	0	3
U18PEAE012	Propulsion	Rockets and Missiles	3	0	0	3
U18PEAE013	Aerodynamics	Experimental Aerodynamics	3	0	0	3
U18PEAE014	Aerodynamics	Boundary Layer Theory	3	0	0	3

List of Professional Elective (PE)II:

Code No.	Specialization	Course Title	L	T	P	C
U18PEAE021	Maintenance	Civil Aviation Regulations	3	0	0	3
U18PEAE022	Structures	Theory of Elasticity	3	0	0	3
U18PEAE023	Propulsion	Principles of Turbo machinery in Air breathing Engines	3	0	0	3
U18PEAE024	Materials science	Aircraft Materials	3	0	0	3

List of Professional Elective (PE) III:

Code No.	Specialization	Course Title	L	T	P	C
U18PEAE031	Maintenance	Vibrations and Elements of Aero elasticity	3	0	0	3
U18PEAE032	Structures	Aircraft Engine Repair and Maintenance	3	0	0	3
U18PEAE033	Propulsion	Missile Aerodynamics	3	0	0	3
U18PEAE034	Materials science	Hypersonic Aerodynamics	3	0	0	3

List of Professional Elective (PE) IV:

Code No.	Specialization	Course Title	L	T	P	C
U18PEAE041	Propulsion	An Introduction to Combustion	3	0	0	3
U18PEAE042	Materials science	Nano Science and Technology	3	0	0	3
U18PEAE043	Maintenance	Airport Engineering	3	0	0	3
U18PEAE044	Structures	Theory of Plate and shell	3	0	0	3

List of Professional Elective (PE) V:

Code No.	Specialization	Course Title	L	T	P	C
U18PEAE051	Materials science	Composite Materials and Structures	3	0	0	3
U18PEAE052	Structures	Experimental Stress Analysis	3	0	0	3
U18PEAE053	Maintenance	Helicopter Maintenance	3	0	0	3
U18PEAE054	Propulsion	Heat Transfer in Aerospace Applications	3	0	0	3

List of Professional Elective (PE) VI:

Code No.	Specialization	Course Title	L	T	P	C
U18PEAE061	Materials science	High Temperature Materials	3	0	0	3
U18PEAE062	Structures	Fatigue and Fracture Mechanics	3	0	0	3
U18PEAE063	Propulsion	Cryogenic Rocket Propulsion	3	0	0	3
U18PEAE064	Structures	Structural Dynamics	3	0	0	3

List of Open Electives

Code No.	Specialization	Course Title	L	T	P	C
U18OEAE001	Aerodynamics	Industrial aerodynamics	3	0	0	3
U18OEAE002	Engineering science	Elements of Aeronautics and Astronautics	3	0	0	3
U18OEAE004	Structures	Unmanned Aerial Vehicle	3	0	0	3

U18OEAE003	Avionics	Avionics systems	3	0	0	3
U18OEAE005	Propulsion	Rocket propulsion	3	0	0	3

LIST OF OPEN ELECTIVES COMMON TO ALL B.Tech PROGRAMMES

ALL THE COURSES WITH L=3, T=0, P=0 & C=3

1. U18OEBA001 Sociology
2. U18OEBA002-Lean Six Sigma
3. U18OEBA003-Cyber Law and Ethics
4. U18OEBA004-Economic Policies in India
5. U18OEBA005-Management Information System
6. Total Engineering Quality Management
7. U18OEBA007-Industrial Psychology
8. U18OEBA008-Entrepreneurship Development and IPR
9. U18OEBA009-Intellectual Property Rights
10. U18OEBA010-Engineering Economics and Cost Analysis
11. U18OEEN001- Soft Skills and Interpersonal Communication
12. U18OEEN002-Indian Writing in English
13. U18OEEN003-Creative Writing
14. U18OEEN004- Proficiency in English and Accent Training
15. U18OEMA001-Cryptography
16. U18OEMA002-Finite Automata Theory / Formal Languages
17. U18OEMA003-Linear Programming
18. U18OECE001 - Metro Systems and Engineering
19. U18OECE002-Pollution Regulations
20 U18OECE003-Road Safety
21. U18OECE004- Infrastructure Development
22. U18OECE005- Project Safety Management
23. U18OECE006- Environment, Health and Safety in Industries
24. U18OEME001-Design for Manufacturing and Assembly
25. U18OEME002Industrial Safety
26. U18OEME003-Refrigeration and Cryogenics
27. U18OEME004- Product Design and Development
28. U18OEAU001-Electric and Hybrid Vehicles
29. U18OEAU002-Intelligent Transportation System
30. U18OEAU003-Vibration and Noise Control
31. U18OEAU004-Automotive Sensors and Applications
32. U18OEMT001-MEMS and Nano Technology
33. U18OEMT002-Non-Destructive Testing
34. U18OEMT003-Bio Mechatronics
35. U18OEMT004-Artificial Intelligence for Robotics
36. U18OEAE001-Industrial Aerodynamics
37. U18OEAE002- Elements of Aeronautics and Astronautics
38. U18OEAE003- Unmanned Aerial Vehicle
39. U18OEAE004- Introduction to Avionics
40. U18OEAE005-Rocket Propulsion

41. U18OEEE001-Green Technologies
42. U18OEEE002-Electrical Safety and Quality Assurance
43. U18OEEE003-Energy Conservation Techniques
44. U18OEEE004-PLC and SCADA for Industrial
45. U18OEEC-001-Communication Systems
46. U18OEEC-002-VLSI circuits
47. U18OEEC-003-Image Processing Techniques
48. U18OEEC-004-Communication Networks
49. U18OEEC-005-An Introduction to DSP
50. U18OEEC-006-Basics of IoT
51. U18OEBM001-Medical Radiation Safety Engineering
52. U18OEBM002-Medical Waste Management
53. U18OEBM003-Quality Control in Healthcare
54. U18OEBM004-Wearable Technology
55. U18OEEI001-Analytical Methods and Instrumentation
56. U18OEEI002-Introduction to process Data Analytics
57. U18OEEI003-Reliability and Safety in Process industries
58. U18OEEI004-Multi sensor data fusion
59. U18OEBT001- Bioprocess Economics & Plant Design
60. U18OEBT002-Brewing technology
61. U18OEBT003-Biomining
62. U18OEBT004-Industrial Safety Engineering
63. U18OEAC001-Geo- informatics for Precision Farming
64. U18OEAC002-Livestock and poultry management
65. U18OEAC003-Extension methodologies and transfer of Agricultural Technologies
66. U18OEAC004-Soil and Water Conservation Engineering
67. U18OEIT001-Block Chain Technology
68. U18OEIT002-Semantic Web
69. U18OEIT003-Entrepreneurship Development
70. U18OEIT004-Ethical Hacking Techniques
71. U18OECS001-Mobile Application Development
72. U18OECS002-System Modelling and Simulation
73. U18OECS003-Web Programming
74. U18OECS004-Virtual Reality
75. U18OECS005- E Commerce
76. U18OEGE001-Metagenomics and Epigenomics
77. U18OEGE002-Molecular Genetics and Genomics
78. U18OEGE003-Principles of Molecular cell biology

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U18HSEN101	**COMMUNICATIVE ENGLISH**	L	T	P	C
	Total Contact Periods – 60	2	0	2	3
	Prerequisite – School English				
	Course Designed by – Department of English				
OBJECTIVES	To gain fundamental knowledge of language and the uses in daily life.				

UNIT I SPEAKING 6

Speaking- Pronunciation, Intonation, Stress and Rhythm -Common Everyday Situations: Conversations and Dialogues -Communication at Workplace -Interviews -Formal Presentations -introducing oneself – exchanging personal information- narrating events, -incidents , speaking about one's friend/pet -Wh- Questions- asking and answering-yes or no questions- parts of speech. Vocabulary development– prefixes- suffixes- articles, prepositions.

UNIT II READING 6

Reading – comprehension (multiple choice questions, short questions) - short narratives and descriptions from newspapers including dialogues and conversations also used as short reading texts-- and longer passages - understanding text structure- use of reference words and discourse markers-coherence-jumbled sentences vocabulary and structures- Vocabulary Building - The concept of Word Formation

UNIT III LISTENING 6

Listening – listening to longer texts and filling in the table- product description- asking about routine actions and expressing opinions. –Listening to telephonic conversations -degrees of comparison- pronouns- direct vs indirect questions- Vocabulary development – single word substitutes- adverbs- Identifying Common Errors in Writing - Subject-verb agreement - Noun-pronoun agreement

UNIT IV WRITING 6

Writing- letter writing, formal and personal letters- after listening to dialogues or conversations and completing exercises based on them. Understanding text structure- use of reference words and discourse markers-coherence-jumbled sentences -Tenses- simple present-simple past-present continuous and past continuous- Vocabulary development- synonyms-antonyms-phrasal verbs- Articles - Prepositions.

UNIT V LANGUAGE DEVELOPMENT 6

Writing short essays – developing an outline- identifying main and subordinate ideas- dialogue writing- listening to talks, conversations to complete the remaining, participating in conversations- short group conversations-Language development-modal verbs- present/ past perfect tense.– paragraph writing- topic sentence- main ideas short narrative descriptions . Synonyms, antonyms, and standard abbreviations- Basic Writing Skills- Sentence Structures- Use of phrases and clauses in sentences - Importance of proper punctuation - Creating coherence- Organizing principles of paragraphs in documents- Techniques for writing precisely

SOFTSKILL LABORATORY 30

LIST OF EXPERIMENTS / EXCERCISES

1. Group discussion
2. Making effective presentations
3. Watching interviews & conversations
4. Reading different genres of texts

5. International English Language Testing System (IELTS)
6. Test of English as a Foreign Language (TOEFL)
7. Mock interviews
8. Time management &stress management
9. Role play
10. Listening to lectures, discussions from TV/ Radio.
11. Articulation of sounds - intonation.
12. Creative and critical thinking.

TEXT BOOKS:

1. English A Course book for Under Graduate Engineers and Technologists. Orient Black Swan Limited, Hyderabad:2015
2. Richards, C. Jack. Interchange Students' Book-2 New Delhi: CUP, 2015.

REFERENCES

1. Bailey, Stephen. Academic Writing: A practical guide for students. New York: Rutledge, 2011.
2. Comfort, Jeremy, et al. Speaking Effectively: Developing Speaking Skills for Business English. Cambridge University Press, Cambridge: Reprint 2011
3. Dutt P. Kiranmai and RajeevanGeeta. Basic Communication Skills, Foundation Books: 2013 Means,L.
4. Thomas and Elaine Langlois. English & Communication for Colleges. Cengage Learning, USA: 2007
5. Practical English Usage. Michael Swan. OUP. 2005.
6. Remedial English Grammar. F.T. Wood. Macmillan.2007
7. On Writing Well. William Zinsser. Harper Resource Book. 2001

COURSE OUTCOMES												
CO1	The student will be able to comprehend the text with clarity											
CO2	The capacity to read and listen will improve											
CO3	Writing technical report will be learnt properly											
CO4	Speaking skills will be acquired											
CO5	Overall communication skills will make them employable											
MAPPING BETWEEN COURSE OUTCOMES& PROGRAMME OUTCOMES												
COs \POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	S										S	M
2		M							M			M
3			S							S		M
4				S		M						M
5					S		S	W				M
Category	Humanities and Social Studies (HS)											
Approval	47th Academic Council Meeting											

U18BSMA101	**ENGINEERING MATHEMATICS – I**	L	T	P	C
	Total Contact Periods – 60	3	1	0	4
	Prerequisite – School Level Mathematics				
	Course Designed by Department of Mathematics				
OBJECTIVES	➢ It aims to familiarize the prospective engineers with techniques in calculus, multivariate integration analysis and linear algebra.				

	➢ It aims to equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling more advanced level of mathematics and applications that they would find useful in their disciplines

UNIT I DIFFERENTIAL CALCULUS - One Variable (9+3)

Representation of functions – limit of a function – continuity – Derivatives – Differentiation rule – Maxima and minima of functions of one variable – Rolle's Theorem – Mean Value Theorem – Taylor's and Maclaurin's Theorem with remainders.

UNIT II INTEGRAL CALCULUS - One Variable (9+3)

Definite integrals – Substitution rule – Techniques of integration – Integration by parts – Trigonometric integrals – Trigonometric substitutions – Integrations of rational functions by partial fractions – Integrations of irrational functions- Integration of improper functions - Beta, Gamma functions and their properties.

UNIT III DIFFERENTIAL CALCULUS - Several Variables (9+3)

Partial derivatives –Euler's theorem on Homogeneous functions - directional derivatives – total derivative – Jacobian – Maxima and minima of two variables.

UNIT IV MULTIPLE INTEGRALS - Several Variables (9+3)

Double integrals in Cartesian co-ordinates – Change of order of integrations – Area as a double integral – Triple integrals in Cartesian co-ordinates –Volume as triple integrals – Double integrals in polar co-ordinates – simple problems.

UNIT V MATRICES (9+3)

Characteristic Equations – Eigenvalue and Eigenvectors of the real matrix– Properties–- Cayley-Hamilton Theorem – Diagonalization of matrices – Reduction of quadratic form to canonical form by orthogonal transformation – Nature of Quadratic form.

TEXT BOOKS

1. Grewal B. S, Higher Engineering Mathematics, Khanna Publisher, Delhi – 2014.
2. Kreyszig. E, Advanced Engineering Mathematics, 10th edition, John Wiley & Sons, Singapore, 2012.

REFERENCE BOOKS

1. Veerarajan T, Engineering Mathematics, II edition, Tata McGraw Hill Publishers, 2008.
2. Kandasamy P &co., Engineering Mathematics, 9th edition, S. Chand & co Pub., 2010.
3. N.P.Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2010.
4. Narayanan S., Manicavachagam Pillai T.K., Ramanaiah G., Advanced Mathematics for Engineering students, Volume I (2nd edition), S.Viswanathan Printers and Publishers,
5. George B. Thomas ,Jr ,Maurice D.Weir, Joel Hass., Thomas' Calculus ,Twelfth Edition Addison-Wesley, Pearson.

COURSE OUTCOMES (COs)

CO1	To apply both the limit definition and rules of differentiation to differentiate functions. Also they will have a basic understanding of Rolle's Theorem that is fundamental to application of analysis to Engineering problems.
CO2	To apply definite integrals of algebraic and trigonometric functions using formulas and substitution. Also they will have a basic understanding of Beta and Gama functions.
CO3	To apply differential and integral calculus to notions of curvature. Also apply differentiation to find maxima and minima of functions.
CO4	To apply multiple integrals to compute area and volume over curves, surface and domain in two dimensional and three dimensional spaces.
CO5	Identify Eigenvalue problems from practical areas using transformations; Diagonalising the matrix would render the Eigen values.

CO/PO Mapping
S – Strong, M – Medium, W – Weak

Cos	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S				M		W			W		
CO2	S		S	W	M			M				
CO3	S				M				W			
CO4	S	M			M				W			
CO5	S		S		M				M	W		

Category	Basic Science (BS)
Approval	47th Academic Council Meeting

U18BSPH101	**WAVES AND OPTICS**	L	T	P	C
	Total Contact Hours - 45	3	0	0	3
	Prerequisite – Higher Secondary School Physics				
	Course designed by – Department of Physics				
OBJECTIVES: To develop Physics and Engineering strategies of Waves and Optics and to discuss their functionalities in modern optoelectronics.					

UNIT 1 NON-DISPERSIVE TRANSVERSE AND LONGITUDINAL WAVES IN ONE DIMENSION 9

Introduction - Transverse wave on a string, the wave equation on a string, Harmonic waves, reflection and transmission of waves at a boundary, standing waves, longitudinal waves and the wave equation for them, acoustics waves and speed of sound. Waves with dispersion, superposition of waves, wave groups and group velocity.

UNIT 2 ULTRASONIC WAVES 9

Production of ultrasonic by magnetostriction and piezoelectric methods - acoustic grating – Detection - Non Destructive Testing – pulse echo system through transmission and reflection modes - A,B and C – scan displays, Industrial and Medical applications – Sonogram.

UNIT 3 THE PROPAGATION OF LIGHT AND GEOMETRIC OPTICS 9

Fermat's principle of stationary time and its applications e.g. in explaining mirage effect, laws of reflection and refraction, Light as an electromagnetic wave and Fresnel equations,

reflectance and transmittance, Brewster's angle, total internal reflection, and evanescent wave. Mirrors and lenses and optical instruments based on them

UNIT 4 WAVE OPTICS 9

Huygens' principle, superposition of waves and interference of light by wave front splitting and amplitude splitting; Young's double slit experiment, Newton's rings, Michelson interferometer. Fraunhofer diffraction from a single slit and a circular aperture, Diffraction gratings and their resolving power

UNIT 5 LASERS 9

Einstein's theory of matter radiation interaction and A & B coefficients; amplification of light by population inversion, different types of lasers: gas lasers (He-Ne, CO2), solid-state lasers (Neodymium), Properties of laser beams: mono-chromaticity, coherence, directionality and brightness, applications of lasers in science, engineering and medicine.

TEXT BOOKS

1. M.N. Avadhanulu and P.G. Kshirsagar, "A Textbook of Engineering Physics" S.Chand Publishers, 2016 (for Units 1,3,4 & 5)
2. G.Senthil Kumar, "Engineering Physics", VRB publishers, Chennai, 2015 (for Unit 2)

REFERENCE BOOKS

1. BrijLal and Subramanian, "Waves and Oscillation", VikasPublishsing House, 2011
2. R.Murugesan,"Optics and Spectroscopy", S.Chand Publishers, 2015
3. BrijLal and Subramanian,"Optics", S.Chand Publishers 2006
4. Ian G. Main, "Vibration and waves in physics", Cambridge University Press, 1978
5. H.J. Pain, "The physics of vibrations and waves", 6th edition, Wiley 2006
6. AjoyGhatak, "Optics", Tata McGraw-Hill publishing company, New Delhi, 2009
7. O. Svelto, "Principles of Lasers", Springer, 2010
8. Online reference Wikipedia.org

Course Outcomes (COs)	
CO1	Understand the basic concept of waves and lights
CO2	Understand the importance of Ultrasonic waves and Non-Destructive Testing
CO3	Understand the propagation of light and geometrical optics
CO4	Understand the optical phenomenon like interference, diffraction and superposition of waves
CO5	Understand the concept of laser and its applications

Mapping of Course Outcomes with Programme Outcomes (POs)
S – Strong, M – Medium, W – Weak

1	COs /POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
2	CO1	S	S	M	S	M			M	S	S		
	CO2	W	S	M	M	S			M		W	S	
	CO3	S	W			W			M	M		M	
	CO4	S	W			W			M	M		M	
	CO5	S	M	M	M				M		S	W	
3	Category	Basic Sciences (BS)											
4	Approval	47th Meeting of the Academic Council											

U18BSCH101	ENGINEERING CHEMISTRY	L	T	P	C
	Total Contact Periods – 45	3	0	0	3
	Prerequisite – School Level Chemistry				
	Course Designed by – Department of Chemistry				
OBJECTIVES: To gain fundamental knowledge of Engineering Chemistry and its applications					

UNITI WATER TECHNOLOGY 9

Introduction - Characteristics: Hardness of Water – Types - Temporary and Permanent Hardness - Estimation by EDTA method. Alkalinity – Types of Alkalinity - Phenolphthalein and Methyl Orange Alkalinity - Determination – Domestic Water Treatment – Disinfection methods (Chlorination, Ozonation, and UV Treatment). Boiler feed water – Requirements – Disadvantages of using hard water in boilers (Caustic embrittlement, Boiler corrosion, Priming and foaming) – Prevention of scale formation – softening of hard water - Internal treatment (Calgon treatment method) – External treatment – Demineralization process – Desalination and Reverse osmosis.

UNIT II PHASE RULE AND ALLOYS 9

Introduction: Statement of Phase Rule and Explanation of terms involved – One component system – Water system – Construction of phase diagram by thermal analysis - Condensed phase rule - Two Component System : Simple eutectic systems (lead-silver system) – eutectic temperature – eutectic composition – Pattinson's Process of desilverisation of Lead.

Alloys: Importance, ferrous alloys – nichrome and stainless steel – 18/8 stainless steel -heat treatment of steel – annealing –hardening – tempering - normalizing – carburizing - nitriding. Non- ferrous alloys: Brass and Bronze.

UNIT III NON-CONVENTIONAL ENERGY SOURCES AND STORAGE DEVICES 9

Introduction: Nuclear fission and nuclear fusion reactions – differences between nuclear fission and nuclear fusion reactions – nuclear chain reactions – nuclear energy critical mass - super critical mass - sub - critical mass Light water nuclear reactor for power generation – breeder reactor. Solar energy conversion – solar cells – wind energy. Fuel cells – hydrogen – oxygen fuel cell. Batteries: Primary and secondary Batteries – differences between Primary and secondary Batteries Secondary batteries: Lead–acid storage battery –working –uses. Nickel–cadmium battery -working –uses. Solid – state battery: Lithium battery.

UNIT IV FUELS 9

Introduction: Calorific value – types of Calorific value - gross calorific value – net calorific value. Analysis of Coal – Proximate and ultimate analysis – hydrogenation of coal - Metallurgical coke –manufacture by Otto-Hoffmann method. Petroleum processing and fractions– cracking – catalytic cracking – types – fixed bed catalytic cracking method- Octane number and Cetane number. Synthetic petrol – Bergius processes – Gaseous fuels- water gas, producer gas, CNG and LPG. Flue gas analysis – importance - Orsat apparatus.

UNIT V NANOCHEMISTRY 9

Introduction: Nanochemistry: Definition - Classification based on dimensions - Size dependent properties. Types of nanomaterials: Nanoparticles: Synthesis by Bottom-up and top-down approaches - Nanoporous materials: Synthesis by sol-gel method. Nanowires: Synthesis by VLS mechanism. Carbon Nanotubes (CNTs): Single walled and Multi walled nanotubes - Mechanical and electrical properties of CNTs - Applications of CNTs - Synthesis of CNTs by

Electric arc discharge method and Laser ablation method. Nanochemistry in biology and medicines – nanocatalysis. NanocomSOsites – sensors and electronic devices.

TEXT BOOKS:

1. P.C.Jain and Monica Jain, "Engineering Chemistry" DhanpatRai Pub, Co., New Delhi (2002).
2. S.S.Dara "A text book of Engineering Chemistry" S.Chand&Co.Ltd., New Delhi (2006).
3. P. J. Lucia, M. Subhashini, "Engineering Chemistry, Volume 1", Crystal Publications, Chennai, (2007).
4. S. Vairam, P. Kalyani and Suba Ramesh, ―Engineering Chemistry‖, Wiley India PVT, LTD, New Delhi, 2013.
5. G. B. Sergeev, Nano chemistry, Elsevier Science, New York, 2006.

REFERENCES:

1. B.K.Sharma "Engineering Chemistry" Krishna Prakasan Media (P) Ltd., Meerut (2001).
2. Sivasankar "Engineering Chemistry" Tata McGraw-Hill Pub.Co.Ltd, New Delhi (2008).

COURSE OUTCOMES (COs)	
CO1	To impart knowledge to the Students about the principles, water characterization, conversant with boiler feed water requirements and water treatment techniques.
CO2	To make them understand the industrial importance of Phase rule and its applications to single and two component systems and appreciate the purpose and significance of alloys
CO3	To make the students to be well versed with the principles of Conventional and non-conventional energy sources and energy storage devices.
CO4	To make the students to have a deep knowledge of the Chemistry of Fuels and calorific value, manufacture of solid, liquid and gaseous fuels.
CO5	To make them understand the Nanochemistry, Types of nanomaterials: Nanoparticles, Nanochemistry in biology and medicines.

CO/SO Mapping:S – Strong, M – Medium, W – Weak

Cos	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	S			M		S		S		W		
CO		W	S		M		S		M			
CO		M		S		W				M	W	
CO	S		M	W			M			S		
CO		S		W		M				S		
Category	Basic Science (BS)											
Approval	47th Academic Council Meeting held in Aug, 2018											

U18ESCS101	**PROBLEM SOLVING AND PYTHON PROGRAMMING**	L	T	P	C
	Total Contact Periods – 45	3	0	0	3
	Prerequisite – NIL				
	Course Designed by – Department of Computer Science & Engineering				
OBJECTIVES	To gain fundamental knowledge of algorithmic problem solving and python programming				

MODULE 1 : ALGORITHMIC PROBLEM SOLVING 9

Introduction to components of a computer system - disks, memory, processor, operating system, compilers – Problems, Solutions, Idea of Algorithm –Representation of Algorithm. Building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Problem Illustrations

MODULE 2: DATA, EXPRESSIONS, STATEMENTS 9

Python interpreter and interactive mode; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two Points.

MODULE 3: CONTROL FLOW, FUNCTIONS 9

Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.

MODULE 4: LISTS, TUPLES, DICTIONARIES 9

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list, Processing list comprehension; Illustrative programs: selection sort, insertion sort, merge sort, histogram.

MODULE 5: FILES, PACKAGES 9

Files and exception: text files, reading and writing files, errors and exceptions, handling exceptions, packages: NumPy, SciPy, Matplotlib, Scikit-learn, Scilab Interface.

TEXT BOOKS:

1. Allen B. Downey, 'Think Python: How to Think Like a Computer Scientist', 2nd edition, Updated for Python3, Shroff/O'Reilly Publishers, 2016
2. (http://greenteapress.com/wp/think-python/)
3. Guido van Rossum and Fred L. Drake Jr,― An Introduction to Python – Revised and updated for Python 3.2, Network Theory Ltd., 2011.

REFERENCES

1. John V Guttag, ―Introduction to Computation and Programming Using Python'', Revised and expanded Edition, MIT Press , 2013
2. Robert Sedgewick, Kevin Wayne, Robert Dondero, ―Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016.
3. Timothy A. Budd, ―Exploring Python‖, Mc-Graw Hill Education (India) Private Ltd.,, 2015.
4. Kenneth A. Lambert, ―Fundamentals of Python: First Programs‖, CENGAGE Learning, 2012.
5. Charles Dierbach, ―Introduction to Computer Science using Python: A Computational Problem-Solving Focus, Wiley India Edition, 2013.

6. Paul Gries, Jennifer Campbell and Jason Montojo, ―Practical Programming: An Introduction to Computer Science using Python 3‖, Second edition, Pragmatic Programmers, LLC, 2013

COURSE OUTCOMES (COs)	
CO1	Develop algorithmic solutions to simple computational problems
CO2	Demonstrate programs using simple Python statements and expressions.
CO3	To gain knowledge regarding control flow and functions associated with python
CO4	Use Python data structures – lists, tuples & dictionaries for representing compound data
CO5	To gain knowledge on files, exception, modules and packages in Python for solving problems

Mapping of Course Outcomes with Programme Outcomes (POs)
CO/SO Mapping:S – Strong, M – Medium, W – Weak

1	COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
2	CO1	S	S	S	M	S	M	W		M	W	M	
	CO2	S	S	M	M		M		W			M	
	CO3	M	M	W	S	M		W		W		M	
	CO4	M	M	W	M	S	M	W	M	W			
	CO5	M	S	W	M	M			M	M	W	M	
3	Category	Engg Sciences (ES)											
4	Approval	47th Meeting of Academic Council held in Aug, 2018											

U18ESME101	**ENGINEERING GRAPHICS & DESIGN (THEORY & LAB.)**	L	T	P	C
	Total Contact Periods – 75	1	0	4	3
	Prerequisite – +12 Level Maths and Physical Science				
	Course Designed by – Department of Mechanical Engineering				
OBJECTIVES	To Prepare students to design a system, component, or process to meet desired needs, using the techniques, skills, and modern engineering tools necessary for engineering practice				

Detailed contents

Traditional Engineering Graphics:

Principles of Engineering Graphics; Orthographic Projection; Descriptive Geometry; Drawing Principles; Isometric Projection; Surface Development; Perspective; Reading a Drawing; Sectional Views; Dimensioning & Tolerances; True Length, Angle; intersection, Shortest Distance.

Computer Graphics:

Engineering Graphics Software; -Spatial Transformations; Orthographic Projections; Model Viewing; Co-ordinate Systems; Multi-view Projection; Exploded Assembly; Model Viewing; Animation; Spatial Manipulation; Surface Modelling; Solid Modelling; Introduction to Building Information Modelling (BIM).

(Except the basic essential concepts, most of the teaching part can happen concurrently in the laboratory)

MODULE 1: INTRODUCTION TO ENGINEERING DRAWING (9+2)

Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Scales – Plain, Diagonal and Vernier Scales; Draw simple annotation, dimensioning and scale. Construction of Conic sections; Cycloid, Epicycloid, Hypo cycloid and Involute of circle.

MODULE 2: ORTHOGRAPHIC PROJECTIONS (10+2)

Principles of Orthographic Projections; Conventions; Projections of points and Orthographic projection of lines in first quadrant - Parallel to both the planes – Perpendicular to one plane – Parallel to one plane and inclined to other plane – Inclined to both the planes; Projections of planes inclined to either HP or VP.

MODULE3:PROJECTIONS OF REGULAR SOLIDS& ISOMETRICPROJECTIONS (10+3)

Projection of solids in first quadrant – Prism, Pyramid, Cone and Cylinder inclined to one plane; Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions - Isometric Views of Simple Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa.

MODULE4: SECTIONSOF SOLIDS AND DEVELOPMENT OF SURFACE (10+3)

Sectional view of Prism, Cylinder, Pyramid, Cone (simple position in first quadrant) with cutting planes perpendicular to one plane and parallel or inclined to another plane– True shape of sections; Development of lateral surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone.

MODULE 5: BUILDING DRAWING (9+2)

Introduction to building drawing; Types of Projection adopted in Building Drawing; Scales for various types of Drawings, Symbols, Conventions and Abbreviations. Drawing of residential single and two storied buildings with detail of Line plan, Foundation Plan, Ground floor Plan, First floor plan, Elevation and Sections.

MODULE 6: OVERVIEW OF COMPUTER GRAPHICS (12+3)

Introduction to CAD; Basic commands; Coordinate systems; Setting up of units and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerance; Orthographic constraints, Snap to objects manually and automatically; Setup a drawing with proper scale – Dimensioning commands, Editing Dimensions and Dimension text; Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles; Create basic drawing of objects such as polygon and general multi-line figures; Creating orthographic views of simple solids like prism, pyramid, cylinder, cone. Drawing sectional views of prism, pyramid, cylinder and cone; Preparation of fabrication drawing (Development of surfaces); Drawing front view, top view and side view of objects from the given pictorial view; Creation of 3-D models of simple objects.

TEXT BOOKS:

1. Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing House
2. Shah, M.B. &Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education
3. Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication
4. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers

(Corresponding set of) CAD Software Theory and User Manuals

COURSE OUTCOMES (COs)	
CO1	Students will gain Exposure to engineering communication.
CO2	Students will learn standards of engineering graphics.
CO3	Students will get Exposure to basics of building construction
CO4	Students will get Exposure to computer-aided geometric design
CO5	Student will gain basic knowledge and Exposure to the visual aspects of Engineering Design.

Mapping of Course Outcomes with Programme Outcomes (POs)
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

1	COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
2	CO1	S			M			S					
	CO2	S	S	W		S	M						
	CO3			S									
	CO4											S	
	CO5	S						W					
3	Category	Engg Sciences (ES)											
4	Approval	47th Meeting of Academic Council held in Aug, 2018											

U18BSPH2L1	**WAVE OPTICS AND MECHANICS LABORATORY** (Common to B.Tech-Civil, Mech, Mechatronics, Aero, Aerospace & Auto)	L	T	P	C
		0	0	3	1.5
	Total Contact Hours - 45				
	Prerequisite – Wave Optics and Mechanics				
	Course designed by – Department of Physics				
OBJECTIVES: To impart Practical knowledge of Physics to the students					

Physics Lab experiments for Semester I & II
List of Experiments for Waves and Optics – Common for all branches

1. Ultrasonic Interferometer
2. Air-wedge Experiment
3. Particle size determination
4. Determination of acceptance angle
5. Determination of Laser Wavelength
6. Spectrometer – Determination of wavelength using grating

List of Experiments for Mechanics

1. Torsional Pendulum – without symmetrical mass
2. Torsional Pendulum – With symmetrical mass
3. Young's Modulus – Non-uniform bending
4. Young's Modulus – Uniform Bending
5. Compound Pendulum
6. Coefficient of viscosity of the given liquid – Poiseuille method

Course Outcome (CO's)	
CO1	Understand the fundamental concept of optics

CO2	Understand the concept of production of ultrasonic waves												
CO3	Understand the basic concept of Mechanics												
Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping:S – Strong M – Medium W-Weak													
1	COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
2	CO1	S		S	S				S	W	M		
	CO2	S	S	W					S	W	M		
	CO3	S	S	W					S	W	M		
3	Category	Basic Sciences (BS)											
4	Approval	47th Academic Council Meeting											

U18BSCH2L1	**CHEMISRY LAB**	L	T	P	C
	Total Contact Hours – 45	0	0	3	1.
	Prerequisite – Engineering Chemistry				
	Course Designed by – Department of Chemistry				
OBJECTIVES: To enhance the practical knowledge on Chemistry through Volumetric and circuit experiments					

LIST OF EXPERIMENTS

1. Determination of Total Hardness, Temporary Hardness and Permanent hardness of Water by EDTA method
2. Estimation of Alkalinity - Titrimetry
3. Estimation of Dissolved Oxygen
4. Estimation of Chlorides in Water by Argentometric Method (MOHR'S Method)
5. Estimation of Copper by EDTA method
6. Estimation of Iron in Water by Spectrophotometry
7. Conductometric Titration of Strong Acid with Strong Base
8 Determination of Molecular weight of a polymer by Viscosity Average Method
9. pH measurements for Acid - alkali Titrations
10. Determination of rate of corrosion by weight loss method.
11. Conductometric Precipitation titration
12. Determination of Water Crystallization

REFERENCES

1. R. Jeyalakshmi, "Practical Chemistry", Devi Publications 2014.
2. S.S. Dara, A text book on experiments and calculation Engg.

COURSE OUTCOMES (COs)	
CO1	Students will able to analyze - hardness, Alkalinity, Dissolved oxygen, Chlorides in Water by Argentometric Method, Determination of Water of Crystallization and as well as estimation of Copper by EDTA method using volumetric analysis.
CO2	Students will understand basic principle of spectrophotometric method
CO3	Students will learn Conductometric Titration of Strong Acid with Strong Base and and Conductometric Precipitation titration.
CO4	Students will be able to analyze Determination of Molecular weight of a polymer by Viscosity Average Method

CO5	Students will understand about pH measurements for Acid - alkali Titrations and rate of corrosion by weight loss method

MAPPING OF COURSE OUTCOMES WITH PROGRAMME OUTCOMES
S – Strong, M – Medium, W – Weak

Cos	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S		M	M		S		S		W	W	S
CO2	W	S			M		S		M			
CO3		M		M						M	W	
CO4	S		M				M					
CO5		S		W		M				S	S	

Category	Basic Sciences (BS)
Approval	47th Meeting of Academic Council held in Aug, 2018

U18ESCS1L1	**PROBLEM SOLVING AND PYTHON PROGRAMMINGLABORATORY**	L	T	P	C
	Total Contact Hours – 45	0	0	3	1.5
	Prerequisite – NIL				
	Course Designed by – Department of Computer Science & Engineering				
OBJECTIVES: To enhance the practical knowledge on writing programs using Python					

LIST OF EXPERIMENTS FOR PROBLEM SOLVING AND PYTHON PROGRAMMING LAB

1. Compute the GCD of two numbers.
2. Find the square root of a number (Newton‘s method)
3. Exponentiation (Power of a number)
4. Find the maximum of a list of numbers
5. Linear search and Binary search
6. Selection sort, Insertion sort
7. Merge sort
8. First n prime numbers
9. Multiply matrices
10. Find the most frequent words in a text read from a file
11. Simulate elliptical orbits in Pygame
12. Simulate bouncing ball using Pygame
13. Simulate matrix operations with Scilab
14. Simulate fitting curve with NumPy and Matplotlib

REFERENCES:

1. Kenneth A. Lambert, ―Fundamentals of Python: First Programs‖, CENGAGE Learning, 2012
2. Timothy A. Budd, ―Exploring Python‖, McGraw Hill Education (India) Private Ltd.,, 2015.
3. PLATFORM NEEDED
4. Python 3 interpreter for Windows/Linux and Scilab

COURSE OUTCOMES (COs)	
CO1	Write, test, and debug simple Python programs.
CO2	Implement Python programs with conditionals and loops
CO3	Develop Python programs step-wise by defining functions and calling them
CO4	Use Python lists, tuples, dictionaries for representing compound data
CO5	Read and write data from/to files in Python and to simulate using the packages Scilab, NumPy and Matplotlib

Mapping of Course Outcomes with Programme Outcomes (POs)
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

1	COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
2	CO1	S	S	M	S	S	M	M	M	M		M	
	CO2	S	S	W	S	S	M	W	M	M	M	M	
	CO3	S	S	M	M	M	M		M	M	M		
	CO4	S	M	S	S	S	M	M	M	M	W	M	
	CO5	S	S	M	S	M	M		M	M	W	M	
3	Category	Engg Sciences (ES)											
4	Approval	47th Meeting of Academic Council held in Aug, 2018											

U18HSEN201	TECHNICAL ENGLISH	L	T	P	C
	Total Contact Periods – 45	2	1	0	3
	Prerequisite – I semester English				
	Course Designed by – Department of English				
OBJECTIVES	To gain fundamental knowledge of English language and its usage in day to day life.				

UNIT I LISTENING 9

Listening- Listening to talks mostly of a scientific/technical nature and completing information-gap exercises- Speaking –Asking for and giving directions- extended definitions –listening to daily issue- -Vocabulary Development- technical vocabulary - Language Development –subject verb agreement – compound words.

UNIT II READING 9

Reading – reading longer technical texts- identifying the various transitions in a text- interpreting charts, graphs after reading the, practice in speed reading- vocabulary Development-vocabulary used in formal letters/emails and reports -Language Development personal passive voice, numerical adjectives.

UNIT III TECHNICAL WRITING 9

Writing after listening to classroom lectures- talk should be on engineering /technology– introduction to technical presentations- longer texts both general and technical, Describing a process, use of sequence words- Vocabulary Development- sequence words- Misspelled words.

UNIT IV FORMAL WRITING 9

Writing- email etiquette- job application – cover letter –Resume preparation (via email and hard copy)- analytical essays and issue based essays–Vocabulary Development- finding suitable synonyms-paraphrasing-. Language Development- clauses- dependant, independent, if conditionals.

UNIT V LANGUAGE DEVELOPMENT 9

Speaking –participating in a group discussion – role play, Writing– Writing reports- minutes of a meeting- accident and survey-Vocabulary Development- transitive, intransitive verbs, Language Development- reported speech.

TEXT BOOKS:

1. Fluency in English A Course book for Engineering and Technology. Orient Blackswan, Hyderabad: 2016
2. Sudharshana.N.P and Saveetha. C. English for Technical Communication. Cambridge University Press: New Delhi, 2016.

REFERENCES

1. Booth-L. Diana, Project Work, Oxford University Press, Oxford: 2014.
2. Grussendorf, Marion, English for Presentations, Oxford University Press, Oxford: 2007
3. Kumar, Suresh. E. Engineering English. Orient Blackswan: Hyderabad,2015
4. Means, L. Thomas and Elaine Langlois, English & Communication For Colleges Cengage Learning, USA: 2007

COURSE OUTCOMES (COs)

On completion of the course, the students will be able to												
CO1	The student will acquire basic proficiency in English											
CO2	Reading and listening ability will improve.											
CO3	Comprehension techniques will develop.											
CO4	writing and speaking skills will be acquired											
CO5	Overall communication skills will make them employable.											
COs \POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	M											M
2		S							M		Ss	M
3			S							S		M
4				M		S						M
5					M		M	W				M
Category			Humanities and Social Studies (HS)									
Approval			47th Meeting of the Academic Council									

U18BSMA201	**ENGINEERING MATHEMATICS II**	L	T	P	C
	Total Contact Periods - 60	3	1	0	4
	Prerequisite – School Level Mathematics				
	Course Designed by Department of Mathematics				
OBJECTIVE	The objective of this course is to equip the students of Engineering and Technology with techniques in ➢ Ordinary equations, vector calculus, complex variables. ➢ Laplace transform with advanced level of mathematics and applications that would be essential to formulate problems in engineering environment.				

UNIT I ORDINARY DIFFERENTIAL EQUATIONS (9+3)

Higher order linear differential equations with constant coefficients – linear differential equations with variable coefficients– Euler's and Legendre's linear equations – Simultaneous first order linear equations with constant coefficients- Method of variation of parameters.

UNIT II VECTOR CALCULUS (9+3)

Scalar and vector point function - Gradient, Divergence and curl – Directional derivatives – Angle between two surfaces - Irrotational and Solenoidal vector fields – Line Integral - Green's theorem – Gauss divergence theorem and Stokes' theorem – Simple applications involving cubes and rectangular parallelepipeds.

UNIT III ANALYTIC FUNCTIONS (9+3)

Functions of complex variable - Analytic functions – Necessary and sufficient conditions (without proof), Cauchy Riemann Equations in Cartesian and polar form – Harmonic functions – properties of analytic functions – Construction of analytic functions using Milne Thomson method –Conformal mapping : and Bilinear Transformation.

UNIT IV COMPLEX INTEGRATION (9+3)

Cauchy integral theorem – Cauchy's integral formula – problems – Taylor's and Laurent's Series – classification of Singularities – Poles and Residues – method of finding residues - Cauchy's residue theorem and its applications to evaluate real integrals – contour integration.

UNIT V LAPLACE TRANSFORMS (9+3)

Transforms of elementary functions – Basic properties – Shifting theorem- Transforms of derivatives and integrals – Initial and final value theorem – Laplace transform of Periodic Functions – Inverse Laplace transform – Convolution theorem – Periodic Functions – Applications of Laplace transform for solving linear ordinary differential equations up to second order with constant coefficient.

TEXT BOOKS

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Willie & Sons, 2006.
2. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000.

REFERENCE BOOKS

1. Venkataraman. M. K, Engineering Mathematics, National Publishing Company, 2000.
2. Bali .N.P and Manish Goyal, A Text book of Engineering Mathematics, Eighth Edition, Laxmi Publications Pvt Ltd., 2011.
3. Veerarajan T, Engineering Mathematics, II edition, Tata McGraw Hill Publishers, 2008.
4. George B. Thomas Jr., Maurice D. Weir, Joel R. Hass., Thomas' Calculus, 12th Edition, Addison-Wesley, Pearson.

COURSE OUTCOMES (COs)	
CO1	The mathematical tools for solution of differential equation that model physical process.
CO2	To evaluate the line, surface and volume integrals using Green's, Stoke's and Gauss Theorems and their verification.
CO3	To understand the analytic functions, conformal mapping and complex integration and their applications.
CO4	To evaluate real and complex integrals using the Cauchy's integral formula and Residue theorem.

CO5	To apply the concept of Laplace Transformation in analysis and solve differential equations.											
CO/PO Mapping: S – Strong, M – Medium, W – Weak												
COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M		W		S				M		S	
CO2	S	M			S			M		W		
CO3	S		W				M		S			
CO4								S	M	M	W	
CO5	S		W	W			M				S	
Cate	Basic Science (BS)											
App	47th Academic Council Meeting											

U18BSPH201	**INTRODUCTION TO MECHANICS**	L	T	P	C
	Total Contact Hours - 45	3	0	0	3
	Prerequisite – Higher Secondary School Physics				
	Course designed by – Department of Physics				

OBJECTIVES: To impart basic knowledge of mechanics involving 1D, 2D and 3D motions of a rigid body

UNIT 1 **9**

Forces in Nature; Newton's laws and its completeness in describing particle motion; Solving Newton's equations of motion in polar coordinates; Problems including constraints and friction; Extension to cylindrical and spherical coordinates

UNIT 2 **9**

Potential energy function; F = - Grad V, equipotential surfaces and meaning of gradient; Conservative and non-conservative forces, curl of a force field; Central forces; Conservation of Angular Momentum; Energy equation and energy diagrams; Elliptical and parabolic orbits;

UNIT 3 **9**

Harmonic oscillator; Damped harmonic motion – over-damped, critically damped and lightly-damped oscillators; Forced oscillations and resonance

UNIT 4 **9**

Definition and motion of a rigid body in the plane; Rotation in the plane; Kinematics in a coordinate system rotating and translating in the plane; Angular momentum about a point of a rigid body in planar motion, Kinetic energy of a rotating body

UNIT 5 **9**

Introduction to three-dimensional rigid body motion — only need to highlight the distinction from two-dimensional motion in terms of (a) Angular velocity vector, and its rate of change and (b) Moment of inertia tensor; Three-dimensional motion of a rigid body wherein all points move in a coplanar manner: e.g. Rod executing conical motion with center of mass fixed

TEXT BOOKS

1. Dr.R.K.Bansal, "A Text Book of Engineering Mechanics", Laxmi publication (P) Ltd. 6th edition, 2013.

REFERENCE BOOKS

1. R.K.Gaur and S.L.Gupta, "Engineering Physics" DhanpatRai Publications" 2012.
2. M.K. Harbola, "Engineering Mechanics", 2nd edition, Cengage, 2013.
3. M.K. Verma, "Introduction to Mechanics", 1st edition, CRC press, 2009.
4. D.Kleppner&R.Kolenkow, "An Introduction to Mechanics", McGraw Hill Education, 2017
5. JL Meriam and L.G.Kraige, "Engineering Mechanics – DynamicsVol 2", 7th ed. Wiley, 2012
6. JP Den Hartog, "Mechanical Vibrations", Dover Publications, Inc., 1985
7. WT Thomson, "Theory of Vibrations with Applications", Pearson, 5th edition, 1997.
8. Online References: Wikipedia org

Course Outcomes

CO1	Understand and solve the various equation of motions in different coordinates
CO2	Understand the conservation of energy and angular momentum
CO3	Understand the concept of harmonic motion in different damped conditions
CO4	Understand the rigid body motion in different criteria
CO5	Understand the rigid body motion in 3D

Mapping of Course Outcomes with Programme Outcomes (POs)
CO/PO Mapping:S – Strong, M – Medium, W – Weak

1	COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
2	CO1		W	W					M	W	M		
	CO2	S	W	W	S				M	W	M	W	
	CO3	M			M				S	M			
	CO4	S	W	W					M	W	M	W	
	CO5	W	S	S	M				M	W	W	W	
3	Category	Basic Sciences (BS)											
4	Approval	47th Academic Council Meeting											

U18BSCH201	**ENVIRONMENTAL SCIENCE**	L	T	P	C
	Total Contact Periods – 45	3	0	0	3
	Prerequisite – NIL				
	Course Designed by – Department of Chemistry				
OBJECTIVES	➢ To study the interrelationship between living organism and environment. ➢ To study of the nature and concepts of ecosystem. ➢ To learn about the integrated themes and biodiversity of an environment. ➢ To study of pollution control and waste management. ➢ To appreciate the importance of environment by assessing its impact on the human world; envision the surrounding environment, its functions and its value.				

UNIT I -NATURAL RESOURCES 9

Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people –Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems - Food resources: World food problems, changes caused by agriculture and overgrazing, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies – Land resources: Land as a resource, land degradation,

man induced landslides, soil erosion and desertification - Equitable use of resources for sustainable lifestyles.

UNIT II -ECOSYSTEMS 9

Introduction: concepts of an ecosystem. Structure and function of an ecosystem, producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids - Introduction, types, characteristic features, structure and function of the following ecosystem :- Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems, (ponds, streams, lakes, rivers, oceans, estuaries)- Water conservation, rain water harvesting, watershed management, Resettlement and rehabilitation - Ethics : Issues and Possible Solutions, Climate change, global warming, acid rain, ozone layer depletion.

UNIT III -BIODIVERSITY AND ITS CONSERVATION 9

Introduction and Definition - genetic, species and ecosystems diversity, Biogeographical classification of India - Value biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values - Biodiversity at global, national and local levels. India as a mega diversity nation, Hot-spots of biodiversity - Threats to biodiversity, habitat, poaching of wildlife, man-wildlife conflicts, Endangered and endemic species of India, Conservation biodiversity - In-situ and Ex-situ conservation of biodiversity.

UNIT IV-ENVIRONMENTAL POLLUTION 9

Definition, Causes, effects and control measures of Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards. Solid waste Management: Causes, effects and control measures of urban and industrial wastes - Role of an individual in prevention of pollution - pollution case studies - Disaster Management: floods earthquake, cyclone and landslides.

UNIT V- SOCIAL ISSUES AND HUMAN POPULATION 9

Social issues: Environmental Protection Act, Air (Prevention and Control of pollution) Act, Water (Prevention and Control of pollution) Act, Wildlife protection Act, Forest Conservation Act, Public awareness – Fireworks and its impact on the Environment – Chemicals used in Fireworks – (Fuel –oxidizing Agent – Reducing Agent –Toxic Materials – Fuel –Binder-Regulator) – Harmful nature of ingredients – chemical effects on health due to inhaling fumes. Human population: population growth, variation among nations, Population explosion-Family Welfare programs, Environment and human health, Human Rights, Value Education, HIV and AIDS, Women and Child Welfare, Role of Information Technology in Environment and Human health - Case Studies.

TEXT BOOKS:

1. Gilbert M. Masters, Introduction to Environmental Engineering and Science‘, 2nd edition, Pearson Education 2004.
2. Benny Joseph, Environmental Science and Engineering‘, Tata McGraw-Hill, New Delhi, 2006.
3. R.K. Trivedi, Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards‘, Vol. I and II, Enviro Media.
4. Rajagopalan, R, Environmental Studies-From Crisis to Cure’, Oxford University Press 2005.
5. K.V.B. Raju and R.T. Ravichandran, “Basics of Civil Engineering”.

REFERENCES:

1. Cunningham, W.P. Cooper, T.H. Gorhani, Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.
2. Dharmendra S. Sengar, Environmental law', Prentice hall of India PVT LTD, New Delhi, 2007.

COURSE OUTCOMES	
CO1	Master core concepts and methods from ecological and physical sciences and their application in environmental problem solving
CO2	Appreciate concepts and methods from ecological and physical sciences and their application in environmental problem solving.
CO3	Appreciate the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems
CO4	Understand the transnational character of environmental problems and ways of addressing them, including interactions across local to global scales
CO5	Apply systems concepts and methodologies to analyze and understand interactions between social and environmental processes

CO/SO Mapping: S – Strong, M – Medium, W – Weak

COs	Programme Outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S			M		S		S		W		
CO2	W	S	S		M		S		M			
CO3		M				W			S	M	M	
CO4	S		M	W			M					
CO5		S		W		M				S		

3	Category	Basic Sciences (BS)
4	Approval	47th Academic Council Meeting

U18BSBT101	**BIOLOGY FOR ENGINEERS**	L	T	P	C
	Total Contact Hours - 30	2	0	0	2
	Prerequisite – Higher Secondary level biology, basic concepts in cell signaling				
	Course Designed by – Dept of Industrial Biotechnology				

OBJECTIVES: To provide a basic understanding of the biological systems and its applications in the industrial sector

UNIT I INTRODUCTION TO LIFE 6

Characteristics of living organisms-Basic classification-cell theory-structure of prokaryotic and eukaryotic cell- Introduction to biomolecules - general classification and important functions of carbohydrates-lipids-proteins-nucleic acids – vitamins

UNIT II BIODIVERSITY 6

Plant System: basic concepts of plant growth-nutrition-photosynthesis-Animal System: elementary study of digestive-respiratory-circulatory-excretory systems and their functions. Microbial System -types of microbes-economic importance and control of microbes.

UNIT III GENETICS AND IMMUNE SYSTEM 6

Evolution: theories of evolution- evidence of laws of inheritance-variation and speciation-nucleic acids as a genetic material-central dogma - immunity- antigens - antibody-immune response.

UNIT IV HUMAN DISEASES 6

Definition- causes, symptoms, diagnosis, treatment and prevention of diabetes, cancer, hypertension, AIDS and Hepatitis

UNIT V BIOLOGY AND ITS INDUSTRIAL APPLICATION 6

Transgenic plants and animals-stem cell and tissue engineering-bioreactors-biopharming-recombinant vaccines -cloning- bioremediation-biofertilizer-biocontrol- biosensors-biopolymers-bioenergy-biomaterials-biochips

TEXT BOOKS:

1. A Text book of Biotechnology, R. C. Dubey, S. Chand Higher Academic Publications, 2013
2. Diseases of the Human Body, Carol D. Tamparo and Marcia A. Lewis, F.A. Davis Company, 2011.
3. Biomedical instrumentation, Technology and applications, R. Khandpur, McGraw Hill Professional, 2004

REFERENCE BOOKS

1. Biology for Engineers, Arthur T. Johnson, CRC Press, Taylor and Francis, 2011
2. Cell Biology and Genetics (Biology: The unity and diversity of life Volume I), Cecie Starr, Ralph Taggart, Christine Evers and Lisa Starr, Cengage Learning, 2008
3. Biotechnology Expanding horizon, B.D. Singh, Kalyani Publishers, 2012

COURSE OUTCOMES (COs)	
CO1	To understand the basic concepts of the cell and its structure
CO2	To understand about biodiversity and its conservation
CO3	To know the fundamentals of genetics and the immune system
CO4	To create an awareness about human diseases
CO5	To give a basic knowledge of the applications of transgenics
CO6	To know the applications of bio systems in environment, medical and agricultural sectors

Mapping of Course Outcomes with Programme Outcomes
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

1	COs/POS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
2	CO1	S					M	M			S	M	
	CO2	S			M		S		M	M			
	CO3	M		M			M					S	
	CO4							S			M		
	CO5	S	S					S	M	M		S	
	CO6	S						S					
3	Category	Basic Sciences (BS)											
4	Approval	47th Meeting of Academic Council											

U18ESEE101	**BASIC ELECTRICAL & ELECTRONICS ENGINEERING**	L	T	P	C
	Total Contact Periods – 45	3	0	0	3
	Prerequisite – School Level Physics				
	Course Designed by–Department of Electrical & Electronics Engineering				

OBJECTIVES	To gain fundamental knowledge of Electrical and Electronics Engineering and its applications

MODULE 1 : DC CIRCUITS 12

Electrical circuit elements, voltage and current sources, Fundamental Relationship of VI for RLC circuit, Ohms Law, Source Transformation ,Kirchoff current and voltage laws, analysis of simple circuits with dc excitation. Basics of Superposition, Thevenin and Norton Theorems, Maximum Power Transfer Theorem.

MODULE 2: AC CIRCUITS 9

Representation of sinusoidal waveforms, peak and RMS values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance. Time-domain analysis of first-order RL and RC circuits. Three-phase balanced circuits, voltage and current relations in star and delta connections.

MODULE 3: ELECTRICAL MACHINES & TRANSFORMERS 9

Principles of operation and characteristics of; DC machines, Synchronous machines, three phase and single phase induction motors. Transformers (single and three phase) regulation and efficiency, all day efficiency and auto-transformer.

MODULE 4: SEMICONDUCTOR DEVICES AND APPLICATIONS 9

Characteristics of PN Junction Diode – Zener Effect – Zener Diode and its Characteristics – Half wave and Full wave Rectifiers – Voltage Regulation. Bipolar Junction Transistor – CB, CE, CC Configurations and Characteristics – Elementary Treatment of Small Signal Amplifier and its applications, Introduction to OP-AMP.

MODULE 5: DIGITAL ELECTRONICS 6

Binary Number System – Logic Gates – Boolean Algebra – Half and Full Adders – Flip-Flops – Registers and Counters – Fundamentals of A/D and D/A Conversion.

TEXT BOOKS:

1. John Bird, Electrical Circuit Theory & Technology, Taylor & Francis Ltd, 6th, edition. 2017.
2. Smarajit Ghosh, Fundamentals of Electrical and Electronics Engineering, Second Edition, PHI Learning, 2007.
3. L. S. Bobrow, “Fundamentals of Electrical Engineering”, Oxford University Press, 2011.
4. E. Hughes, “Electrical and Electronics Technology”, Pearson, 10th Edition, 2011.
5. V. D. Toro, “Electrical Engineering Fundamentals”, Pearson, 2nd Edition, 2015.
6. Millman and Halkias, “Integrated Electronics”, McGraw Higher Ed, 2nd Edition, 2011.
7. Vincent Del Toro, `Electrical Engineering Fundamental, Prentice Hall, 2nd Edition, 2015.
8. K.A.Krishnamurthy and M.R.Raghuveer, `Electrical and Electronics Engineering for Scientists', New Age International Pvt Ltd Publishers, 2011.

REFERENCES:

1. D. P. Kothari and I. J. Nagrath, “Basic Electrical Engineering”, Tata McGraw Hill, Third Reprint,2016.
2. D. C. Kulshreshtha, “Basic Electrical Engineering”, Mcgraw Higher Ed, 1st Edition, 2011.
3. Jacob Millman and Christos C-Halkias,“Electronic Devices and Circuits”, Mcgraw Higher Ed, 4th Edition, 2015.

COURSE OUTCOMES (COs)	
CO1	To gain knowledge regarding the various laws and principles associated with DC Circuits.
CO2	To gain knowledge regarding fundamentals of AC circuits.
CO3	To gain knowledge regarding electrical machines and transformers.
CO4	To gain knowledge regarding various types of semiconductor devices and small signal amplifiers.
CO5	To gain knowledge on principles of digital electronics systems.

Mapping of Course Outcomes with Programme Outcomes
S- Strong, M-Medium, W- Weak

1	COs/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
2	CO1	S	W			M				S			
	CO2	S	W			M				S			
	CO3	S	M			M				S			
	CO4	S	W			M				S			
	CO5	S	W			M				S			
3	Category	Engg Sciences (ES)											
4	Approva	47th Meeting of the Academic Council											

U18ESME1L2	Workshop/Manufacturing Practices Laboratory	L	T	P	C
	Total Contact Periods – 75	1	0	4	3
	Prerequisite – NIL				
	Course Designed by – Department of Mechanical Engineering				
OBJECTIVES	To educate the students on common manufacturing processes employed in Industries.				

Lectures & videos: (15 hours)

1. Detailed contents
2. Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods (3 lecture)
3. CNC machining, Additive manufacturing (2 lecture)
4. Fitting operations & power tools (2 lecture)
5. Carpentry (2 lecture)
6. Plastic moulding, glass cutting (2 lecture)
7. Metal casting (2 lecture)
8. Welding (arc welding & gas welding), brazing (2 lecture)

WORKSHOP PRACTICE:

Machine shop (6 hours)

1. Facing
2. Turning
3. Drilling Practice

Fitting shop (6 hours)

1. Fitting Exercises–Preparation of square fitting
2. Vee–fittingmodels.

Carpentry (9 hours)

a) Preparation of Lap joints.

b) Mortise and Tenonjoints.
c) Cross Half joints.
d) Dove Tail joints.

Welding shop (Arc welding 6 hrs + gas welding 3 hrs)
(9 hours)
Preparation of butt joints, lap joints and Tee joints

Sheet Metal working (9 hours)
Forming &Bending:
Model making–Trays, funnels, etc.
Different type of joints

Demonstration (6 Hours)
Smithy operations, upsetting, swaging, setting down and bending. Example–Exercise–Production of hexagonal headed bolt.
Examinations could involve the actual fabrication of simple components, utilizing one or more of the techniques covered above.

SUGGESTED TEXT/REFERENCE BOOKS:

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of Workshop Technology", Vol. I 2008 and Vol. II 2010, Media promoters and publishers Private Limited, Mumbai.
2. Kalpakjian S. And Steven S. Schmid, "Manufacturing Engineering and Technology",4th edition, Pearson Education India Edition, 2002.
3. Gowri P. Hariharan and A. Suresh Babu,"Manufacturing Technology – I" Pearson Education, 2008.
4. Roy A. Lindberg, "Processes and Materials of Manufacture", 4th edition, Prentice Hall India, 1998.
5. Rao P.N., "Manufacturing Technology", Vol. I and Vol. II, Tata McGraw Hill House, 2017.

COURSE OUTCOMES (COs)	
CO1	Students will gain knowledge of the different manufacturing processes.
CO2	Students will be able to fabricate components with their own hands.
CO3	Students will gain practical knowledge of the dimensional accuracies and dimensional tolerances.
CO4	Students will be able to produce small devices of their interest.

Mapping of Course Outcomes with Programme Outcomes
(S/M/W indicates strength of correlation) S-Strong, M-Medium, W-Weak

1	COs/POS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
2	CO1											S	
	CO2			S	M								
	CO3		M									S	
	CO4	S			W							S	
3	Category	Engg Sciences (ES)											
4	Approval	47th Meeting of Academic Council held in Aug, 2018											

U18ESEE1L3	**BASIC ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY**	L	T	P	C
	Total Contact Hours – 45	0	0	3	1.5

	Prerequisite – School Level Physics & Basic Electrical and Electronics Engineering
	Course Designed by – Department of Electrical & Electronics Engineering
OBJECTIVES: To enhance the practical knowledge on basics of electrical and electronics components and circuits.	

LIST OF EXPERIMENTS FOR BASIC ELECTRICAL ENGINEERING LAB

1. Verification of Ohms and Kirchoff's Voltage and Current Laws
2. Measurement of the steady-state and transient time-response of R-L, R-C, and R-L-C circuits to a step change in voltage (transient may be observed on a storage oscilloscope). Sinusoidal steady state response of R-L, and R-C circuits – impedance calculation and verification.
3. Fluorescent lamp wiring
4. Staircase wiring
5. Measurement of energy using single phase energy meter
6. Observation of the no-load current waveform on an oscilloscope and Measurement of Primary and secondary voltages and currents of a Transformer
7. Demonstration of cut-out sections of machines: dc machine (commutator-brush arrangement), induction machine (squirrel cage rotor), synchronous machine (field winging - slip ring arrangement) and single-phase induction machine.
8. Demonstration of (a) dc-dc converters (b) dc-ac converters – PWM waveform (c) the use of dc-ac converter for speed control of an induction motor and (d) Components of LT switchgear.

LIST OF EXPERIMENTS FOR BASIC ELECTRONICS ENGINEERING LAB

Measurement of ac signal parameters using cathode ray oscilloscope and function generator.
Characteristics – Half wave and Full wave Rectifiers
Characteristics – Common Base transistor configuration
Verification of truth tables of OR, AND, NOT, NAND, NOR gates and Flip-flops - JK and RS
Applications of Operational Amplifier

REFERENCE BOOKS:

1. S. K. Bhattacharya, "Basic Electrical and Electronics Engineeing", Pearson Education India,2011

COURSE OUTCOMES (COs)	
CO1	To handle basic electrical equipment and verify current and voltage law
CO2	To understand the steady-state and transient time-response of R-L, R-C, and R-L-C circuits
CO3	To understand domestic wiring procedures practically.
CO4	To analyze ac signal parameters using cathode ray oscilloscope and function generator
CO5	To understand all the fundamental concepts semiconductor Diode and Transistor
CO6	To understand all the fundamental concepts of logic Gates and Flip-Flaps

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)
(S/M/W indicates strength of correlation) S- Strong, M-Medium, W- Weak

1	COs/POS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
2	CO1	S	S			S				S		M	
	CO2	S	S			S				S		M	

	CO3	S	S			S				S		M	
	CO4	S	S			S				S		M	
	CO5	S	S			S				S		M	
	CO6	S	S			S				S		M	
3	Category	Engg Sciences (ES)											
4	Approval	47th Meeting of Academic Council held in Aug, 2018											

SEMESTER III

U18BSMA302	**PARTIAL DIFFERENTIAL EQUATIONS, PROBABILITY AND STATISTICS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 60	**3**	**1**	**0**	**4**
	Prerequisite – Engg Mathematics I & II				
	Course Designed by – Department of Mathematics				

OBJECTIVE:

- Grasp the Fourier series expansion for given periodic function in specific intervals and their different forms.
- Learn techniques of solving the standard types of first order and second order partial differential equations.
- Learn solving wave and heat equation using Fourier series. Learn basics of probability, Baye's Theorem.
- Understand the concept of random variable, moment generating functions and their properties; learn standard distributions in discrete and continuous cases. Learn measures of central tendency and correlation and regressions, rank correlation, statistical intervals for single sample and test of hypothesis for a small and large sample.

UNIT I FOURIER SERIES 12

Dirichlet's conditions – General Fourier Series – Half range Sine and Cosine series – Parseval's Identity – Harmonic Analysis.

UNIT II PARTIAL DIFFERENTIAL EQUATIONS 12

Formation – Solutions of standard types of first order equations – Lagrange's linear equations – Linear partial differential equation of second and higher order with constant coefficients.

UNIT III BOUNDARY VALUE PROBLEMS FOR PARTIAL DIFFERENTIAL EQUATIONS 12

Classifications second order linear partial differential equations – Solution of one dimensional wave equation – One dimensional heat equation – Steady state solution of two dimensional heat equation – Fourier Series solutions in Cartesian coordinates.

UNIT IV PROBABILITY DISTRIBUTION 12

Probability – Axioms of probability – Conditional probability – Baye's theorem – Random variables – Binomial – Poisson – Geometric – Uniform – Exponential and normal distribution and their properties.

UNIT V STATISTICS AND TESTING OF HYPOTHESIS 12

Measures of central tendency – Moments – Skewness and kurtosis – Correlation and Regression – Rank correlation – Test of significance: Large sample test for single proportion, difference of proportions – Chi Square test for goodness fit and independence of attributes.

TEXTBOOKS:

1. S. J. Farlow, Partial Differential Equations for Scientist and Engineers, Dover Publications 1993. [Units I to V].
2. S.C.Gupta&V.K.Kapoor, "Fundamentals of Mathematical Statistics", Sultan Chand and Sons, New Delhi, 2003. [Units I to III].

REFERENCES:

1. R. Haberman, Elementary Applied partial differential equations with Fourier Series and Boundary Value Problems, 4th Ed., Prentice Hall, 1998.
2. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2001.
3. Manish Goya and .N.P Bali l, Transforms and Partial Differential Equations, University Science Press, Second Edition, 2010.
4. Douglas C. Montgomery and George C. Runger. "Applied Statistics and Probability for Engineers", 6th Edition. Wiley India Pvt Ltd., New Delhi-2. 2010.
5. TirupathiR.Chandrauptta. "Quality and Reliability in Engineering". Book Vistas, New Delhi.

WEBLINKS:

https://nptel.ac.in/courses/111105093/
https://onlinecourses.nptel.ac.in/noc18_ma12/preview

COURSE OUTCOMES	
CO1	The student will know how to formulate and solve partial differential equations
CO2	The student will use various mathematical methods to solve engineering problems
CO3	The student will be able to solve boundary value problems
CO4	The student will use probability to solve engineering problems
CO5	The student will use statistics to solve engineering problems

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)
L –LOW, M – MEDIUM, H – HIGH

1	COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
2	CO1	H	L	M	L									M	
	CO2	H	L	M	H										
	CO3	H	M	M									L	H	
	CO4	H	L	M											
	CO5	H	L	M	H								L	M	
3	Category	Basic Sciences (BS)													
4	Approval	47th Academic Council Meeting													

U18PCAE301	**FUNDAMENTALS OF AERONAUTICS AND ASTRONAUTICS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 30	**2**	**0**	**0**	**2**
	Prerequisite – Nil				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVE: To help the student understand the history of aviation, different kinds of aircrafts, spacecrafts, their components and functioning.

UNIT I EVOLUTION OF FLIGHT 4

Brief history of Aviation-Hot air balloon and heavier than air flying machines-early airplane configurations-Modern Airplanes-Components of airplane and their functions-Rotary wing aircrafts-Space vehicles.

UNIT II FUNDAMENTALS OF AERODYNAMICS 10

International Standard Atmosphere-Pressure, Temperature and Density altitude, Bernoulli's equation-Mach number-subsonic, transonic, sonic and supersonic flow regimes, Measurement of pressure and airspeed- IAS,EAS and TAS. Airfoil geometry and nomenclature - airfoil characteristics - lift, drag and moment coefficients-angle of attack-aspect ratio- induced drag and parasite drag.

UNIT III AIRCRAFT STRUCTURES AND MATERIALS 4

Structural components of an airplane- monocoque and semi monocoque structure –materials for structural components – composite materials and their significance in Aviation Technology.

UNIT IV AIRCRAFT PROPULSION 8

Propeller Engine – Gas Turbine Engine – Turbo prop, Turbo jet, Turbo fan Engines -variation of thrust, powerand specific fuel consumption with speed and altitude – materials for engine components.

UNIT V SPACE VEHICLES AND ASTRONAUTICS 4

Basics of Rocket Technology – escape velocity – re-entry vehicles – Satellite technology– Hypersonic vehicles, Elements of Astronautics.

TEXTBOOKS:

1. Anderson, J. D., Introduction to Flight, Tata-McGraw-Hill Higher Education, 6th edition 2010.

REFERENCES:

1. Kermode, A. C, Barnard, R. H and Philpott, D. R, Mechanics of Flight, Pearson education, 2012.
2. Shevell, R. C., Fundamentals of Flight., Prentice hall (2nd edition), 1989.
3. Steven, A. Brandt, Randall J. Stiles, John J. Bertin and Ray Whitford, Introduction to Aeronautics: A Design Perspective, AIAA Education series (2nd edition),2004.
4. Torenbeek, E and Wittenberg, H, Flight Physics:Essentials of Aeronautical Disciplines and Technology, with Historical Notes, Springer, 2009.

WEBLINKS:

https://www.edx.org/course/introduction-to-aeronautical-engineering

COURSE OUTCOMES	
CO 1	The knowledge about the development of aircrafts and spacecrafts will be helpful during the design of aircrafts and spacecrafts
CO 2	The knowledge of basic aerodynamics will help in aerodynamic analysis and design of aircrafts.

CO 3	The knowledge of aircraft construction and materials will help the student in the structural design of the aircrafts and spacecrafts
CO 4	The student will be able to select appropriate propulsion device during an aircraft design according to the requirements
CO 5	The student will know about space vehicles; their development and will be able to select appropriate orbits for satellites and also knowledge of re entry vehicles will be helpful during their design

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	PSO1	**PSO2**
CO 1	L	L	M	L										M
CO 2	H	L	M	L								H		
CO 3	H	L	M	L										
CO 4	H	L	M	L										M
CO 5	L	L	M	L										
Category	**Professional Core (PC)**													
Approval	**48th Academic Council Meeting**													

U18PCAE302	**FUNDAMENTALS OF MECHANICS AND MACHINES**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Introduction to Mechanics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVE: To enable the student to understand about the basics of mechanics, working of machines, the forces acting on different machines and the corresponding motion, prediction and design of machines.

UNIT I EQUILIBRIUM OF RIGID BODIES 9

Free Body Diagram, Equilibrium of Forces and Moments, Lame's theorem, Parallelogram and Triangle Law of Forces, Force Resolution, Types of Supports and Reactions, Requirements of Stable Equilibrium, Moments and Couple – Moment of force about a point and about an axis, Vector operation of forces, Resolution of Forces, Resultant of Several Concurrent Forces, Forces in Space

UNIT II PROPERTIES OF SURFACES AND SOLIDS 8

Determination of Areas, First Moment of Area and the Centroid of Standard Sections – T Section, I Section, Composite Figures, Hollow Section – Second Moments of Plane Area (Rectangle, Triangle, Circle, T Section, I Section, Hollow Section), Parallel Axis Theorem, Perpendicular Axis Theorem, Polar Moment of Inertia, Principal Moments of Inertia of Plane Areas – Basic Concepts of Mass Moment of Inertia

UNIT III MECHANISMS 10

Machine and Structure – Kinematic link, pair and chain – Grueblers criteria – Constrained motion – Degrees of freedom –Kutzbach criterion - Slider crank and crank rocker mechanisms – Inversions – Applications –Kinematic analysis of simple mechanisms – Determination of velocity and acceleration. – Introduction to Gears and Cams

UNIT IV FRICTION 8

Frictional force, Laws of Coulomb Friction, Cone of Friction, Angle of Repose, Friction in screw and nut – Pivot and collar – Thrust bearing – Plate and disc clutches – Belt (Flat and Vee) and rope drives. Ratio of tensions – Effect of centrifugal and initial tension – Condition for maximum power transmission – Open and crossed belt drive.

UNIT V FORCE ANALYSIS AND BALANCING 10

Introduction to force analysis – Inertia force and inertia torque - Static and dynamic balancing Single and several masses in different planes –Balancing of reciprocating masses- primary balancing and concepts of secondary balancing – Single and multicylinder engines

TEXTBOOKS:

1. F. P. Beer, E.R. Johnston, and J.T. Dewolf, Mechanics of Materials, McGraw-Hill (4th edition), 2006 (Unit 1 & 2)
2. Rattan.S.S., Theory of Machines, Tata McGraw–Hill Publishing Co, New Delhi, 2004. (Unit 3 to 5)

REFERENCES:

1. Rao, J.S and Dukkipati, R.V, "Mechanism and Machine Theory", Second Edition, Wiley Eastern Ltd., 1992.
2. Malhotra, D.R and Gupta, H.C., "The Theory of Machines", Satya Prakasam, Tech. India Publications, 1989.
3. Gosh, A. and Mallick, A.K., "Theory of Machines and Mechanisms", Affiliated East West Press,1989.
4. Shigley, J.E. and Uicker, J.J., "Theory of Machines and Mechanisms", McGraw-Hill, 1980.
5. Burton Paul, "Kinematics and Dynamic of Planer Machinery", Prentice Hall, 1979.
6. Balaguru. S., Dynamics of Machinery, SciTech publication (2nd edition), 2009.

WEBLINKS:

www.simplemachines.org/
ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=5593596
https://onlinecourses.nptel.ac.in/noc19_me29/preview

	COURSE OUTCOMES
CO1	Students will have an understanding of static force relationships and inertia forces and their effect that exist in machines
CO2	Students will be able to estimate the various surface and solid properties
CO3	The students will be able to determine velocities & accelerations of various planar mechanisms.
CO4	Students will understand the significance of fiction and design and carry out preliminary kinematic analysis for flat belt design and gears
CO5	Students will be able to perform balancing rotating and reciprocating masses

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs /POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO1	H	H	L	M									M	
CO2	H	H	L	M								L		
CO3	H	L	H											
CO4	H	L	H										M	
CO5	H	H	H	M										

Category	Professional Core (PC)
Approval	48th Academic Council Meeting

U18ESAE301	FUNDAMENTALS OF FLUID MECHANICS	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Introduction to Mechanics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVE: To help the student understand the basic physics of fluids, fluid behavior under different conditions, laws governing fluid flows, measurements in fluids and functioning of fluid machinery.

UNIT I INTRODUCTION 7

Fluid –definition-Fluid properties-Newton's law of viscosity-Classification of fluids-fluid statics-Hydrostatic forces on submerged surfaces- basics of Stability of floating bodies

UNIT II FLUID FLOW ANALYSIS AND FLOW MEASUREMENT 10

Ideal and real flow-Concept of continuum-Eulerian and Lagrangian approaches-Velocity field-Pathline, Streakline, Streamline- Stream tube- Fluid acceleration-Continuity, momentum differential equations-Navier Stokes equation-Bernoulli's equation and its applications-Venturimeter-Orifice meter, Coefficient of Discharge, Flow Rate and Velocity Measurement.

UNIT III DIMENSIONAL ANALYSIS 8

Dimensional Homogeneity, Buckingham's Pi Theorem-Non dimensional numbers and their significance-Flow similarity, similitude, incomplete similarity and model studies – distorted models

UNIT IV FLOW THROUGH PIPES 11

Laminar and turbulent flow- Boundary layer flow – Boundary layer thickness - Reynolds number and its significance-Laminar fully developed pipe flow-Hagen-Poiseuille flow-Coefficient of friction-Head loss – Darcy-Weisbach equation-Hydraulic gradient- Total energy lines-Moody's diagram

UNIT V FLUID MACHINERY 9

Classification of fluid machines-Reciprocating and centrifugal pumps-impulse and reaction turbines and velocity triangles-Working principle of Pelton, Francis and Kaplan turbines

TEXTBOOKS:

1. Rathakrishnan. E, Fundamentals of Fluid Mechanics, Prentice-Hall (3rd edition), 2012.

REFERENCES:

1. Bansal. R. K., "A textbook of Fluid Mechanics", Laxmi Publications, 2008
2. Frank M White, Fluid Mechanics, The McGraw Hill companies. (7th edition), 2011.
3. Yunus A Cengel and John M Cimbala, Fluid mechanics: Fundamentals and Applications, Tata McGraw Hill (2nd edition), 2010.
4. Irving H Shames, Mechanics of Fluids, The McGraw Hill companies (4th edition), 2003.
5. Yuan, S.W, Foundations of Fluid Mechanics, Prentice-Hall, 1967.

WEBLINKS:

reu.eng.ua.edu › Programs
www.fluidmechanics.co.uk/

https://onlinecourses.nptel.ac.in/noc17_me04/course

COURSE OUTCOMES	
CO1	The knowledge about fluid properties and forces acting on submerged bodies will be helpful during the design of aircrafts
CO2	The student will be able to perform flow field analyses and will also have an understanding to measure flow properties that will be helpful in the testing of models designed by the student.
CO3	The student will be able to construct appropriate models for testing the prototype design and will also be able to come up with relations for various forces.
CO4	Knowledge of flow through pipes will help the student in the design of various ducts, conduits in aerospace applications
CO5	The student will be able to select appropriate machinery to aid in the fluid dynamics taking place in fuel, oil, hydraulic and pneumatic systems

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COS/ POS	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
	H		M	M								H		
	H	H	M	M	M								M	
	H	M	H	H	M									
	H	H	M	H	M									
	H		M	H	L								M	
Category	**Engineering Science (ES)**													
Approval	**48th Academic Council Meeting**													

U18ESAE302	FUNDAMENTALS OF AERO – THERMODYNAMICS	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Nil				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVE: To make the student understand about the basics of engineering thermodynamics, various laws and their applications, prediction of thermodynamic performance of various engines, and other thermal devices.

UNIT I BASIC CONCEPTS AND FIRST LAW 7

Continuum, microscopic and macroscopic approach, thermodynamic system and surrounding, state, path, process, heat and work, zeroth law, concept of ideal and real gases, internal energy, specific heat capacities, enthalpy, first law of thermodynamics – PMM-1

UNIT II FIRST LAW APPLIED TO FLOW PROCESSES 10

Control volume – steady flow processes – steady flow energy equation – mass and energy balance – example of steady flow processes – variable flow processes

UNIT III SECOND LAW AND ENTROPY 11

Second law of thermodynamics, Kelvin – Planck's and Clausius Statements, PMM-2, reversibility and irreversibility, Carnot theorem, refrigerator, heat engine and heat pump, concept of entropy, irreversibility, Clausius inequality, principle of increase in entropy,

absolute entropy, entropy generation in open and closed systems, entropy change in non-flow processes, availability, exergy

UNIT IV AIR POWER CYCLES 9

Carnot, Otto, Diesel, Dual, Stirling and Ericsson cycle - Air standard efficiency – Mean effective pressure

UNIT V BRAYTON CYCLE 8

Introduction to aircraft propulsion – gas turbine engine cycles – open and closed Brayton cycle – Brayton cycle with reheat, regeneration and intercooling.

TEXTBOOKS:

1. Rathakrishnan E., Fundamentals of Engineering Thermodynamics, Prentice-Hall India, 2012.

REFERENCES:

1. Nag.P.K.,Engineering Thermodynamics, Tata McGraw-Hill, New Delhi, 2007.
2. Yunus A Cengel and Michael A Boles., Thermodynamics- an Engineering approach, McGraw Hill Education (7th edition), 2012.
3. Holman.J.P. Thermodynamics, McGraw-Hill (3rd edition), 2007.
4. Merle C Potter and Craig W Somerton., Thermodynamics for Engineers, Schaum's Outline Series, Tata McGraw-Hill (2nd edition), 2009.

WEBLINKS:

www.thermocalc.com/
www.grc.nasa.gov/WWW/cdtb/software/t-mats.html
https://www.edx.org/course/thermodynamics-2

COURSE OUTCOMES	
CO1	The student will understand the basic principles of thermodynamics
CO2	The student will be able to solve various thermal problems based on the laws of thermodynamics
CO3	The student will understand the limits of a thermal device based on entropy
CO4	The student will be able to design and analyze engines based on the air power cycles
CO5	The student will have a knowledge of design and analysis of aircraft propulsion systems

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO1	H	M	L	M	M							H	M	
CO2	H	M	L	M	L									
CO3	H	M	M	L	L								M	
CO4	H	M	M	L	M									
CO5	H	M	H	L	M								H	

Category	**Engineering Science (ES)**
Approval	**48th Academic Council Meeting**

U18ESAE303	**FUNDAMENTALS OF STRUCTURAL MECHANICS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Introduction to Mechanics				

	Course Designed by – Department of Aeronautical Engineering
OBJECTIVE: To equip the students with the basics of structural mechanics and materials, material behavior & failure under load, its prediction and design based on it.	

UNIT I INTRODUCTION TO STRENGTH OF MATERIALS 10

Introduction to mechanics of deformable bodies - Material selection criteria – stress – strain – Stress and strain diagram - Hook's law - Elastic constants – definition of engineering constants: elastic moduli – Young's modulus, Bulk Modulus& Volumetric Strain, Poisson's ratio, Shear Modulus, relation between three elastic moduli and Poison's ratio, Statically determinate and indeterminate problems in tension and compression – Thermal stress – Impact loading – Composite bars

UNIT II STRESSES IN BEAMS 9

Shear force and bending moment diagrams for simply supported, cantilever beams and overhanging beams– bending stress variation in beams of symmetric sections, neutral axis

UNIT III DEFLECTION OF BEAMS 9

Double integration, Macaulay's method, moment area method, conjugate beam method, method of superposition, Maxwell's reciprocal theorem.

UNIT IV TORSION 8

Torsion of solid and hollow circular shafts – Power transmission in shafts – Open and closed-coiled helical springs – Stresses in helical springs.

UNIT V BI – AXIAL STRESSES AND ELEMENTS OF ELASTICITY 9

Stresses in thin cylindrical and spherical shell under internal pressure and volumetric strain– Principle stresses and maximum shear stresses– Combined loading – Mohr's circle and its construction – concept of theory of elasticity, basic assumptions, coordinate transformation, plane stress and plane strain conditions, stress tensor

TEXTBOOKS:

1. Gere & Timoshenko, Mechanics of Materials, McGraw Hill, 1993

REFERENCES:

1. F. P. Beer, E.R. Johnston, and J.T. Dewolf, Mechanics of Materials, McGraw-Hill (4th edition), 2006
2. Dym,C.L., and Shames,I.H., Solid Mechanics, McGraw Hill, Kogakusha, 1973.
3. Stephen Timoshenko, Strength of Materials, Vol I & II, CBS Publishers and Distributors, Third Edition.
4. R.K. Rajput, Strength of Materials, S. Chand and Co., 1999.
5. William Nash, Strength of Materials, Tata McGraw Hill, 2004
6. Timoshenko,S. and Young,D.H., Elements of Strength of Materials, T.VanNostrand Co. Inc., Princeton, N.J., 1977.

WEBLINKS:

www.mdsolids.com/
https://onlinecourses.nptel.ac.in/noc17_ce22/preview
https://www.actuspotentia.com/MechMat.shtml

COURSE OUTCOMES	
CO1	The student will understand the basic concepts in strength of materials

CO2	The student will know about the relationship between stress and strains and their relationships for various materials
CO3	An understanding of the bending moment and the shear forces will help the student in the design of aircraft wings and fuselages
CO4	The student will be able to design aircraft or other components that will be able to withstand the torsion imposed upon them
CO5	The student will be able to design pressure vessels based on strength requirements

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO1	H	M	M	H	H							H	M	
CO2	H	M	M	H	H									
CO3	H	M	H	L	M								H	
CO4	H	M	H	L	M									
CO5	H	M	H	L	M								M	
Category	**Engineering Science (ES)**													
Approval	**48th Academic Council Meeting**													

U18PCAE3L1	**STRENGTH OF MATERIALS LABORATORY**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**0**	**0**	**3**	**1.5**
	Prerequisite – Strength Of Materials				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVE: To equip the students with hands on experience on conducting various structural tests to determine the structural properties of a given material.

LIST OF EXPERIMENTS

1 Tension test of a mild steel and aluminium rod.
2 Shear test on mild steel and aluminium rod.
3 Torsion test on mild steel rod.
4 Hardness test (a) Brinell& (b) Rockwell.
5 Impact tests (a) Izod& (b) Charpy.
6 Estimation of Stiffness of a Helical Spring (a) Open Coil & (b) Closed Coil
7 Fatigue test: Rotating beam.
8 Block compression test.
9 Flexural test by 3 point bending method

REFERENCES:

1. Strength of Materials Lab Manual, Department of Aeronautical Engineering, 2017

WEBLINKS:

https://www.youtube.com/watch?v=D8U4G5kcpcM
https://www.youtube.com/watch?v=jpogdcw_Uh0

COURSE OUTCOMES	
CO 1	The student will be able to perform tensile and compressive tests on new materials like composites to evaluate their mechanical properties.
CO 2	The shear test, torsion test and hardness test will be helpful to the student to find the various strengths of a material that will be helpful during design.
CO 3	The impact test will give out the impact strength that will be helpful during design.

CO 4	The knowledge of spring tests will help the student in designing appropriate springs for various members like landing gears
CO 5	The student will be able to design aircraft parts according to their fatigue limits by gaining knowledge of the fatigue test.

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

Cos / Pos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO 1	H	H	H	H	H								M	
CO 2	H	H	H	H	H								H	
CO 3	H	H	H	H									M	
CO 4	H	H	H	H										
CO 5	H	M	H	H									M	

Category	**Professional Core (PC)**
Approval	**48th Academic Council Meeting**

U18PCAE3L2	**COMPUTER AIDED DESIGNING AND DRAFTING**	**L**	**T**	**P**	**C**
	Total Contact Hours – 30	**0**	**0**	**2**	**1**
	Prerequisite – Engineering Graphics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVE: To equip the student with a practical experience of engineering drawing in the computer using commercial software packages.

LIST OF EXPERIMENTS

1 Study of various software for engineering design and drafting
2 Study of commercial software packages and their tools
3 Exercise on 2D drawing
4 Exercise on pad and groove
5 Exercise on shaft, mirror and array
6 Exercise on threading, bores and tappings
7 Exercise on part assembly
8 Exercise on drafting
9 Exercise on surface modeling
10 Exercise on kinematics

REFERENCES:

1. CADD Lab Manual, Department of Aeronautical Engineering, 2017

WEBLINKS:

https://grabcad.com/tutorials

COURSE OUTCOMES	
CO 1	The student will get an awareness of the different designing software and their applications.
CO 2	The student will get a basic idea about the applications of CAD software and its interface.
CO 3	The student will possess the skill to use the different components of CAD software to design a part or a model

CO 4	The student will have the skill of assembling different mechanical parts in CAD software
CO 5	The student will know about the drafting process, nomenclature, rules to be followed while drafting etc.

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO 1	H		H		H					M		H		
CO 2	H		H		H					M		H	H	
CO 3	H		H		H					M		H	M	
CO 4	H		H		H					M		H	M	
CO 5	H		H		H					H		H		

Category	**Professional Core (PC)**
Approval	**48th Academic Council Meeting**

U18ESAE3L1	**FLUID MECHANICS AND MACHINERIES LABORATORY**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**0**	**0**	**3**	**1.5**
	Prerequisite – Fundamentals Of Fluid Mechanics				
	Course Designed by – Department of Civil Engineering				

OBJECTIVE: To equip the students with hands on experience on conducting various experimental tests to determine the fluid properties of a given fluid and also to assess the performance of various fluid machinery.

LIST OF EXPERIMENTS

1 Determination of pipe flow losses.
2 Calibration of orifice meter and venture meter.
3 Flow through notches and weir.
4 Flow through open orifice
5 Buoyancy experiment – Metacentric Height.
6 Verification of Bernoulli's Equation.
7 Performance characteristics of centrifugal pump.
8 Performance characteristics of submergible pump.
9 Performance characteristics of jet pump.
10 Performance characteristics of oil gear pump.
11 Characteristics of impulse turbine – Pelton wheel turbine.
12 Characteristics of reaction turbine – Francis turbine

REFERENCES:

1. Fluid Mechanics and Machineries Lab Manual, Department of Civil Engineering, 2017

WEBLINKS:

https://www.arborsci.com/cool/fluid-mechanics/

COURSE OUTCOMES	
CO 1	The student will be able to understand the flow losses and will be able to measure them.

CO 2	The buoyancy test and Bernoulli's principle will be helpful for the student during the aerodynamic design
CO 3	The student will be able to measure the flow rate and will understand the concept behind it that will help in designing other such devices.
CO 4	The characteristics of various pumps will enable the student to select appropriate pumps during design of hydraulic and pneumatic systems.
CO 5	The knowledge about turbines will be helpful to understand about the operation of various turbines and their requirements.

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

Cos / Pos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS01	PSO2
CO 1	H	M	L	M										
CO 2	H		H											
CO 3	H	H	L	H										
CO 4	H		L											
CO 5	H		L											

Category	**Engineering Science (ES)**
Approval	**48th Academic Council Meeting**

SEMESTER IV

U18BSMA401	**NUMERICAL METHODS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Mathematics I & II, Partial Differential Equations				
	Course Designed by – Department of Mathematics				

OBJECTIVE:

- The objective of this course is to familiarize the prospective engineers with techniques in calculus, multivariate integration analysis and linear algebra.
- It aims to equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling more advanced level of mathematics and applications that they would find useful in their disciplines.

UNIT I SOLUTION OF POLYNOMIAL AND TRANSCENDENTAL EQUATIONS 12

Fixed Point Iteration methods - Newton - Raphson method and Regula-Falsi method for single variable - solutions of linear system of equations by Gaussian, Gauss-Jordan, Jacobian and Gauss-Siedel methods.

UNIT II INTERPOLATION 12

Finite differences - Relation between finite difference operators- Interpolation using Newton's forward and backward difference formulae, Interpolation with unequal intervals-Newton's Divided difference formula, Lagrange's Interpolation formula.

UNIT III NUMERICAL DIFFERENTIATION AND INTEGRATION 12

Numerical Differentiation with interpolation polynomials, Numerical integration by Trapezoidal and Simpson's Both 1/3rd and 3/8th rules. Double integration using Trapezoidal rule and Simpson rule.

UNIT IV INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS 12

Single step methods- Taylor series, Euler and modified Euler methods, Runge-Kutta method of fourth order for solving first and second order differential equations, Multiple step methods- Milne and Adam's - Bash forth predictor and corrector methods.

UNIT V BOUNDARY VALUE PROBLEMS FOR ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS 12

Finite difference - solution of 2nd order ODE - Finite difference solutions for two dimensional Laplace and Poisson equations, Finite difference solutions for one dimensional heat equation both implicit and explicit (Bender-Schmidt and Crank-Nicholson methods), Finite difference explicit method for one dimensional wave equation.

TEXTBOOKS:

1. Sastry.SS "Introductory Numerical Methods" 5th edition, PHI, 2012.
2. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 42nd Edition, 2016.
3. Jain K.K. Iyengar, S.R.K and Jain, R.K. "Numerical Methods for Scientific and Engineering Computation" 4rd edition, 2005.

REFERENCES:

1. Curtis F. Gerald. "Applied Numerical Analysis", 7th Edition. Pearson Education,
2. Dennis G. Zill and Warren S.Wright. "Advanced Engineering Mathematics", 3rd Edition. Jones & Bartlett Publishers, UK. 1992.
3. P.Kandasamy, K.Thilagavathy, K.Gunavathi - Numerical methods, S.Chand& Company, 2nd Edition 2010.

WEBLINKS:

https://onlinecourses.nptel.ac.in/noc17_ma14/course

COURSE OUTCOMES	
CO 1	To learn the problem solving methods in Eigen value problems.
CO 2	To learn interpolation techniques for solving various methods.
CO 3	To have a clear understanding about numerical differentiation and integration equations
CO 4	Properties of ordinary differential equation and problem solving using it
CO 5	Properties of partial differentiation equation and problem solving using it

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO 1	H	L	H	H	H									
CO 2	H	L	H	H	H									
CO 3	H	L	H	H	H									
CO 4	H	L	H	H	H									
CO 5	H	L	H	H	H									

Category	**Basic Sciences (BS)**
Approval	**47th Academic Council Meeting**

	ELEMENTS OF AEROSPACE STRUCTURES	L	T	P	C
U18PCAE401	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Fundamentals of Mechanics and Machines, Fundamentals of Structural Mechanics				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To enable the student to understand about the basics of aerospace structures, different types of structural members, their design and analysis.					

UNIT I TRUSSES AND FRAMES 9

Statically determinate frames - Analysis of plane Truss - Method of joints - 3 D Truss-Plane frames - Composite beam.

UNIT II STATICALLY INDETERMINATE BEAMS 9

Propped Cantilever - Fixed-Fixed beams - Clapeyron's Three Moment Equation – moment distribution method.

UNIT III ENERGY METHODS 11

Strain energy evaluation in structural members – Castigliano's Theorem – dummy load & unit load methods – Maxwell's reciprocal theorem – energy methods applied to statically determinate and indeterminate beams, frames, rings & trusses

UNIT IV COLUMNS 9

Euler's column curve – inelastic buckling – effect of initial curvature – the Southwell plot – columns with eccentricity – use of energy methods – theory of beam columns – beam columns with different end conditions – stresses in beam columns.

UNIT V FAILURE THEORY 7

Fail safe and safe life structures, factor of safety, Brief introduction of yield material, brittle vs. ductile behavior, Creep and creep rupture, viscoelastic materials - environmental stress, stress potentials, effect of time and temperature - Fatigue and Fracture - Maximum Stress theory – Maximum Strain Theory – Maximum Shear Stress Theory – Distortion Theory – Maximum Strain energy theory – Application to aircraft Structural problems.

TEXTBOOKS:

1. "Rajput, R. K.", "A Textbook of Strength of Materials", S Chand Publications, 2018 Edition

REFERENCES:

1. Timoshenko, S., Strength of Materials, Vol. I and II, Princeton D. Von NostrandCo, 1990.
2. Peery, D. J., and Azar J. J., Aircraft Structures, McGraw – Hill (2nd edition), 1999.
3. Bruhn.E.F., Analysis and design of flight vehicle structures,Tri set of offset company, 1973.
4. Michael C.Y.Niu,Airframe structural design (ISBN No.962-7128-04-X), 1998
5. Rivello,Theory and Analysis of Flight Structures, McGraw-Hill, 1969.

WEBLINKS:

https://online.stanford.edu/courses/aa240-analysis-aircraft-structures
https://www.edx.org/course/introduction-to-aerospace-structures-and-materials-0

COURSE OUTCOMES	
CO 1	The student will be able to design truss and frame structures based on the loading conditions.
CO 2	The student will be able to design and analyze aircraft wings, fuselages and other beam structures.
CO 3	The knowledge of strain energy methods will enable to student to solve complex structural problems.
CO 4	The student will be able to design supporting structures like struts, columns and landing gears.
CO 5	Using failure theories, the student will be able to predict the failure loads and design structures accordingly.

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO 1	H	H	H	M	L									
CO 2	H	H	H	M	L								M	
CO 3	H	M	M	L										M
CO 4	H	H	H	M	L							H	M	
CO 5	H	L	H	M	L									
Category	**Professional Core (PC)**													
Approval	**48th Academic Council Meeting**													

U18PCAE402	LOW SPEED AERODYNAMICS	L	T	P	C
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Mathematics I & II, Fundamentals of Fluid Mechanics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVE: To equip the students with the basic concepts necessary to understand the flow around low speed aircrafts, tools to estimate the forces thus generated and methods to design airfoils and wings of an aircraft.

UNIT I BASIC AERODYNAMIC PRINCIPLES 9

Models of fluid - System and Control volume approach, substantial, local and convective derivative, Continuity, momentum and energy equations, Inviscid flow, Euler equation, incompressible Bernoulli's Equation. Circulation and Vorticity

UNIT II FUNDAMENTALS OF INVISCID FLOWS 9

Elementary Flows and their combinations – Ideal Flow over a circular cylinder, D'Alembert's Paradox, Magnus effect, KuttaJoukowski Theorem, Starting Vortex, Kutta condition, Real flow over smooth and rough cylinder

UNIT III AIRFOIL THEORY 9

Complex Potential, Methodology of Conformal Transformation, Kutta-Joukowski transformation and its applications, Karman Trefftz Profiles, Thin Airfoil theory and its applications.

UNIT IV FINITE WING THEORY 9

Vortex Filament, Biot and Savart Law, Bound Vortex and trailing Vortex, Horse Shoe Vortex, Lifting Line Theory and its limitations, induced drag coefficient, elliptic and general lift distribution, Oswald's wing efficiency factor, effect of plan form and aspect ratio

UNIT V VISCOUS FLOW THEORY 9

Laminar Boundary layer and its thickness, displacement thickness, momentum thickness, Energy thickness, Shape parameter, Boundary layer equations for a steady two dimensional incompressible flow, Boundary Layer growth over a Flat plate, Critical Reynolds Number, Blasius solution, Basics of Turbulent flow

TEXTBOOKS:

1. Anderson, J.D., Fundamentals of Aerodynamics, McGraw Hill Book Co., 2006, Sixth Edition

REFERENCES:

1. Rathakrishnan,E., Theoretical Aerodynamics, John Wiley & Sons, Inc., 2013
2. Milne Thomson, L.H., Theoretical Aerodynamics, Macmillan, 1985
3. John J Bertin., Aerodynamics for Engineers, Pearson Education Inc, 5th Edition.
4. Clancy L J., Aerodynamics, John Wiley & sons, 1991.

WEBLINKS:

https://www.edx.org/course/introduction-to-aerodynamics
https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-100-aerodynamics-fall-2005/

COURSE OUTCOMES	
CO 1	Basic knowledge of the terms and mathematical formulations in aerodynamics will help in flow field analysis.
CO 2	The student will be able to predict the actual flow field based on the ideas gathered through simple ideal flow analysis.
CO 3	The student will be able to design new airfoils and to analyze the designed airfoil numerically with the help of transformations.
CO 4	The student will understand the concept of lift generation and will be able to design efficient wings for aircrafts.
CO 5	The student will be able to predict skin friction drag over aircrafts and understand the phenomenon of mixing process in fluids.

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO 1	H	H	M	M	H							L		
CO 2	H	H	L	M	H							L		
CO 3	H		H		M							L	M	
CO 4	H		H									L		
CO 5	H	H	H	L	M								M	
Category	**Professional Core (PC)**													
Approval	**48th Academic Council Meeting**													

U18PCAE403	AIRCRAFT PROPULSION	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Fundamentals of Aero – Thermodynamics				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To enable the student to understand about the basics of propulsion, working of different parts of a gas turbine engine, their design and analysis.					

UNIT I FUNDAMENTALS OF ENGINES 7

Gas turbine engine cycle - Engine performance parameters – Efficiencies, Methods of thrust augmentation – Characteristics of propeller, turboprop, turbofan and turbojet engines.

UNIT II INLETS AND NOZZLES 11

Subsonic inlets– External and internal flow pattern – inlet performance criterion –Boundary layer separation – Supersonic inlets – the starting problem – external deceleration– Exhaust nozzles –Theory of flow in isentropic nozzles – Losses in nozzles –Nozzle efficiency—nozzle choking –Over expanded and under expanded nozzles – Ejector and variable area nozzles

UNIT III COMPRESSORS 9

Principle of operation of centrifugal compressor – Work done and pressure rise – Velocity diagrams – Concept of pre whirl – Rotation stall – Operating Principle of axial flow compressor – Velocity triangles – degree of reaction – Centrifugal and Axial compressor performance characteristics.

UNIT IV COMBUSTION CHAMBERS 9

Classification of combustion chambers - Combustion process – Stoichiometric Ratio – Equivalence Ratio – Important factors affecting combustion chamber design — Combustion chamber performance – Effect of operating variables on performance – Flame tube cooling – Flame stabilization – flame holders.

UNIT V TURBINES 9

Operating Principle of axial flow turbine – Stator and rotor blades – losses in the blade – choice of blade profile, chord and pitch – stage and overall performance – blade cooling – radial flow turbine.

TEXTBOOKS:

1. Ganesan, V., Gas Turbines, Tata McGraw Hill Publications, Third Edition (Units 1, 3, 4 & 5)
2. Hill, P.G. & Peterson, C.R, Mechanics & Thermodynamics of Propulsion, Addison – Wesley Longman INC, 1999. (Unit 2)

REFERENCES:

1. Cohen, H. Rogers, G.F.C. and SaravanaMuttoo, H.I.H., Gas Turbine Theory, Longman, 1989.
2. Ahmed F. El-Sayed, Aircraft Propulsion and Gas turbine engines, CRS Press, 2008
3. Saeed Farokhi, Aircraft Propulsion, John Wiley & Sons, Inc ., 2009
4. Rolls Royce Jet Engine – 5thEdition – 1996.
5. Oates, G.C., Aero thermodynamics of Aircraft Engine Components, AIAA Education Series.

WEBLINKS:

https://freevideolectures.com/course/3008/jet-aircraft-propulsion
https://cosmolearning.org/courses/introduction-jet-propulson/

COURSE OUTCOMES	
CO 1	The student will be able to perform a basic thermodynamic analysis of gas turbine engines.
CO 2	The student will be able to design inlets and nozzles based on operating requirements.
CO 3	The student will understand the flow dynamics of compressors and will be able to design and analyze compressors according to requirements.
CO 4	The student will understand the process of combustion and will be able to design efficient combustion chambers and related components.
CO 5	The student will understand about the turbines and will be able to design and analyze them.

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS01	PS02
CO 1	H	H	L	H								L		
CO 2	H	M	H	M									L	
CO 3	H	H	H	M	M									
CO 4	H	L	L	L			L							
CO 5	H	H	H	M	M								L	
Category	**Professional Core (PC)**													
Approval	**48th Academic Council Meeting**													

U18PCAE404	**AIRCRAFT SYSTEMS AND INSTRUMENTATION**	**L**	**T**	**P**	**C**
	Total Contact Hours – 30	**2**	**0**	**0**	**2**
	Prerequisite – Fundamentals of Aeronautics and Astronautics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVE: To enlighten the student about the various systems and instruments necessary for the operation of a flight vehicle.

UNIT I AIRCRAFT SYSTEMS 6

Hydraulic systems - Study of typical workable system - components –Hydraulic systems controllers – Pneumatic systems - Advantages - Working principles - Typical Air pressure system – Brake system- Typical Pneumatic power system - Components, Landing Gear systems – Classification.

UNIT II AIRPLANE CONTROL SYSTEMS 8

Conventional Systems - fully powered flight controls - Power actuated systems – Modern control systems - Digital fly by wire systems - Auto pilot system active control Technology.

UNIT III ENGINE SYSTEMS 6

Fuel systems for Piston and jet engines, - Components of multi engines. Lubricating systems for piston and jet engines - Starting and Ignition systems - Typical examples for piston and jet engines.

UNIT IV AUXILIARY SYSTEMS 5

Basic Air cycle systems - Vapour Cycle systems, Evaporative vapour cycle systems - Oxygen systems - Fire protection systems, Deicing and anti-icing systems.

UNIT V AIRCRAFT INSTRUMENTS 5

Flight Instruments and Navigation Instruments – Gyroscope - Accelerometers, Air speed Indicators - Mach Meters - Altimeters - Principles and operation – Operation and Working Principle of various types of engine instruments – Tachometers, Temperature gauges, Pressure Gauges.

TEXTBOOKS:

1. General Hand Books of Airframe and Powerplant Mechanics, U.S. Dept. of Transportation, Federal Aviation Administration, The English Book Store, NewDelhi1995.

REFERENCES:

1. Mekinley, J.L. and Bent, R.D., Aircraft Power Plants, McGraw-Hill, 1993.
2. Pallet, E.H.J., Aircraft Instruments & Principles, Pitman & Co., 1993.
3. Treager, S., Gas Turbine Technology, McGraw-Hill, 1997.

WEBLINKS:

http://www1.rmit.edu.au/courses/c6011aero53861105
https://www.canvas.net/browse/erau/courses/aviation-101

COURSE OUTCOMES	
CO 1	The student will understand the basic systems operated by hydraulic and pneumatic power
CO 2	The student will know about the various control systems and will be able to select and design appropriate control system based on optimum conditions.
CO 3	The student will be able to design engine systems for better engine health monitoring and control.
CO 4	The student will understand about the auxiliary systems of the aircraft and design them
CO 5	The student will understand the operation of various aircraft instruments and able to select appropriate instruments for aircrafts and to design new instruments.

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO 1	H	L	L	L	L									
CO 2	H	L	L	L	L									M
CO 3	H	L	L	L	L									
CO 4	H	L	L	L	L									M
CO 5	H	L	L	L	L									
Category	**Professional Core (PC)**													
Approval	**48th Academic Council Meeting**													

U18PCAE405	**MANUFACTURING TECHNOLOGY**	**L**	**T**	**P**	**C**
	Total Contact Hours – 30	**2**	**0**	**0**	**2**
	Prerequisite – Engineering Graphics & Design				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To help the student to understand about the different types of manufacturing processes and the uniqueness of different methods.					

UNIT I METAL WORKING PROCESS 5

Mechanical working of metals –hot and cold working –rolling, extrusion, spinning, wire-drawing, press working. Welding – different types of gas and arc welding process, soldering and brazing. Casting –different types, furnaces

UNIT II MACHINING PROCESSES 7

Lathe – introduction, types, construction, mechanisms and attachments for various operations, nomenclature of single point cutting tool. Capstan and turret lathes various mechanisms, tool and loading arrangement. Automatic lathes - single spindle and multi spindle mechanisms, Introduction to CNC machining

UNIT III SHAPER, PLANER AND MILLING PROCESSES 7

Shaper, planer and slotter: types, specifications, mechanisms, holding devices, difference between shaper and planer. Milling machine – types and specification, mechanisms, holding devices, milling operations.

UNIT IV DRILLING, BORING, BROACHING, SURFACE FINISHING PROCESSES 6

Drilling, Boring- Specification, Nomenclature of drilling and reaming tool and its specification. Broaching: Specification, types, mechanisms, nomenclature of broaching tool. Grinding process, Types of grinding machines, Grinding Wheels, Honing, Super finishing, Polishing, Metal spraying, Galvanizing, Electroplating.

UNIT V NON – TRADITIONAL MACHINING PROCESSES 5

Non-traditional machining techniques, classification, Abrasive jet machining, Electrical Discharge Machining, E. D wire cutting, Electro chemical machining, Electron Beam Machining, Laser Beam Machining, Ultrasonic Machining – Introduction to 3D Printing

TEXTBOOKS:

1. HajraChowdary S.K, The fundamentals of work shop technology Vol. I & II, Media publishers, 1997.

REFERENCES:

1. W.A.J. Chapman., Workshop Technology. Vol I, II& III, 1975, ELBS.
2. Roy A Lindberg, Process and Material Manufacture, PHI, 1995.
3. Kalpakjan, Manufacturing Engineering and Technology, Addison Wesley, 2005.
4. P.C. Sharma., A text book of Production Technology, S.Chand& Company ltd, 2007.
5. P.N.Rao. Manufacturing Technology-Foundry Forging and Welding, TMH publishing co, 2009.

WEBLINKS:

https://onlinecourses.nptel.ac.in/noc17_me03
https://www.edx.org/course/fundamentals-manufacturing-processes-mitx-2-008x-0

COURSE OUTCOMES	
CO 1	The students will have the knowledge of various metal working processes.
CO 2	The student will be able to decide on appropriate tool and machine parameters during cutting.
CO 3	The student will understand the processes like planing, shaping and milling.
CO 4	The student will be able to use the drilling and boring machines and have an understanding of various surface finishing processes.

CO 5	The student will know about the non – traditional machining processes and will use them effectively towards his / her requirements.

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO 1	L		H		H	H								M
CO 2	L		H		H	H								
CO 3	L		H		H	H								
CO 4	L		H		H	H								M
CO 5	M		H		H	H	M							
Category	**Professional Core (PC)**													
Approval	**48th Academic Council Meeting**													

U18PCAE4L1	**AERODYNAMICS LABORATORY**	**L**	**T**	**P**	**C**
	Total Contact Hours – 30	**0**	**0**	**2**	**1**
	Prerequisite – Fundamentals of Fluid Mechanics, Co-requisite – Low Speed Aerodynamics				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To give to the student a practical experience of using the subsonic wind tunnel to carry out experimentation on different design models and to calculate forces acting on the models based on the experimentation.					

LIST OF EXPERIMENTS

1 Calibration of subsonic wind tunnel.
2 Pressure distribution over smooth cylinder
3 Pressure distribution over rough cylinder.
4 Pressure distribution over symmetric airfoil.
5 Pressure distribution over cambered airfoil.
6 Pressure distribution over a wing
7 Pressure distribution over a building model.
8 Determination of base drag of a missile model.
9 Study of flow field over a backward facing step.
10 Power estimation of Wind Turbine
11 Aerodynamic studies of automotive models.
12 Flow visualization at subsonic velocity (a) Using Tuft (b) Oil flow visualization.

REFERENCES:

1. Aerodynamics Lab Manual, Department of Aeronautical Engineering, 2017

WEBLINKS:

https://www.youtube.com/watch?v=IdES9fdUh2c
https://www.youtube.com/watch?v=E9ZSAX56m0E
https://www.youtube.com/watch?v=UqBmdZ-BNig

COURSE OUTCOMES	
CO 1	The student will know about the operation and calibration of a subsonic wind tunnel
CO 2	The student will be able to estimate pressure distributions over various models
CO 3	The student will be able to calculate the aerodynamics forces through pressure distributions on the models

CO 4	The student will understand the flow behavior through flow visualization techniques
CO 5	The student will know how to measure the aerodynamic forces using a wind tunnel balance

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO 1	H	H	L	L	L									
CO 2	H	H	L	L	M								M	
CO 3	H	H	L	M	M									
CO 4	H	H	L	M	M									
CO 5	H	H	L	M	M								M	

Category	**Professional Core (PC)**
Approval	**48th Academic Council Meeting**

U18PCAE4L2	**MANUFACTURING TECHNOLOGY LABORATORY**	**L**	**T**	**P**	**C**
	Total Contact Hours – 30	**0**	**0**	**2**	**1**
	Prerequisite – Nil, Co-requisite – Manufacturing Technology				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To equip the student with the knowledge and practical experience of operating various manufacturing machines like lathes, milling machines, shaper, planer					

LIST OF EXPERIMENTS

1 Study of centre, capstan and automatic lathes and their accessories.
2 Exercise on setting the work piece and the tool in the lathe.
3 Plane turning and step turning.
4 Taper turning and knurling.
5 Eccentric Turning.
6 Thread cutting and grooving.
7 Drilling and reaming.
8 Drilling and boring.
9 Surface grinding
10 Study of shaper and planer machines.
11 Study of milling and grinding machines.

REFERENCES:

1. Machine Shop Lab Manual, Department of Mechanical Engineering, 2017

WEBLINKS:

https://www.youtube.com/watch?v=8EsAxOnzEms
http://www.sme.org/fmp/
https://www.youtube.com/watch?v=-9fLQ9NHc4g

COURSE OUTCOMES	
CO 1	The student will understand about the operation of lathe.
CO 2	The student will have to skill to perform different operations using lathe.
CO 3	The student will have the skill to perform drilling and boring operations.
CO 4	The student will have the skill of thread cutting and grooving operations.
CO 5	The student will possess the skill of operation of shaper, planer and milling machines.

CO / PO MAPPING L –LOW, M – MEDIUM, H – HIGH														
COs / POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO 1	H				H	M	M	L	L			L		
CO 2	H				H	M	M	L	L			L	M	
CO 3	H				H	M	M	L	L			L		
CO 4	H				H	M	M	L	L			L	M	
CO 5	H				H	M	M	L	L			L		
Category	**Professional Core (PC)**													
Approval	**48th Academic Council Meeting**													

U18PCAE4L3	**AERO DESIGN AND MODELING LABORATORY**	**L**	**T**	**P**	**C**
	Total Contact Hours – 30	**0**	**0**	**2**	**1**
	Prerequisite – Fundamentals of Aeronautics and Astronautics				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To give the students a hands on experience on the design of small gliders, parachutes, paper planes, ornithopters, RC aircraft, quadrotors					

LIST OF EXPERIMENTS

1 Design and fabrication of gliders using light weight materials.
2 Design and fabrication of catapult.
3 Design and fabrication of power gliders.
4 Design and fabrication of single and double crank flapping wing mechanism.
5 Design and fabrication of pivoted double crank flapping wing mechanism.
6 Design and fabrication of wing using light weight materials.
7 Design and fabrication of horizontal and vertical stabilizer using light weight materials.
8 Design and fabrication of fuselage using light weight materials
9 Design and fabrication of control surfaces using glass fibers composite.
10 Estimation the discharge rate of Li-Po battery for different thrust setting.
11 Estimating the propeller thrust for different voltage setting.
12 Assembling of Remote Control Aircraft.

REFERENCES:

1. Aero Design and Modeling Lab Manual, Department of Aeronautical Engineering, 2017

WEBLINKS:

https://www.modelaircraft.org/

COURSE OUTCOMES	
CO 1	Student able to design and fabricate gliders, catapult and power gliders.
CO 2	Student can design and fabricate single, double and pivoted double crank flapping wing mechanism.
CO 3	Student can design and fabricate wing, vertical and horizontal stabilizer using balsa wood.
CO 4	Student can design and fabricate fuselage and control surfaces using polystyrene and glass fibers.
CO 5	Student can estimate discharge rate of Li-Po battery, propeller thrust and assembling Remote Control Aircraft.
CO / PO MAPPING	

L –LOW, M – MEDIUM, H – HIGH														
COs / POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO 1	H		H		H						M	M	**M**	
CO 2	H		H		H						M	M		
CO 3	H		H		H						M	M	**M**	
CO 4	H		H		H						M	M		
CO 5	H		M		H						M	M		
Category	**Professional Core (PC)**													
Approval	**48th Academic Council Meeting**													

SEMESTER V

U18PCAE501	**AIRCRAFT STRUCTURAL MECHANICS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Elements of Aerospace Structures				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To equip the student with the knowledge about the mechanics of different aircraft structural members, and their design.					

UNIT I UNSYMMETRICAL BENDING 9

Bending of symmetric beams subject to skew loads - bending stresses in beams of unsymmetrical sections – generalized 'k' method, neutral axis method, principal axis method- advantages and disadvantages.

UNIT II SHEAR FLOW IN OPEN SECTIONS 9

Thin walled beams – concept of shear flow – the shear centre and its determination – shear flow distribution in symmetrical and unsymmetrical thin-walled sections – structural idealization – shear flow variation in idealized sections.

UNIT III SHEAR FLOW IN CLOSED SECTIONS 9

Bredt - Batho theory – single-cell and multi-cell tubes subject to torsion – shear flow distribution in thin-walled single & multi-cell structures subject to combined bending torsion – with walls effective and ineffective in bending – shear center of closed sections.

UNIT IV BUCKLING OF PLATES 9

Bending of thin plates – rectangular sheets under compression - local buckling stress of thin walled sections – crippling strength by Needham's and Gerard's methods – thin-walled column strength – load carrying capacity of sheet stiffener panels – effective width – inter-rivet and sheet wrinkling failures - short panel failing strength.

UNIT V STRESS ANALYSIS OF WING AND FUSELAGE 9

Wing structural arrangements – factors influencing - wing stress analysis methods – determination of shear force and bending moment distribution over fuselage – Numerical problems – Tension field beam – general Wagner equation - Semi-tension field beams.

TEXTBOOKS:

1. Megson T M G, 'Aircraft Structures for Engineering Students', Fifth Edition, Elsevier Aerospace Engineering Series,2007. (Units 1, 2, 3 & 5)

2. Peery, D.J., and Azar, J.J., Aircraft Structures, 2nd edition, McGraw – Hill, N.Y., 1999 (Unit 4)

REFERENCES:

1. Rivello, R.M., Theory and Analysis of Flight Structures, McGraw Hill, 1993.
2. Howard D Curtis, 'Fundamentals of Aircraft Structural Analysis', WCB-McGraw Hill, 1997
3. Bruhn. E.H., 'Analysis and Design of Flight Vehicles Structures', Tri-state off-set company, USA, 1985

WEBLINKS:

https://www.sciencedirect.com/topics/engineering/shear-centre
http://nptel.ac.in/courses/105106049/63
https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-21-techniques-for-structural-analysis-and-design-spring-2005/

COURSE OUTCOMES	
CO 1	The analytical ability of calculating the bending stresses in beams of unsymmetrical sections and ability to solve problems requiring the concepts with wall effective and ineffective in bending.
CO 2	Make appropriate assumptions when applying the Shear flow in single &multicell structures under torsion and using the basic concepts of shear flow Shear flow in single and multicell under bending with walls effective and ineffective.
CO 3	Apply the concepts of Needham's and Gerard's methods on stresses developed and to describe the performance of the structural panel and physical interpretation and application of stress analysis to solve problems.
CO 4	Physical interpretation and application of stress analysis to solve problems.
CO 5	Solving ability of complex problems into an orderly and logical way through analytical approach.

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO 1	H	H	H	M	M								**M**	
CO 2	H	H	H	M	M									
CO 3	H	H	M	H	M								**H**	
CO 4	H	H	H	M	H								**H**	
CO 5	H	H	M	H	H									
Category	**Professional Core (PC)**													
Approval	**48th Academic Council Meeting**													

U18PCAE502	**GAS DYNAMICS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Low Speed Aerodynamics				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To make the student understand about the flow physics of high speed gases, shocks and high speed aircraft and experimentation techniques.					

(Use of Gas Tables is permitted)

UNIT I FUNDAMENTAL ASPECTS OF COMPRESSIBLE FLOW 9

Compressibility, Continuity, Momentum and Energy equation for steady one dimensional flow, Compressible Bernoulli's equation, Area – Mach number – Velocity relation, Mach cone, Mach angle, One dimensional Isentropic flow through variable area duct, Isentropic relations - Critical conditions, Characteristic Mach number, Maximum discharge velocity.

UNIT II SHOCKS AND EXPANSION WAVES 10

Normal shock relations, Prandtl's relation, Hugonoit equation, Rayleigh Supersonic Pitot tube equation, Oblique shocks, θβM relation, Shock Polar, Reflection of oblique shocks, Left running and Right running waves, Interaction of oblique shock waves, slip line, Rayleigh flow, Fanno flow, Expansion waves, Prandtl-Meyer expansion, Maximum turning angle, Simple and non-simple regions, Operating characteristics of convergent and convergent-divergent nozzles.

UNIT III TWO DIMENSIONAL COMPRESSIBLE FLOW 10

Potential equation for 2-dimensional compressible flow, Linearization of potential equation,Small perturbation theory, Linearized Pressure Coefficient, Linearized subsonic flow, Prandtl-Glauert rule, Linearized supersonic flow, Method of characteristics, Wave drag coefficient.

UNIT IV HIGH SPEED FLOW OVER AIRFOILS, WINGS AND AIRPLANE CONFIGURATION 8

Critical Mach number, Drag divergence Mach number, Shock Stall, Shock- Boundary layer interaction, Supercritical Airfoil Sections, Transonic area rule, Swept wing, Airfoils for supersonic flows, Lift, drag, Pitching moment and Centre of pressure for supersonic profiles, Shock-expansion theory, wave drag, supersonic wings.

UNIT V EXPERIMENTAL METHODS 8

Wind tunnels for Subsonic, transonic, Supersonic and hypersonic flows, Various Measurement techniques – velocity, pressure, Flow visualization techniques in high speed flows, Shock tube, Gun tunnels

TEXTBOOKS:

1. Rathakrishnan.. E, Gas Dynamics, Prentice Hall of India, Sixth Edition, 2017.

REFERENCES:

1. Anderson, J. D, Modern Compressible Flow, Third Edition, Tata McGraw-Hill & Co., 2012.
2. Shapiro, A. H., Dynamics and Thermodynamics of Compressible Fluid Flow, Ronald Press, 1982.
3. Zucrow, M. J. and Anderson, J. D., Elements of Gas Dynamics, McGraw- Hill & Co., 1989.
4. Oosthuizen,P.H., &Carscallen,W.E., Compressible Fluid Flow, McGraw- Hill & Co., 19976.
5. Yahya S.M., Fundamentals of Compressible Flows, Third Edition, New Age International Publishers, 2003.

WEBLINKS:

https://onlinecourses.nptel.ac.in/noc17_ae05/course

COURSE OUTCOMES

CO 1	The student will understand the compressible flow dynamics and governing equations and will realize the relationship between the various terms in the governing equation.
CO 2	The student will gain knowledge about the changes taking place during flow through variable area ducts.
CO 3	The student will be able to estimate flow properties across shock waves and expansion waves.
CO 4	The student will gain the skill of estimating aerodynamic properties in compressible flows.
CO 5	The student will be able to design appropriate geometry for the aircraft components based on performance requirements.

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS01	PS02
CO 1	H	H	H	H	H								**M**	
CO 2	H	H	M	L	M									
CO 3	H	M	M	L									**M**	
CO 4	H	M	M	L										
CO 5	H	H	M	H	H								**M**	
Category	**Professional Core (PC)**													
Approval	**48th Academic Council Meeting**													

U18PCAE503	**ADVANCED AEROSPACE PROPULSION**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Aircraft Propulsion				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVE: To enable the student to understand about the advanced aero engines, rocket engines, electric engines, components and functions.

UNIT I RAMJET PROPULSION 11

Operating principle of ramjet engine – Components of ramjet engines and their efficiencies – Combustion in ramjet engine – Critical, subcritical and supercritical modes of operation - Ramjet engine and its performance characteristics – Ramjet design calculations – Flame stability problems in ramjet combustors –Integral ram rockets.

UNIT II SCRAMJET PROPULSION 9

Introduction to hypersonic vehicles, design challenges and supersonic combustion - problems associated with supersonic combustion– Types of scramjet combustors – Fuel injection schemes in scramjet combustors – Flame Stabilization

UNIT III SOLID PROPELLANT ROCKETS 8

Operating principle – Specific impulse of rocket – Internal ballistics – Selection criteria of solid propellants – propellant grain design considerations – Progressive, Regressive and neutral burning in solid rockets.

UNIT IV LIQUID PROPELLANT ROCKETS 8

Liquid propellant rockets – selection of liquid propellants – various feed systems for liquid rockets –basics of cryogenic techniques – Cooling in liquid rockets and the associated heat transfer problems – advantages of liquid rockets over solid rockets - introduction to hybrid

propulsion – advantages and limitations of hybrid propulsion - static testing of rockets and safety considerations

UNIT V NON – CONVENTIONAL PROPULSION TECHNIQUES 9

Pulse propulsion – combustion process in pulsejet engines – inlet charging process – Introduction to nozzleless propulsion and basic concepts - Electric rocket propulsion - Ion propulsion – Nuclear rocket – Types – Solar Sail - comparison of performance of these propulsion systems with chemical rocket propulsion systems.

TEXTBOOKS:

1. El-Sayed, Ahamed F, "Aircraft Propulsion and Gas Turbine Engines", CRC Press, 2008 (Unit 1)
2. Corin Segal, "The Scramjet Engine", Cambridge University Press, 2009 (Unit 2)
3. Ramamurthy, K., "Rocket Propulsion", Trinity Publishers, 2nd Edition (Units 3, 4 & 5)

REFERENCES:

1. J D Mattingly, "Elements of Propulsion - Gas Turbines and Rockets ", AIAA Education Series, 2006.
2. David H. Heiser and David T. Pratt., "Hypersonic Air -breathing Propulsion", AIAA Education Series, 1999.
3. DanM.Goebel, Ira Katz, 'Fundamentals of Electric Propulsion', John Wiley & Sons Inc, New York, 2003.
4. Thomas A Ward, "Aerospace Propulsion Systems", John Wiley & Sons Inc., New York, 2010.
5. Sutton, G.P., "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 7th Edition, 2001

WEBLINKS:

https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-512-rocket-propulsion-fall-2005/

COURSE OUTCOMES	
CO 1	The student will be able to understand how to operate the scramjet and ramjet engines.
CO 2	The student will be able to understand the pulsejet engine propulsion techniques.
CO 3	The student will be able to understand the solid propulsion rockets types and operation.
CO 4	The student will decide the selection criteria of liquid propellant rocket engines.
CO 5	By knowing about the various types of non conventional propulsion techniques used for nozzle less propulsion techniques.

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO 1	H	H	H	M										
CO 2	H	H	H										**M**	
CO 3	H	L	M	M									**M**	
CO 4	H	L	M	M										
CO 5	H	L	L		H									

Category	Professional Core (PC)
Approval	48th Academic Council Meeting

U18PCAE504	AIRCRAFT PERFORMANCE	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Low Speed Aerodynamics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVE: To equip the student with the knowledge of estimating the performance parameters of an aircraft and its design.

UNIT I AERODYNAMICS OF THE AIRPLANE 10

International Standard Atmosphere, TAS, IAS and EAS, , Aerodynamic Lift, Drag and Moments – Lift, Drag and Moment Co-efficient- Aerodynamic Center – NACA airfoil nomenclature – Streamlined and Bluff body – Skin friction Drag, Pressure Drag and Induced Drag – Drag Polar – Various drags of an airplane – Methods of Drag Reduction – Mach Number – Effect on Drag Polar.

UNIT II AIRCRAFT ENGINE PERFORMANCE 10

Piston engines, Thrust and Efficiency – Froude's momentum Theory – Characteristics of Propeller – Factors affecting propeller performance, Prediction of propeller performance, Propeller noise, Propeller selection, Jet engines, Turbojet, Turboprop and Turbofan Engines, Engine performance parameters, Comparative study of different gas turbine engines, Ramjet and rocket engines

UNIT III STEADY LEVEL FLIGHT 10

Steady level flight, Thrust required and Power required, Thrust available and Power available for propeller driven and jet powered aircraft, Effect of altitude, maximum level flight speed, conditions for minimum drag and minimum power required, Effect of drag divergence on maximum velocity, Range and Endurance of Propeller and Jet aircrafts

UNIT IV GLIDING AND CLIMBING FLIGHT 8

Shallow and steep angles of climb, Rate of climb, Climb hodograph, Maximum Climb angle and Maximum Rate of climb- Effect of design parameters for propeller and jet aircrafts, Absolute and service ceiling, Cruise climb, Gliding flight, Glide hodograph

UNIT V ACCELERATED FLIGHT 7

Estimation of take-off and landing distances, Methods of reducing landing distance, level turn, minimum turn radius, bank angle and load factor, Constraints on load factor, Pull up and pull down maneuvers, maximum turn rate, V-n diagram.

TEXTBOOKS:

1. Anderson, Jr., J.D. Aircraft Performance and Design, McGraw-Hill International Edition, 2010.

REFERENCES:

1. Miado Saarlas, Aircraft Performance, John Wiley & Sons, 2007
2. Torenbeek E and Wittenberg H, Flight Physics, Springer, 2009
3. Anderson, Jr., J.D. Introduction to Flight, McGraw-Hill International Edition, 1999.
4. Pamadi, B.N. Performance, Stability, Dynamics, and Control of Airplanes, AIAA Education Series, 2004

5. Houghton,E.L. and Carruthers, N.B. Aerodynamics for engineering students, Edward Amold Publishers, 1988

WEBLINKS:
https://swayam.gov.in/course/1316-introduction-to-airplane-performance

COURSE OUTCOMES	
CO 1	The student will have knowledge of basic principles relating to drag polar equation of the aircraft and its importance in evaluating aircraft performance in steady level flight.
CO 2	The student will acquire knowledge of aircraft engine performance
CO 3	The student acquire knowledge of aircraft performance pertaining to steady level flight and performance pertaining to range, endurance climbs and glide performance under various flight conditions.
CO 4	The student will acquire knowledge of aircraft performance pertaining to climb and glide performance
CO 5	The student will acquire knowledge of aircraft performance pertaining to take off, landing and turning performance under various flight conditions.

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO 1	H	H	H	M									**M**	
CO 2	H	H	H	M									**M**	
CO 3	H	H	H	M										
CO 4	H	H	H	M	L								**M**	
CO 5	H	H	M	M	L									
Category	**Professional Core (PC)**													
Approval	**48th Academic Council Meeting**													

U18PCAE505	**CONTROL SYSTEMS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Basic Electrical and Electronics Engg				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To equip the student with the various methods necessary to carry out the design and analysis of aerospace control systems.					

UNIT I SYSTEM AND REPRESENTATION 9
Basic elements in control systems – Open and closed loop systems – Electrical analogy of mechanical systems – Transfer function – Block diagram reduction techniques

UNIT II TIME RESPONSE 9
Time response – Time domain specifications – Types of test input- I and II order system response – Error coefficients – Generalised error series – Steady state error- P, PI, PID modes of feedback control – Time response analysis.

UNIT III FREQUENCY RESPONSE 9

Frequency response – Bode plot- polar plot – Determination of closed loop response from open loop response – Correlation between frequency domain and time domain specifications.

UNIT IV CONCEPT OF STABILITY 9

Characteristics equation – Root Locus construction - Routh Hurwitz stability criterion

UNIT V SAMPLED DATA SYSTEMS 9

Sampled data control systems- functional elements – sampling process- z-transforms- properties inverse z transforms – ZOH and First Order Hold process- pulse transfer functions – step response – Introduction to digital control system, Digital Controllers and Digital PID controller

TEXTBOOKS:

1. Nagarath.I.J. and Gopal M, " Control System Engineering', New Age International Publishers, New Delhi, 2015. (Units 1 to 4)
2. Houpis, C.H. and Lamont, G.B. Digital control Systems, McGraw Hill Book co., New York, U.S.A. 1995 (Unit 5)

REFERENCES:

1. OGATO, Modern Control Engineering, Fifth Edition, Prentice-Hall of India Pvt.Ltd., New Delhi, 2010.
2. Kuo, B.C. Automatic Control Systems, Prentice-Hall of India Pvt.Ltd., New Delhi, 2009.
3. Azzo, J.J.D. and C.H. Houpis, Feedback Control System Analysis And Synthesis, McGraw-Hill International 3rd Edition, 1998.
4. Naresh K Sinha, Control Systems, New Age International Publishers, New Delhi, 1998.

WEBLINKS:

https://onlinecourses.nptel.ac.in/noc18_ee41/course

COURSE OUTCOMES	
CO 1	Students will be able to understand basic pneumatic, hydraulic thermal system and flight control system. Able to do Analogies of mechanical systems
CO 2	Students will be able to apply concept of Block diagram reduction technique and signal flow graph to find transfer function of system
CO 3	Students will be able to understand various types of signals and time response analysis of first order and second order system.
CO 4	Students will be able to develop bode plot, root locus diagrams and can do stability analysis
CO 5	Students will be able to understand digital systems, digital controllers. Also able to apply z- transform to analysis digital systems.

CO / PO MAPPING::L –LOW, M – MEDIUM, H – HIGH

COs / POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO 1	L												**H**	
CO 2	H	H		H	H									
CO 3	H	H	M	H	H									
CO 4	H	H	M	H	H								**M**	
CO 5	H	M	M	M	H									
Category	**Professional Core (PC)**													
Approval	**48th Academic Council Meeting**													

U18PCAE5L1	**AIRCRAFT STRUCTURES LABORATORY**	**L**	**T**	**P**	**C**

	Total Contact Hours – 30	**0**	**0**	**2**	**1**
	Prerequisite – Elements of Aerospace Structures, Co-requisite – Aircraft Structural Mechanics				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To enable the student to understand about the structural analysis of different aircraft parts, shear centers, combined loading					

LIST OF EXPERIMENTS

1 Determination of Young's modulus of aluminum using electrical extensometers.
2 Deflection of beams with various end conditions.
3 Verification of Maxwell's theorem and principle of superposition.
4 Column – Testing.
5 Testing of riveted joints.
6 Unsymmetrical Bending of a Beam
7 Determination of Shear Centre in open Section
8 Determination of Shear Centre in closed Section
9 Combined bending and Torsion of a Hollow Circular Tube
10 Constant Strength Beams
11 Wagner beam – Tension field beam
12 Material properties test of composite laminate

REFERENCES:

1. Aircraft Structures Lab Manual, Department of Aeronautical Engineering, 2017

WEBLINKS:

https://www.youtube.com/watch?v=Na7vONvHqOc
https://www.youtube.com/watch?v=SH_NlsDe3jE
https://www.youtube.com/watch?v=EEQqmYPOLIQ

COURSE OUTCOMES	
CO 1	The student will gain knowledge of the different experimental setups used to carry out structural analysis.
CO 2	The student will understand about the possible loads on beams; their analysis and effects.
CO 3	The student will be able to design and analyze column like structures in aerospace applications.
CO 4	The student will understand the effect of complex loading on aerospace structures.
CO 5	The student will realize the importance of shear flow analysis in aerospace design.

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO 1	H	H	M	H	M									
CO 2	H	H	M	M	M									
CO 3	H	H	H	M	M								**M**	
CO 4	H	M	H	H										
CO 5	H	H	M	M										

Category	Professional Core (PC)
Approval	48th Academic Council Meeting

U18PCAE5L2	AIRCRAFT MAINTENANCE LABORATORY	L	T	P	C
	Total Contact Hours – 30	0	0	2	1
	Prerequisite – Aircraft Systems and Instruments				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVE: To acquaint the students with the basic inspection, repair and maintenance practices carried out for aircrafts.

LIST OF EXPERIMENTS

1 Aircraft systems observations during Ground run.
2 Aircraft "Mooring" and "Leveling" procedure.
3 Control System "Rigging check" procedure
4 Aircraft "Symmetry Check" procedure
5 Procedure to find the centre of gravity of Aircraft
6 Piston Engine – Cleaning, Visual Inspection. NDT Checks
7 Piston Engine Components – Dimensional Checks
8 Jet Engine – Identification of Components and Defects
9 Welding using MIG and TIG Apparatus
10 Fabrication using composites
11 Tube Bending and Flaring
12 Sheet Metal Forming

REFERENCES:

1. Aircraft Systems Lab Manual, Department of Aeronautical Engineering, 2017
2. Airframe and Aero Engine Repair Lab Manual, Department of Aeronautical Engineering, 2017.

WEBLINKS:

https://www.youtube.com/watch?v=pmJmwkrkcC8

COURSE OUTCOMES	
CO 1	To know the different aircraft systems, components, safety precautions, location in the aircraft.
CO 2	In depth knowledge of basic principle and Understand the jacking procedure, levelling and symmetric checks done in the aircraft.
CO 3	To know the operation of the control rigging in the aircraft.
CO 4	To know the operation of brake torque load test
CO 5	To understand the operation of aircraft systems related with instruments to develop the skills of trouble shooting, time saving, cost saving, quality concepts implementation in the industry.

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO 1	H		L											

CO 2	H		L	M	M									
CO 3	H	M	L	M									**M**	
CO 4	M	M	L											
CO 5	M	H	M		H									
Category	**Professional Core (PC)**													
Approval	**48th Academic Council Meeting**													

U18PCAE5L3	**FLIGHT SIMULATION LABORATORY**	**L**	**T**	**P**	**C**
	Total Contact Hours – 30	**0**	**0**	**2**	**1**
	Prerequisite – Fundamentals of Aeronautics and Astronautics				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To acquaint with the basic starting and operation of a Cessna 172 aircraft through a flight simulator					

LIST OF EXPERIMENTS

1 Specification of Cessna C-172 –S
2 Cessna-172 Trainer Aircraft Operational Check
3 Study of Cessna – 172 Flight Simulators
4 Demonstrate the Autopilot Mode and Automatic Direction Control Mode of Cessna 172 Trainer Aircraft
5 Demonstration of Takeoff And Landing in Cessna-127 Trainer Aircraft using Flight Simulator
6 Demonstration of Basic Aircraft Instruments
7 Study of Ring Laser Gyro
8 Study of Fly-By-Wire And Fly-By-Light
9 Demonstration of Lateral Autopilot
10 Demonstration of Longitudinal Autopilot

REFERENCES:

1. Flight Simulation Lab Manual, Department of Aeronautical Engineering, 2017

WEBLINKS:

https://www.digitaltrends.com/gaming/best-free-flight-simulators/

COURSE OUTCOMES	
CO 1	The student will realize the significance of an aircraft simulator
CO 2	The student will know the basic flight operation procedures, instruments in a Cessna 172 aircraft
CO 3	The student will know how to start, takeoff and land the aircraft
CO 4	The student will know to execute different maneuvers in the airplane
CO 5	The student will have an understanding of the autopilot

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO 1	H	H	H	H										
CO 2	H	H	H	H										
CO 3	H	H	H	H									**M**	

CO 4	H	M	H	M	L									
CO 5	H	H	M	M	M									
Category	**Professional Core (PC)**													
Approval	**48th Academic Council Meeting**													

U18PCAE5L4	**SIMULATION TOOL FOR AEROSPACE APPLICATIONS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 30	**0**	**0**	**2**	**1**
	Prerequisite – Mathematics I & II				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To acquaint with the MATLAB application to solve various engineering problems.					

LIST OF EXPERIMENTS

1 Introduction to MATLAB
2 Relational and Logical Expressions in MATLAB
3 Working with Matrices
4 Plotting using MATLAB
5 Exercise on Curve Fitting
6 Exercise on Complex and Statistical Analysis
7 Program Flow Control in MATLAB
8 Input and Output of Variables
9 Exercise on solving ODE's and PDE's
10 Exercise on using SIMULINK for dynamic simulation.

REFERENCES:

1. MATLAB Lab Manual, Department of Aeronautical Engineering, 2018.

WEBLINKS:

https://www.mathworks.com/support/learn-with-matlab-tutorials.html

COURSE OUTCOMES	
CO 1	The student will be able to solve various aerospace engineering problems using matlab
CO 2	The students will realize the power of computing using matrices and arrays
CO 3	The students will realize the significance of matlab in various scientific tools like curve fitting, data analysis
CO 4	The student will be able solve various governing differential equations using matlab
CO 5	The student will be able to carry out simulations

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO 1	H	M	M	M	H							H	**M**	
CO 2	H	M	M	M	H									
CO 3	H	H	M	H	H								**M**	

CO 4	H	H	M	H	H									
CO 5	H	H	M	H	H									
Category	**Professional Core (PC)**													
Approval	**48th Academic Council Meeting**													

SEMESTER VI

U18HSBA601	Organizational Behavior of Engineer	L	T	P	C
	Total No. of contact hours: 45	3	0	0	3
	Pre-requisite: Nil				
	Course Designed by: Dept of Management Studies				

Course Objectives

1. Understanding the basic approaches in organization
2. Knowledge on theories of Personality
3. Clear sight on the Decision Making in Groups
4. Analyse the behaviour of individuals and groups in organizations in terms of the key factors that influence organizational behaviour.
5. Assess the potential effects of organizational - level factors (such as structure, culture and change) on organizational behaviour.

UNIT I **9 hours**

Orgnanizational Behavior – Definition, Need for studying Organizational Behavior, Disciplines involved in the study of Organizational Behavior, -Contributing disciplines and area - Application of Organizational Behavior in Business.

UNIT II **9 hours**

Individual behaviour – personality, perception, learning, attitudes inter-personal behavior – Group and inter-group behaviour.

UNIT III **9 hours**

Group Dynamics – Formal and Informal Group, Group Norms, Group Cohesiveness, Group Behaviour and Group Decision – Motivation – Need and Importance – Theories of Motivation

UNIT IV **9 hours**

leadership-nature, stles and approaches, development of leadership including laboratory training. Power and Authority – Definition of Power – Types of Power.

UNIT V **9 hours**

Management of change-conflict Management- Management of culture, Cross Cultural Management.

REFERENCES

1. Uma Sekaran, Organizational Behavior: Text and Cases TMH Publications
2. Ashwathappa K, Organizational Behavior: Text, cases and games, Himalaya Publishers
3. Chandhan JS, Organizational Behavior, Vikas Publishers
4. Stephen Robbins, Organizatonal Behavior, Pearson Education
5. RS Diwedi, Human Relations and Organizational Behavior, Mac Millan

COURSE OUTCOMES (COs)	
CO1	Familiarity with the knowledge of Frame work of Organizational Behaviour

CO2	Knowledge of the Interpersonal perception
CO3	Awareness of the Merits and Demerits of Group decision making.
CO4	Understanding of the Sources of power
CO5	Familiarity with the knowledge of types of Conflicts

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO 1						H		H		L		L		
CO 2						H		H		L				
CO 3						H		H		L				
CO 4						H		H		L				
CO 5						H		H		L		L		
Category	**Humanities and Sciences (HS)**													
Approval	**48th Academic Council Meeting held in Aug, 2018**													

U18PCAE601	**FINITE ELEMENT ANALYSIS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Elements of Aerospace Structures				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To acquaint the student with basic numerical techniques called finite element techniques to analyze structural components.					

UNIT I INTRODUCTION 9

Introduction to FEA - historical background - Review of various approximate methods – Rayleigh Ritz method, Weighted residual methods - Convergence criteria - Fundamentals of Finite Element Modeling – Element Division - Numbering Scheme - Examples of Finite Element Modeling

UNIT II ONE DIMENSIONAL SYSTEMS 9

Direct stiffness method – spring element- Derivation of the stiffness matrix- Example of a spring assemblage-Assembly of global stiffness matrix-Types of boundary conditions- The Potential energy approach –Examples- bar element – Coordinate systems and Shape Functions-The Potential Energy Approach- Assembly of Global Stiffness Matrix and Load Vector - Boundary Conditions- Temperature Effects – Heat transfer problems in 1D bar and wall

UNIT III TWO DIMENSIONAL SYSTEMS 9

Beam element – element stiffness – load vector – global stiffness matrix – boundary conditions – solution, Plane truss structure - Coordinate Transformation – Local & Global Coordinate-The Element Stiffness Matrix- Stress Calculations- Temperature Effects –Examples.Plane stress & strain – Constant Strain Triangle (CST)- Potential Energy Approach - Element Stiffness; Force Terms, Stress Calculations- Temperature Effects- Examples

UNIT IV THREE DIMENSIONAL SYSTEMS 9

Axisymmetric formulation – Element stiffness matrix and force vector – Body forces and temperature effects – Stress calculations – Boundary conditions and Nodal Solution; Mapping and Numerical Integration—Applications to cylinders under internal or external pressures –

Rotating discs - Isoparametric Representation- Four noded quadrilateral for axisymmetric problems

UNIT V APPLICATIONS OF FEM TO AEROSPACE STRUCTURES 9

Linear static analysis-non linear static analysis –dynamic analysis-simple harmonic motion-damping consideration-forced vibration -Case studies and problems using software packages and programming.

TEXTBOOKS:

1. Tirupathi.R. Chandrapatha and Ashok D. Belegundu", Introduction to Finite Elements in Engineering", Prentice Hall India,Fourth Edition, 2011.

REFERENCES:

1. Reddy J.N.,"An Introduction to Finite Element Method ",McGraw Hill , 3rd edition, 2005.
2. Krishnamurthy, C.S., "Finite Element Analysis", Tata McGraw Hill, 2nd 2001.
3. Bathe, K.J. and Wilson, E.L., "Numerical Methods in Finite Elements Analysis", Prentice Hall of India, 1985.
4. Rao. S.S., "Finite Element Methods in Engineering", Butterworth and Heinemann, Fourth Edition, 2005.
5. Daryl L. Logan, "A First Course in the Finite Element Method", 5th Edition, PWS Publishing Company, Boston, 2010.

WEBLINKS:

https://nptel.ac.in/courses/112104116/

COURSE OUTCOMES														
CO 1	Student will have clear understanding basic numerical methods for analyzing structural components.													
CO 2	Student gets an understanding of finite element modeling and analysis of one dimensional system.													
CO 3	Students get an understanding of finite element modeling and analysis of two dimensional systems.													
CO 4	Students get an understanding of finite element modeling and analysis of three dimensional systems.													
CO 5	Student acquaint with the application of finite element method to aerospace structures.													
CO / PO MAPPING::L –LOW, M – MEDIUM, H – HIGH														
COs / POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO 1	H	H		H	M								**M**	
CO 2	H	H	M	M	M									
CO 3	H	H	M	M	M								**M**	
CO 4	H	H	H	H	M									
CO 5	H	H	M	M	H								**M**	
Category	**Professional Core (PC)**													
Approval	**48th Academic Council Meeting**													

U18PCAE602	**AIRCRAFT STABILITY AND CONTROL**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Low Speed Aerodynamics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVE: To make the students understand the concept of stable and non-stable configuration of airplanes.

UNIT I STATIC LONGITUDINAL STABILITY AND CONTROL 12

General concepts-Degrees of freedom of a rigid body, Static and dynamic stability, Need for stability in an airplane, inherently and marginally stable airplanes, Stability and Controllability, Requirements of control surfaces, criteria for longitudinal static stability, contribution to stability by wing, tail, fuselage, wing fuselage combination, Total longitudinal stability, Neutral point-Stick fixed and Stick free aspects, Free elevator factor, static margin, Hinge moment, Power effects on stability-propeller and jet aircrafts, longitudinal control, Movement of centre of gravity, elevator control effectiveness, elevator control power, elevator angle to trim, elevator angle per g, maneuver point, Stick force gradient and stick force per g, Aerodynamic balancing

UNIT II STATIC DIRECTIONAL STABILITY AND CONTROL 11

Directional stability-yaw and sideslip, Criterion of directional stability, contribution to static directional stability by wing, fuselage, tail, Power effects on directional stability-propeller and jet aircrafts, Rudder fixed and rudder free aspects, Rudder lock and Dorsal fin, Directional control, rudder control effectiveness, rudder requirements, adverse yaw, asymmetric power condition, spin recovery

UNIT III STATIC LATERAL STABILITY AND CONTROL 8

Lateral stability-Dihedral effect, criterion for lateral stability, evaluation of lateral stability-contribution of fuselage, wing, wing fuselage, tail, total static lateral stability, lateral control, aileron control power, aileron effectiveness, strip theory estimation of aileron effectiveness, roll control by spoilers, aileron reversal, aileron reversal speed

UNIT IV DYNAMIC LONGITUDINAL STABILITY 8

Aircraft Equations of motion, small disturbance theory, Estimation of longitudinal stability derivatives stability derivatives, Routh's discriminant, solving the stability quartic, Phugoid motion, Factors affecting the period and damping.

UNIT V DYNAMIC LATERAL AND DIRECTIONAL STABILITY 6

Dutch roll and spiral instability, Auto rotation and spin, Stability derivatives for lateral and directional dynamics.

TEXTBOOKS:

1. Nelson, R.C. "Flight Stability & Automatic Control", McGraw Hill, 1998.

REFERENCES:

1. McCormick, B.W. "Aerodynamics, Aeronautics & Flight Mechanics", John Wiley, 1995.
2. Babister, A.W. "Aircraft Stability and response", Pergamon Press, 1996.
3. Etkin, B., "Dynamics of Flight Stability and Control", John Wiley, New York, 1982.
4. Perkins C.D. &Hage R.E. "Airplane performance, stability and control", John Wiley & Sons 1976.
5. Pamadi, B.N.,"Performance, Stability, Dynamics, and Control of Airplanes", AIAA Education Series, 2004

WEBLINKS:

https://nptel.ac.in/courses/101104062/10

COURSE OUTCOMES	
CO 1	The student will have knowledge about the fundamental principles relating to longitudinal stability of aircraft

CO 2	The student will have knowledge about the fundamental principles relating to directional stability of aircraft
CO 3	The student will have knowledge about the fundamental principles relating to directional stability of aircraft
CO 4	The student will have knowledge about the fundamental principles relating to dynamic longitudinal stability of aircraft
CO 5	The student will have knowledge about the fundamental principles relating to dynamic lateral and directional stability of aircraft

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO 1	H	H	H	M									**M**	
CO 2	H	H	H	M										
CO 3	H	H	H	M									**M**	
CO 4	H	H	H	M	L									
CO 5	H	H	M	M	L								**M**	
Category	**Professional Core (PC)**													
Approval	**48th Academic Council Meeting**													

U18PCAE6L1	**COMPUTER AIDED ANALYSIS LABORATORY**	**L**	**T**	**P**	**C**
	Total Contact Hours – 30	**0**	**0**	**2**	**1**
	Prerequisite – Elements of Aerospace Structures, Low Speed Aerodynamics				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To acquaint the student with various computer software for engineering analysis					

LIST OF EXPERIMENTS

1 Study of commercial software packages and their tools
2 Stress analysis of beams with different loading conditions
3 Stress analysis of a plate with circular hole
4 Stress analysis of an axisymmetric component
5 Vibration analysis of cantilever beam
6 Simple conduction example
7 Thermal mixed boundary example
8 Flow field analysis of jets
9 Flow field simulation over an airfoil
10 Fluid – Structure interaction

REFERENCES:

1. CAA Lab Manual, Department of Aeronautical Engineering, 2017

WEBLINKS:

https://www.ansys.com/en-in/academic/free-student-products/support-resources

COURSE OUTCOMES	
CO 1	The student will get an awareness of the different engineering analyses software and their applications.

CO 2	The student will get a basic idea about the applications of analysis software and its interface.
CO 3	The student will possess the skill to use the different components of analysis software to perform structural, thermal and flow analysis.
CO 4	Structural analysis skills will help the student in analyzing structural integrity and material selection.
CO 5	Thermal analysis skills will help the student to know about the temperature distribution in a particular component and hence enable him to fabricate the part or temperature control for it accordingly.

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO 1	H				H							H		
CO 2	H				H								**M**	
CO 3	H	H	M	H	H									
CO 4	H	H	M	H	H									
CO 5	H	H	M	H	H									
Category	**Professional Core (PC)**													
Approval	**48th Academic Council Meeting**													

U18PCAE6L2	**PROPULSION LABORATORY**	**L**	**T**	**P**	**C**
	Total Contact Hours – 30	**0**	**0**	**2**	**1**
	Prerequisite – Low Speed Aerodynamics, Aircraft Propulsion				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To give an experience on experimentation with fluid jets, combustion and heat transfer.					

LIST OF EXPERIMENTS

1 Estimation of spread rate in incompressible circular jets.
2 Estimation of spread rate in incompressible non- circular jets.
3 Estimation of centre line velocity decay in supersonic circular jets.
4 Estimation of centre line velocity decay in supersonic non-circular jets.
5 Determination of Wall jet velocity profile.
6 Study of free convective heat transfer over a flat plate.
7 Study of forced convective heat transfer over a flat plate.
8 Study of conduction heat transfer in a flat plate.
9 Operation of a subsonic Ramjet engine.
10 Velocity and pressure measurements of Co-axial jets.
11 Effect of swirl on diffusion flame.
12 Determination of flash point and fire point

REFERENCES:

1. Propulsion Lab Manual, Department of Aeronautical Engineering, 2017

WEBLINKS:

https://www.youtube.com/watch?v=PxYfyUNQi5k
https://www.youtube.com/watch?v=27IsaLGoRBE

COURSE OUTCOMES	
CO 1	Student will know the different types of incompressible jets.
CO 2	Student will gain in depth knowledge of basic principle and understand the supersonic jets.
CO 3	Student will know the determination of the wall jet velocity.
CO 4	Students will know the operation of ramjet engine.
CO 5	Students will be able to determine the flash point and fire point of various oils

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO 1	H	H	M	M	H									
CO 2	H	H	M	M	H								**M**	
CO 3	H	M	M		H									
CO 4	M													
CO 5	L		L											
Category	**Professional Core (PC)**													
Approval	**48th Academic Council Meeting**													

U18EEAE6L1	AIRCRAFT DESIGN PROJECT I	L	T	P	C
	Total Contact Hours – 60	**0**	**0**	**4**	**2**
	Prerequisite – Flight Mechanics, Engineering Graphics				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To enable the student to carry out a preliminary design of an aircraft.					

LIST OF EXPERIMENTS

1 Comparative configuration study of different types of airplanes
2 Comparative study on specification and performance details of aircraft
3 Preparation of comparative data sheets
4 Work sheet layout procedures
5 Comparative graphs preparation.
6 Selection of main parameters
7 Preliminary weight estimations.
8 Power plant selection.
9 Aerofoil selection
10 Wing and stabilizers selection.
11 Control surfaces designing.
12 Drag estimation
13 Detailed performance calculations
14 Stability Estimates
15 Preparation of layouts of balance diagram and three view drawings

REFERENCES:

1. Aircraft Design Project Reference Guide, “E. Tulapurkara”, NPTEL, 2017
2. Aircraft Performance and Design, “John D Anderson”, Tata McGraw Hill Publications

3. Nelson, R.C." Flight Stability & Automatic Control", McGraw Hill, 1998.

WEBLINKS:
https://onlinecourses.nptel.ac.in/noc17_ae08/

COURSE OUTCOMES	
CO 1	The student will get an idea of how various parameters are inter related by the comparative study of the different configurations
CO 2	The student will be able to perform a thorough estimation of the weight of the airplane and size it to various performance requirements
CO 3	The student will be able to decide on the type of power plant to be sued according to the weight and thrust requirements
CO 4	The student will be able to calculate the geometry and dimensions of the tail plane and will also be able to estimate the stability of the airplane
CO 5	The student will be able to draw a three view diagram of the designed airplane with all the markings and dimensions

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO 1	H	H	M			L	L		H		H			
CO 2	H	M	H		L				H		H		**M**	
CO 3	H	M	H		L	L	L		H		H			
CO 4	H	M	H		M				H		H		**M**	
CO 5	H	M			H				H	H	H			

Category	**Employability Enhancement (EE)**
Approval	**50th Academic Council Meeting held in Jun, 2018**

SEMESTER VII

	COMPUTATIONAL FLUID DYNAMICS IN AEROSPACE ENGINEERING	L	T	P	C
U18PCAE701	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Low Speed Aerodynamics, Numerical Methods				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To equip the student with the knowledge of various numerical techniques to carry out flow analysis.					

UNIT I GOVERNING EQUATIONS 9

Basics of computational fluid dynamics – Governing equations of fluid dynamics – Continuity, Momentum and Energy equations. Time-Averaged Equations for Turbulent flow – Reynolds Stress Equations.

UNIT II FDM AND FVM FOR DIFFUSION PROBLEMS 10

Derivation of finite difference equations – Simple Methods – General Methods for first and second order accuracy – Finite volume formulation for steady One, Two and Three dimensional diffusion problems –Parabolic equations – Explicit and Implicit schemes –

Example problems on elliptic and parabolic equations – Use of Finite Difference and Finite Volume methods.

UNIT III FVM FOR CONVECTION – DIFFUSION PROBLEMS 9

Steady one-dimensional convection diffusion – Central, upwind differencing schemes properties of discretization schemes – Conservativeness, Boundedness, Transportiveness, Hybrid, Power-law, QUICK Schemes. - SIMPLE, SIMPLER algorithms.

UNIT IV TURBULENCE MODELING 9

Turbulence models, mixing length model, Two equation (k-ε) models – High and low Reynolds number models. Large eddy simulation- Direct numerical simulation.

UNIT V APPLICATIONS 8

Large Scale problems in CFD – Iterative Solvers – Preconditioning Techniques – Vector and Parallel Computing – Post Processing for Visualization – CFD analysis using commercial packages and programming

TEXTBOOKS:

1. H.K. Versteeg and W. Malalasekera "An Introduction to Computational Fluid Dynamics, The Finite Volume Method", Longman Scientific & Technical, 2007. (Units 1 to 3)
2. JiyuanTu, Guan, HengYeoh, Chaoqun Liu, "Computational Fluid Dynamics A Practical Approach" Springer Verlag, 2012. (Units 4 & 5)

REFERENCES:

1. J. D. Anderson, "Computational Fluid Dynamics", McGraw Hill International, 2012.
2. T. J. Chung, "Computational Fluid Dynamics", Cambridge University Press, 2002.
3. C. Hirch, "Numerical Computation of Internal and External Flows" Volume-2, John Wiley and Sons, 1994.

WEBLINKS:

http://www.cfdonline.com
https://onlinecourses.nptel.ac.in/noc16_ch02

COURSE OUTCOMES	
CO 1	Have a clear understanding of various fluid flow analysis techniques.
CO 2	Get an understanding of computational technique for fluid flow analysis.
CO 3	Learn various numerical method used in computational analysis.
CO 4	Have knowledge of various challenges involved in computational techniques.
CO 5	Have knowledge of its applications and recent developments.

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO 1	M	H			H	L								
CO 2	L	M	H	M	L								**M**	
CO 3	L	L	L	H	M									
CO 4	L	L	L	M	H								**M**	
CO 5	L	L	L	M	H									
Category	**Professional Core (PC)**													
Approval	**48th Academic Council Meeting**													

U18PCAE702	INTRODUCTION TO AVIONICS	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Basic Electricals and Electronics Engg				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVE: To provide the students an understanding of avionics in civil and military industry, avionics subsystems, integrated systems and design approaches

UNIT I OVERVIEW 9

Introduction to aircraft – Axes system – Parts, importance and role of Avionics- systems which interface directly with pilot – Aircraft state sensor systems – Navigation systems- – External world sensor systems – task automation systems- Avionics architecture evolution. Avionics Data buses – MIL STD 1553, ARNC 429.

UNIT II RADIO NAVIGATION 9

Types of Radio Navigation – ADF, DME, VOR, LORAN, DECCA, OMEGA, ILS, MLS

UNIT III INERTIAL AND SATELLITE NAVIGATION SYSTEMS 9

Inertial sensors – Gyroscopes, Accelerometers, Inertial navigation systems – Block diagram, Platform and strap down INS, Satellite Navigation – GPS

UNIT IV AIR DATA SYSTEMS AND AUTOPILOT 9

Air data quantities – Altitude, Airspeed, Mach no., Vertical speed, Total Air temperature, Stall warning, Altitude warning. Autopilot – basic principles – longitudinal and lateral autopilot. Digital Fly by wire.

UNIT V COCKPIT DISPLAYS 9

Display technologies –LED, LCD, CRT, Flat Panel Display, Primary Flight parameter displays – Head UP Display, Helmet Mounted Display, Night vision goggles, Head Down Display, MFD, MFK, Virtual cockpit.

TEXTBOOKS:

1. Albert Helfrick. D, ‘ Principle of Avionics’, Avionics Communications Inc., 2004
2. Collinson, R.P.G, ‘Introduction to Avionics’, Chapman and Hall, 1996

REFERENCES:

1. Middleton, D.H., Ed., Avionics systems, Longman Scientific and Technical, Longman Group UK Ltd., England, 1989.
2. Spitzer, C.R. ‘Digital Avionics Systems’, Prentice-Hall, Englewood Cliffs, N.J., U.S.A. 1993.
3. Spitzer, C.R. ‘The Avionics Handbook’, CRC Press, 2000
4. Pallet, E.H.J, ‘Aircraft Instruments and Integrated Systems’, Longman Scientific, 2015

WEBLINKS:

https://www.aea.net/training/

COURSE OUTCOMES	
CO 1	Students will be able to understand avionics systems, subsystem, mission requirements, design methodology, integration of avionics and weapon system

CO 2	Students will be able to apply code conversion, arithmetic operations in various numbering system, boolean algebra. Students can identify types of gates, design combinational circuits along with truth table.
CO 3	Students will be able to understand microprocessor 8085, various memories and how to interface it with analog system
CO 4	Students will be able to understand different types of architectures, mil standard 1553B, Arinc 429 and Arinc 629.
CO 5	Students will be able to understand types of cockpits, various IO devices and their functions in cockpit.

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO 1		L	H	M										
CO 2	L	M	M	M	L								**M**	
CO 3			L	L	M									
CO 4	L		L		H	L							**M**	
CO 5	L		M	L	M	L								
Category	**Professional Core (PC)**													
Approval	**48th Academic Council Meeting**													

U18PCAE7L1	**AVIONICS LABORATORY**	**L**	**T**	**P**	**C**
	Total Contact Hours – 30	**0**	**0**	**2**	**1**
	Prerequisite – Basic Electricals and Electronics Engg				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To enable the student to understand about the basics of aircraft electronics					

LIST OF EXPERIMENTS

1 Addition/Subtraction of binary numbers.
2 Multiplexer/Demultiplexer Circuits.
3 Encoder/Decoder Circuits.
4 Timer Circuits, Shift Registers, Binary Comparator Circuits.
5 Addition and Subtraction of 8-bit and 16-bit numbers.
6 Sorting of Data in Ascending & Descending order.
7 Sum of a given series with and without carry.
8 Greatest in a given series & Multi-byte addition in BCD mode.
9 Interface programming with 4 digit 7 segment Display & Switches & LED's.
10 Channel Analog to Digital Converter & Generation of Ramp, Square, Triangular wave by Digital to Analog Converter.
11 Study of Different Avionics Data Buses.
12 MIL-Std – 1553 Data Buses Configuration with Message transfer.
13 MIL-Std – 1553 Remote Terminal Configuration.

REFERENCES:

1. Avionics Lab Manual, Department of Aeronautical Engineering, 2017

WEBLINKS:
https://www.aea.net/training/

COURSE OUTCOMES	
CO 1	Student will be able to practice about basic digital electronic circuits like Adder, subtractor, multiplexer, demultiplexer, encoder, decoder
CO 2	Student will learn about timer, shift register and comparator circuits.
CO 3	Student will understand the concept of 8-bit and 16 bit operation and to learn mnemonic's coding for 8-bit and 16-bit circuit.
CO 4	Student will understand the concept of interface programming and analog to digital conversion.
CO 5	Student will get acquainted to the concept of data buses, its configuration and remote terminal.

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO 1	H	M	H	M	H									
CO 2	H	M	L	M	L								**M**	
CO 3	H	M	H	M	L									
CO 4	H	M	H	M	L								**M**	
CO 5	H	M	H	M	H									
Category	**Professional Core (PC)**													
Approval	**48th Academic Council Meeting**													

	AIRCRAFT DESIGN PROJECT II	L	T	P	C
U18EEAE7L1	Total Contact Hours – 60	**0**	**0**	**4**	**2**
	Prerequisite – Aircraft Structural Mechanics, Aircraft Design Project I				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To introduce to the student about the various kinds of loads acting on an airplane and about the detailed structural design of an aircraft					

LIST OF EXPERIMENTS

1 V-n diagram for the design study
2 Gust and maneuverability envelopes
3 Critical loading performance and final V-n graph calculation
4 Structural design study – Theory approach
5 Load estimation of wings
6 Load estimation of fuselage.
7 Balancing and Maneuvering loads on tail plane, Aileron and Rudder loads.
8 Detailed structural layouts.
9 Design of some components of wings, fuselage
10 Preparation of a detailed design report with drawings.
11 Preparation of model using computer aided design packages.
12 Preparation of structural analysis report for wing.
13 Preparation of structural analysis report for Fuselage.
14 Preparation of flow analysis report for wing.

15 Preparation of flow analysis report for fuselage.

REFERENCES:

1. Aircraft Performance and Design, "John D Anderson", Tata McGraw Hill Publications
2. Analysis and Design of Flight Vehicle Structures, E F Bruhn
3. CADD and CAA Lab Manuals, Department of Aeronautical Engineering, 2015

WEBLINKS:

https://www.pce.uw.edu/courses/design-and-analysis-aircraft-structures-1

COURSE OUTCOMES	
CO 1	The student will get knowledge of the different loads acting on the airplane which will be useful for him/her during the structural design
CO 2	The student will be able to estimate the various loads acting on the aircraft and their effects
CO 3	The student will be able to perform a detailed structural design of the aircraft
CO 4	The student will be able to make a detailed design report and aircraft drawings
CO 5	The student will be able to model the designed aircraft and will be able to perform a flow analysis that will help him/her in the evaluation of the design

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO 1	H	L	M		M	M			H	H	H	H		
CO 2	H	M	M		M				H	H	H		**M**	
CO 3	H	H	H		M				H	H	H			
CO 4	H	H	H		M				H	H	H		**M**	
CO 5	H	H	H		H				H	H	H			
Category	**Employability Enhancement (EE)**													
Approval	**48th Academic Council Meeting held in Jun, 2019**													

U18EEAE7P1	**PROJECT PHASE I**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**4**	**0**	**6**	**3**
	Prerequisite – Gas Dynamics, Aircraft Structural Mechanics, Advanced Aerospace Propulsion				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To acquaint the student with theoretical and experimental studies related to aeronautical science.
2. To enable the student to get involved in key area of research in the branch of study.
3. To perform the literature studies and survey that will help in formulating the problem statement.
4. To enable the student to understand the concept of the acquired statement to get the idea about the work.
5. To work according to the acquired idea and to develop report in the form as specified in the guidelines

DESCRIPTION

The objective of the project phase I is to enable the students in convenient groups of not more than 4 members on a project involving theoretical and experimental studies related to the

branch of study. Every project work shall have a guide who is the member of the faculty of the institution. Each student shall finally produce a comprehensive report covering background information, literature survey and problem statement. This final report shall be in typewritten form as specified in the guidelines.

COURSE OUTCOMES	
CO 1	Student will be able to acquaint with the theoretical and experimental studies related to aeronautical science.
CO 2	Student will get involved in one of the key areas of research in the branch of study.
CO 3	Student will know how and where to access literature for research.
CO 4	Student can understand the concept of acquired statement to get the idea about the work.
CO 5	Student will be able to list out the budget for his / her project.

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	L	H	M	L	M	L	M		L		M	
CO 2	H	M		M		M						
CO 3	M	H	M	H	M							
CO 4	L	M	H	H	H							
CO 5	M	M	L	M								
Category	**Employability Enhancement (EE)**											
Approval	**48th Academic Council Meeting held in Jun, 2019**											

SEMESTER VIII

	Project Phase II	L	T	P	C
	Total Contact Hours – 18 periods per week	**0**	**0**	**18**	**9**
	Prerequisite – Low Speed Aerodynamics, Aircraft Structural Mechanics, Advanced Aerospace Propulsion				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To introduce to the student about the scientific method of research
2. To accustom the student to the processes involved during a project work
3. To enable the student to understand the concepts of scrutiny to get the idea about the work that takes place during a project
4. To familiarize the student on the preparation of technical reports/paper of his/her project work
5. To enable the student to be able to make a proper presentation of his/her assigned work/project

DESCRIPTION

The objective of the project work is to enable the students in convenient groups of not more than 4 members on a project involving theoretical and experimental studies related to the branch of study. Every project work shall have a guide who is the member of the faculty of the institution. Eighteen periods per week shall be allotted in the time table and this time shall be utilized by the students to receive the directions from the guide, on library reading, laboratory work, computer analysis or field work as assigned by the guide and also to present in periodical seminars on the progress made in the project. Each student shall finally produce a

comprehensive report covering background information, literature survey, problem statement, project work details and conclusion. This final report shall be in typewritten form as specified in the guidelines

COURSE OUTCOMES	
CO 1	The student will research in his/her area of interest and will be able to arrive at a research/project of self interest and will be able to research on it by the scientific method
CO 2	The student will be able to plan and organize his/her course of work
CO 3	The student will understand how to get information on unknown/unclear topics or concepts
CO 4	The student will be able to prepare a well organized and clear technical report
CO 5	The student will able to explain his/her concept lucidly through a presentation

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO 1	H	H	H	H	H	M	M	M	H	H	H	H		
CO 2	H	H	H	H	H	M	M	M	H	H	H	H	**M**	
CO 3	H	H	H	H	H	M	M	M	H	H	H	H		
CO 4	H	H	H	H	H	M	M	M	H	H	H	H	**M**	
CO 5	H	H	H	H	H	M	M	M	H	H	H	H		

Category	**Employability Enhancement (EE)**
Approval	**48th Academic Council Meeting**

PROFESSIONAL ELECTIVE I (PE I)

	AIRCRAFT GENERAL ENGINEERING AND MAINTENANCE PRACTICES	**L**	**T**	**P**	**C**
U18PEAE011	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Fundamentals of Aeronautics and Astronautics				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To acquaint the student with the fundamentals aspects of aircraft general engineering and maintenance practices					

UNIT I AIRCRAFT GROUND HANDLING AND SUPPORT EQUIPMENT 10
Mooring, jacking, leveling and towing operations – Preparation – Equipment – precautions– Engine starting procedures – Piston engine, turboprops and turbojets – Engine fire extinguishing – Ground power unit.

UNIT II GROUND SERVICING OF VARIOUS SUB SYSTEMS 8
Air conditioning and pressurization – Oxygen and oil systems – Ground units and their maintenance.

UNIT III HAZARDOUS MATERIALS AND SAFETY PRACTICES 5
Hazardous materials- characterization – NFPA Hazard Diamond – Hazardous waste handling – Material Safety Data Sheet (MSDS)

UNIT IV INSPECTION 10

Process – Purpose – Types – Inspection intervals – Techniques – Checklist – Special inspection – Publications, bulletins, various manuals – FAR Air worthiness directives – Type certificate Data sheets – ATA Specifications

UNIT V AIRCRAFT HARDWARE, MATERIALS AND SYSTEM PROCESSES 12

Hand tools – Precision instruments – Special tools and equipment in an airplane maintenance shop – Identification terminology – Specification and correct use of various aircraft hardware (i.e. nuts, bolts, rivets, screws etc) – American and British systems of specifications – Threads, gears, bearings, etc – Drills, tapes and reamers – Identification of all types of fluid line fittings. Materials, metallic and non-metallic - Plumbing connectors – Cables – Swaging procedures, tests, Advantages of swaging over splicing.

TEXTBOOKS:

1. Aviation Maintenance Technician Handbook, General, AC 65-9A, Shroff Publishers and Distributors, 2008

REFERENCES:

1. Aviation Maintenance Technician Handbook, Airframe, AC 65-15A, Shroff Publishers and Distributors, 2008
2. Kroes Watkins Delp, "Aircraft Maintenance and Repair", McGraw Hill, 7th edition, New York, 2013.

WEBLINKS:

https://onlinecourses.nptel.ac.in/noc18_ae03

COURSE OUTCOMES	
CO 1	The student will have a basic idea of ground handling of the aircraft
CO 2	The student will know about the various ground servicing processes
CO 3	The student will be aware of the various hazardous materials and how to handle them
CO 4	The student will know about the different inspection techniques
CO 5	The student will have a knowledge of different kinds of aircraft material and hardware

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO 1	H		M	M		H								**M**
CO 2	H			M										
CO 3	H			M										**M**
CO 4	H			H					M					
CO 5	H			M										

Category	**Professional Elective (PE)**
Approval	**49th Academic Council Meeting**

	ROCKETS AND MISSILES	**L**	**T**	**P**	**C**
U18PEAE012	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Low Speed Aerodynamics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVE: To learn about the aerodynamics and stability of Rockets and Missiles.

UNIT I AERODYNAMICS OF ROCKETS AND MISSILES 9

Airframe components of rockets and missiles – forces acting on a missile while passing through atmosphere – classification of missiles – slender body aerodynamics – method of describing forces and moments – lift force and lateral moment –lateral aerodynamic damping moment – longitudinal moment – drag estimation – body upwash and body downwash in missiles – rocket dispersion.

UNIT II ROCKET MOTION IN FREE SPACE AND GRAVITATIONAL FIELD 9

One dimensional and 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.

UNIT III ROCKET SYSTEMS 9

Ignition system in rockets – types of igniters and igniter design considerations – injection system of liquid rockets and their design considerations – design considerations of liquid rocket thrust chambers – cryo fuel systems – combustion mechanisms of liquid and solid propellants.

UNIT IV STAGING AND CONTROL OF ROCKETS AND MISSILES 9

Design philosophy behind multistaging of launch vehicles and ballistic missiles – multistage vehicle optimization – stage separation techniques in atmosphere and in space – stage separation dynamics and lateral separation characteristics – various types of thrust vector control methods including secondary injection thrust vector control – numerical problems on stage separation and multistaging.

UNIT V MATERIALS FOR ROCKETS AND MISSILES 9

Selection criteria of materials for rockets and missiles – materials for various airframe components and engine parts – materials for thrust control devices – various adverse conditions faced by aerospace vehicles and the requirement of materials to perform under these conditions.

TEXTBOOKS:

1. Ramamurthy K, “Rocket Propulsion”, Trinity Publications, 2017. (Units 2, 3 & 5)
2. Sutton, G.P., “Rocket Propulsion Elements”, John Wiley & Sons Inc., New York, 9th Edition (Units 1 & 4)

REFERENCES:

1. J.D.Mattingly, Elements of Propulsion - Gas Turbines and Rockets, AIAA Education series, 2006,.
2. Mathur, M.L., and Sharma, R.P., “Gas Turbine, Jet and Rocket Propulsion”, Standard Publishers and Distributors, Delhi, 1988.
3. Martin J L Turner, Rocket and Spacecraft Propulsion, Springer-Praxis Publishing, 2001

WEBLINKS:

www.propulsion-analysis.com/
www.rocket.com/design-and-analysis

COURSE OUTCOMES

CO 1	The knowledge about various systems of rockets will help the student to select appropriate type of systems during rocket design.
CO 2	The aerodynamics of rockets and missile will help the student in designing rockets or missiles according to their mission requirements.
CO 3	The knowledge of the equations of motion will be useful in predicting the trajectory of the rocket and hence the student will be able to design it according to mission.
CO 4	The knowledge about rocket staging and control techniques will be helpful to the student to design control systems for the airplane and rocket staging according to payload requirements.
CO 5	The student will be able to select suitable materials for rockets and missiles during their design.

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO 1	H			L									**M**	
CO 2	H		H	L	H									
CO 3	H		H	L	L								**M**	
CO 4	H		H	L										
CO 5	H		M	L		L	L							
Category	**Professional Elective (PE)**													
Approval	**49th Academic Council Meeting**													

U18PEAE013	**EXPERIMENTAL AERODYNAMICS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Low Speed Aerodynamics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVE: To understand the various experimentation and measurement techniques in the field of aerodynamics.

UNIT I LOW SPEED WIND TUNNEL TESTING 9

Low speed wind tunnels-Power losses in wind tunnel, energy ratio, Calibration, Flow angularity, Yaw Sphere, Yaw meter, Turbulence sphere, Pressure sphere, Wind tunnel balances, boundary layer correction, calculation of CL and CD for airfoils, Magnetic suspension methods

UNIT II HIGH SPEED WIND TUNNEL TESTING 9

High Speed wind tunnels- Blow down, Induction Type Tunnels, Losses in supersonic tunnels, Second throat, running time estimation, transonic, hypersonic tunnels, Shock tunnels, Gun tunnels

UNIT III MEASUREMENT TECHNIQUES 9

Pressure measurement, Hot wire anemometer, laser Doppler anemometer for turbulence and velocity Measurements-Temperature measurement, Measurement of wall shear stress, Rotameters and Ultrasonic flow meters, Laser Doppler velocimetry, Particle image velocimetry,

UNIT IV FLOW VISUALIZATION AND ANALOGUE METHODS 9

Heleshaw Apparatus, Smoke tunnel, Tuft method, chemical coating, interferometer, Shadowgraph method, Schlieren method, laser induced fluorescence, Hydraulic analogy, limitations of analogy

UNIT V DATA ACQUISITION AND UNCERTAINTY ANALYSIS 9

Measurement systems, data acquisition, signal conditioning, multiplexing, data conversion, uncertainty analysis

TEXTBOOKS:

1. Rathakrishnan. E "Instrumentation, Measurement and Experiments in Fluids", CRC Press, London, 2007

REFERENCES:

1. Rae W.H and Pope. A "Low speed wind tunnel testing" John Wiley Publication, 1999
2. Pope. A andGoin. L "High speed wind tunnel testing" John Wiley, 1985

WEBLINKS:

https://nptel.ac.in/courses/101106040/

COURSE OUTCOMES	
CO 1	To have knowledge of basic principles relating to low speed wind tunnel calibration, balances, testing and estimation of aerodynamic coefficients
CO 2	To acquire knowledge of basic principles relating to supersonic, transonic, hypersonic and special tunnels like shock tunnel and gun tunnel
CO 3	To acquire knowledge of measurement techniques relating to pressure, velocity and temperature in a flow field
CO 4	To have knowledge about the fundamental principles relating to flow visualization and analogue methods
CO 5	To have knowledge about the fundamental principles relating to data acquisition and uncertainty analysis and estimation of accuracy and error in experiments

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO 1	H	M	M	L	H								**M**	
CO 2	H	M	M	L	H									
CO 3	H	H	L	H	H								**M**	
CO 4	H	M	L	H	H									
CO 5	H	M	L	H	H									
Category	**Professional Elective (PE)**													
Approval	**49th Academic Council Meeting**													

U18PEAE014	**BOUNDARY LAYER THEORY**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Fundamentals of Fluid Mechanics, Co-requisite – Gas Dynamics				

	Course Designed by – Department of Aeronautical Engineering
OBJECTIVE: To enable the student to understand about the various aspects of viscous flow, laminar and turbulent boundary layer, prediction of skin friction drag	

UNIT I FUNDAMENTAL EQUATIONS OF VISCOUS FLOW 9

Fundamental equations of viscous flow, Conservation of mass, Conservation of Momentum-Navier-Stokes equations, Energy equation, Mathematical character of basic equations, Dimensional parameters in viscous flow, Non dimensionalising the basic equations and boundary conditions, vorticity considerations, creeping flow, boundary layer flow

UNIT II SOLUTIONS OF VISCOUS FLOW EQUATIONS 9

Solutions of viscous flow equations, Couette flows, Hagen-Poisuelle flow, Flow between rotating concentric cylinders, Combined Couette-Poiseuille Flow between parallel plates, Creeping motion, Stokes solution for an immersed sphere, Development of boundary layer, Displacement thickness, momentum and energy thickness.

UNIT III LAMINAR BOUNDARY LAYER EQUATIONS 9

Laminar boundary layer equations, Flat plate Integral analysis of Karman – Integral analysis of energy equation – Laminar boundary layer equations – boundary layer over a curved body-Flow separation- similarity solutions, Blasius solution for flat-plate flow, Falkner–Skan wedge flows, Boundary layer temperature profiles for constant plate temperature –Reynold's analogy, Integral equation of Boundary layer – Pohlhausen method – Thermal boundary layer calculations

UNIT IV TURBULENT BOUNDARY LAYER EQUATIONS 9

Turbulence-physical and mathematical description, Two-dimensional turbulent boundary layer equations — Velocity profiles – The law of the wall – The law of the wake – Turbulent flow in pipes and channels – Turbulent boundary layer on a flat plate – Boundary layers with pressure gradient, Eddy Viscosity, mixing length , Turbulence modeling

UNIT V COMPRESSIBLE BOUNDARY LAYERS EQUATIONS 9

Compressible boundary layer equations, Recovery factor, similarity solutions, laminar supersonic Cone rule, shock-boundary layer interaction

TEXTBOOKS:

1. White, F. M., Viscous Fluid Flow, McGraw-Hill & Co., Inc., New York, 2005.

REFERENCES:

1. Schlichting, H., Boundary Layer Theory, McGraw-Hill, New York, 2000.
2. Reynolds, A, J., Turbulent Flows Engineering, John Wiley and Sons, 1980.

WEBLINKS:

https://onlinecourses.nptel.ac.in/noc16_me04

COURSE OUTCOMES	
CO 1	Student able to acquaint with the fundamentals of viscous flow.
CO 2	Student can learn the different regime of viscous flow and its solution.
CO 3	Student can understand the concept of laminar boundary layer.
CO 4	Student can understand the concept of turbulent boundary layer.
CO 5	Student can acquaint the concept of compressible boundary layer.

CO / PO MAPPING L –LOW, M – MEDIUM, H – HIGH														
COs / POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO 1	H	L	M	M									**M**	
CO 2	H	L	L	M										
CO 3	M	H	M	M	H								**M**	
CO 4	M	H	M	M	H									
CO 5	M	L	L		M									
Category	**Professional Elective (PE)**													
Approval	**49th Academic Council Meeting**													

PROFESSIONAL ELECTIVE II (PE II)

U18PEAE021	**CIVIL AVIATION REGULATIONS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Fundamentals of Aeronautics and Astronautics				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To familiarize the student with the various aircraft rules and regulations in India.					

UNIT I CAR SERIES "A" & "B" 9

C.A.R series 'A' - procedure for civil air worthiness Requirements and responsibility operators vis-a-vis Air Worthiness directorate - Responsibilities of operators/owners; procedure of CAR issue, amendments etc; objectives and targets of airworthiness directorate; airworthiness regulations and safety oversight of engineering activities of operations.

C.A.R. series "B" – issue approval of cockpit check list, MEL, CDL - Deficiency list (MEL & CDL); preparation and use of cockpit check list and emergency check list.

UNIT II CAR SERIES "C" & "D" 9

C.A.R. series 'C' - defect recording, monitoring, investigation and reporting- Defect recording, reporting, investigation, rectification and analysis; Flight report; Reporting and rectification of defects observed on aircraft; Analytical study of in-fight readings & recordings; Maintenance control by reliability Method.

C.A.R. series 'D'-aircraft maintenance programmes - Reliability Programme (Engines); Aircraft maintenance programme& their approval - On condition maintenance of reciprocating engines; TBO - Revision programme; Maintenance of fuel and oil uplift and consumption records - Light aircraft engines; Fixing routine maintenance periods and component TBOs - Initial & revisions.

UNIT III CAR SERIES "E" & "F" 9

C.A.R. series 'E' - approval of organizations - Approval of organizations in categories A, B, C, D, E, F, & G; Requirements of infrastructure at stations other than parent base.

C.A.R. series 'F' - air worthiness and continued air worthiness - Procedure relating to registration of aircraft; Procedure for issue / revalidation of Type Certificate of aircraft and its engines / propeller; Issue / revalidation of Certificate of Airworthiness; Requirements for renewal of Certificate of Airworthiness

UNIT IV CAR SERIES "L" & "M" 9

C.A.R. series 'L' - aircraft maintenance engineer – licensing - Issue of AME License, its classification and experience requirements, Complete Series 'L'. C.A.R. series 'M' Mandatory Modifications / Inspections.

UNIT V CAR SERIES "T" & "X" 9

C.A.R. series 'T' - flight testing of aircraft - Flight testing of (Series) aircraft for issue of C of A; Fight testing of aircraft for which C or A had been previously issued.

C.A.R. series 'X' - miscellaneous requirements - Registration Markings of aircraft; Weight and balance control of an aircraft; Provision of first aid kits & Physician's kit in an aircraft; Use of furnishing materials in an aircraft; Concessions; Aircraft log books; Document to be carried on board on Indian registered aircraft; Procedure for issue of taxy permit; Procedure for issue of type approval of aircraft components and equipment including instruments.

TEXTBOOKS:

1. " Aircraft Manual (India) ", The English Book Store, 17-1, Connaught Circus, New Delhi.

REFERENCES:

1. " Civil Aviation Requirements with latest Amendment (Section 2 Airworthiness) ", Published by DGCA, The English Book Store, 17-1, Connaught Circus, New Delhi.
2. "Aeronautical Information Circulars (relating to Airworthiness) ", from DGCA Advisory Circulars ", form DGCA.

WEBLINKS:

https://www.iata.org/training/subject-areas/Pages/civil-aviation-courses.aspx

COURSE OUTCOMES	
CO 1	The student will know whether an aircraft is airworthy or not and also the student will be able to prepare important documents like emergency check list, cockpit check list and deficiency list
CO 2	The student will be able to record, monitor, investigate and report about the defects in an aircraft and also, he/she will be able decide on the inspection and maintenance procedures and schedules
CO 3	The student will know the procedure of approval for aircraft manufacturing and maintenance industries and also, the student will know about the aircraft registration process and procedures to obtain licenses for engines, aircrafts
CO 4	The student will understand the procedure of conduct of AME examinations and license issue and its renewal and also about the mandatory inspection procedures
CO 5	The student will get organized with procedures relating to the flight testing of aircrafts and about various other requirements of aircrafts like marking, log book maintenance

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO 1					M	H	M	H	H	M		L		
CO 2					M	H	M	H	H	M		L	**M**	
CO 3					M	H	M	H	H	M		L		
CO 4					M	H	M	H	H	M		L	**M**	

CO 5					M	H	M	H	H	M		L		
Category	**Professional Elective (PE)**													
Approval	**49th Academic Council Meeting**													

U18PEAE022	**THEORY OF ELASTICITY**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Nil				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To make the student understand the elastic behavior of different structural components under various loadings and boundary conditions					

UNIT I BASIC EQUATIONS OF ELASTICITY 9

Definition of Stress and Strain: Stress - Strain relationships - Equations of Equilibrium, Compatibility equations, Boundary Conditions, Saint Venant's principle - Principal Stresses, Stress Ellipsoid - Stress invariants

UNIT II PLANE STRESS AND PLANE STRAIN PROBLEMS 9

Airy's stress function, Bi-harmonic equations, Polynomial solutions, Simple two dimensional problems in Cartesian coordinates like bending of cantilever and simply supported beams.

UNIT III POLAR COORDINATES 9

Equations of equilibrium, Strain - displacement relations, Stress – strain relations, Airy's stress function, Axi – symmetric problems, Introduction to Dunder's table, Curved beam analysis, Lame's, Kirsch, Michell's and Boussinesque problems – Rotating discs

UNIT IV TORSION 9

Navier's theory, St. Venant's theory, Prandtl's theory on torsion, semi- inverse method and applications to shafts of circular, elliptical, equilateral triangular and rectangular sections. Membrane Analogy.

UNIT V INTRODUCTION TO THEORY OF PLATES AND SHELLS 9

Classical plate theory – Assumptions – Governing equations – Boundary conditions – Navier's method of solution for simply supported rectangular plates – Levy's method of solution for rectangular plates under different boundary conditions.

TEXTBOOKS:

1. Timoshenko, S., and Goodier, T.N., "Theory of Elasticity", McGraw–Hill Ltd., Tokyo, 1990.

REFERENCES:

1. Enrico Volterra & J.H. Caines, "Advanced Strength of Materials", Prentice Hall, New Jersey, 1991.
2. Wng, C.T., "Applied Elasticity", McGraw–Hill Co., New York, 1993.
3. Sokolnikoff, I.S., "Mathematical Theory of Elasticity", McGraw–Hill New York,1978.

COURSE OUTCOMES	
CO 1	The student will know about the basic equations of elasticity
CO 2	The student will be able to solve plane stress and plane strain problems using modules
CO 3	The student will know the procedure of coordinates system.
CO 4	The student will understand the procedure of conduct torsion problems

CO 5	The student will get an idea of theory of plates and shells

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO 1	H		M	M	M	M								
CO 2		H			M	M							**M**	
CO 3	M		M	M										
CO 4		M		M	M								**M**	
CO 5	M			M										
Category	**Professional Elective (PE)**													
Approval	**49th Academic Council Meeting**													

U18PEAE023	**PRINCIPLES OF TURBOMACHINERY IN AIRBREATHING ENGINES**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Aircraft Propulsion				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To familiarize the student with the basic of turbomachinery in air breathing engines, components and their design.					

UNIT I INTRODUCTION TO TURBOMACHINERY 9

Turbomachinery- definition, Classification of Turbomachines, Power absorbing and power producing turbomachines, Centrifugal compressor-components, Axial compressor-components, Single stage and multi stage, subsonic and transonic axial compressors, Radial turbine-components, Axial turbine-single and multistage, Review of basic laws-conservation of mass, momentum and energy, Euler's turbo machine equation, simple gas turbine cycle, Variation of thrust and SFC with Mach number and altitude for typical turbojet engine

UNIT II CENTRIFUGAL COMPRESSORS 9

Work done and pressure rise, impeller, velocity triangle, slip factor, power input factor, Coriolis acceleration, diffuser, compressibility effects, inlet Mach number for impeller and diffuser, prewhirl, Compressor characteristics, non-dimensional quantities, stage pressure ratio, Instability-surge, rotating stall, choking

UNIT III AXIAL FLOW COMPRESSORS 9

Basic operation, stator, rotor, velocity triangle, factors affecting stage pressure ratio, de Haller number, diffusion factor, degree of reaction, radial equilibrium of fluid element, basic design process, estimation of number of stages, considerations in blade design, blade cascade, compressibility effects, axial compressor characteristics

UNIT IV AXIAL AND RADIAL TURBINES 11

Elementary theory of axial flow turbines, blade loading coefficient, flow coefficient, degree of reaction, rotor blade loss, Vortex theory-Free vortex design, constant nozzle angle design, choice of blade profile, pitch and chord, rotor blade stresses, Firtree root, limiting factors in turbine design, Radial flow turbine

UNIT V MATCHING OF COMPONENTS AND BLADE COOLING 7

Component characteristics-compressor, turbine, off-design operation, load characteristics, equilibrium running, matching of two turbines in series, turbine blade cooling

TEXTBOOKS:

1. Ganesan. V, "Gas Turbines", Tata McGraw Hill Education, 3rd Edition, 2010 (Units 1 to 4)
2. Cohen H, Rogers GFC, and Saravanamuttoo HIH, "Gas Turbine Theory" Addison Wesley Longman Limited, 1998 (Unit 5)

REFERENCES:

1. El-Wakil, M M; Power plant Technology, 1984, McGraw-Hill Pub.
2. NASA-SP-290, Axial Flow turbines, 2002 (re-release), NTIS, USA.
3. J H Horlock, Axial flow compressors, Butterworths, 1958, UK.
4. J H Horlock, Axial Flow Turbines, Butterworths, 1965, UK.
5. B Lakshminarayana; Fluid Mechanics and Heat Transfer in turbomachineries,1995, USA.
6. Nicholas Cumpsty, Compressor Aerodynamics, 2004, Kreiger Publications, USA.
7. Johnson I.A., Bullock R.O. NASA-SP-36, Axial Flow Compressors, 2002 (re-release), NTIS.
8. Ahmed F. El-Sayed; Aircraft Propulsion and Gas Turbine Engines; CRC press, 2008

WEBLINKS:

https://www.coursebuffet.com/sub/aerospace-engineering/415/turbomachinery-aerodynamics

COURSE OUTCOMES	
CO 1	The student will be able to understand the basic principles of the turbo machines and will be able to understand the effects of each main governing parameter in the of the turbo machines
CO 2	The student will be able to design the blade geometry, orientation and arrangement on the disc based on the operating conditions and requirements for axial flow compressors and fans
CO 3	The student will be able to design the blade geometry, orientation and arrangement on the disc based on the operating conditions and requirements for axial flow turbines
CO 4	The student will be able to design impeller and diffuser geometry and orientation according to the requirements of the centrifugal compressors
CO 5	The student will be able to design the geometry and orientation of the impeller and diffuser of the radial flow turbines based in the operating requirements

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO 1	M	H	H	H										
CO 2	H	H	H	M	H								**M**	
CO 3	H	H	H	M	H									
CO 4	H	H	H	M	H								**M**	
CO 5	H	H	H	M	H									

Category	**Professional Elective (PE)**
Approval	**49th Academic Council Meeting**

U18PEAE024	**AIRCRAFT MATERIALS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Nil				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To introduce to the students about the importance of materials in the design of the aircraft					

UNIT I INTRODUCTION 9

Properties of Flight Vehicle Materials, Importance of strength to weight ratio and change in properties with respect to temperature variations, factors affecting choice of material for different parts of airplane, Structure of solid materials - crystal structure, effect of crystal imperfections on mechanical properties

UNIT II ALLOYS FOR AIRCRAFT APPLICATIONS 9

Aluminum alloys, High strength and corrosion resistance alloys. Magnesium alloys and their properties, Carbon Steels and Steel Alloys, Effect of alloying elements, Applications of these alloys to aircrafts.

UNIT III HIGH STRENGTH AND HEAT RESISTANT ALLOYS 9

Classification of heat resistant materials, Iron, Nickel and Cobalt base alloys, Refractory materials, Ceramics, Titanium and its alloys, properties of Inconel, Monel & K-Monel, Nimonic and Super Alloys – Applications to Aircrafts

UNIT IV HEAT TREATMENT AND CORROSION RESISTANCE 9

Heat treatment of carbon steel, aluminium alloys, magnesium alloys and titanium alloys used in aircraft. Types of corrosions - Effect of corrosion on mechanical properties - Protection against corrosion - Corrosion resistant materials used in aerospace vehicles.

UNIT V MODERN MATERIALS 9

Significance of Composites and Nanomaterials in Aerospace Engineering, Introduction to graphene, spider silk, silica aerogel, shrilk, stanene and metamaterials and their applications.

TEXTBOOKS:

1. Aircraft Material and Processes: G F Titterton, 5th Edition, Himalayan Books, New Delhi.

REFERENCES:

1. Martin, J.W., "Engineering Materials, Their Properties, and Applications ",Wykedham Publications (London) Ltd., 1987.
2. Titterton, G., "Aircraft Materials and Processes ", V Edition, Pitman Publishing Co., 1995.
3. Krishnadas Nair, C.G., "Handbook of Aircraft Materials ", Interline Publishing, 1993.
4. Balram Gupta, "Aerospace Materials ", Vol. I, Vol. II and Vol. III, S. Chand &Company Ltd., New Delhi -1996.
5. Thiruvadigal, J.D., Ponnusamy,S. and Vasuhi.P.S., Materials Science 5thedition, Vibrant Publications, Chennai, 2007.

WEBLINKS:
https://www.edx.org/course/introduction-to-aerospace-structures-and-materials-0

COURSE OUTCOMES	
CO 1	The students will realize the significance of materials in aircraft engineering
CO 2	The students will have a knowledge of different kind of metal alloys used in aircrafts
CO 3	The students will have a knowledge of different kind high strength and heat resistant alloys used in aircrafts
CO 4	The students will have a knowledge of heat treatment processes and corrosion resistance metal alloys used in aircrafts
CO 5	The students will have a knowledge of modern materials

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO 1	H	H	M									M		
CO 2	H	H	L	M									**M**	
CO 3	H	H	L	M										
CO 4	M	H	H	H	M							H	**M**	
CO 5	M		H		H							H		
Category	**Professional Elective (PE)**													
Approval	**47th Academic Council Meeting**													

OPTIONS FOR PROFESSIONAL ELECTIVE (PE) III

	VIBRATIONS AND ELEMENTS OF AERO ELASTICITY	L	T	P	C
U18PEAE031	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Elements of Aerospace Structures				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVE: To know about the role of Vibrations, vibration analysis and ideas about Aero elasticity in engineering and industry and design and analysis of components subject to vibrations.

UNIT I SINGLE DEGREE OF FREEDOM SYSTEMS 10

Vibration Terminologies, Simple harmonic motion, Newton's law, D' Alembert's principle, Energy methods, Free vibrations, Damped vibrations, Forced Vibrations with and without damping, Support excitation, Transmissibility, Vibration measuring instruments.

UNIT II MULTI DEGREE OF FREEDOM SYSTEMS 10

Two degrees of freedom systems, static and dynamic couplings, Vibration absorbers, Principal co-ordinates, principal modes and orthogonal condition, Eigen value problems, Lagrangean equations and applications.

UNIT III CONTINUOUS SYSTEMS 8

Vibration of elastic bodies, vibration of strings, Longitudinal –lateral and Torsional vibrations.

UNIT IV APPROXIMATE METHODS 9

Approximate methods-Rayleigh's method, Dunkerleys method, Holzer method, Matrix iteration method

UNIT V ELEMENTS OF AEROELASCTICITY 8

Vibrations due to coupling of bending and torsion, collars triangle, aero elastic instabilities and their prevention, Wing divergence, reversal of aileron control, Flutter and its prevention.

TEXTBOOKS:

1. V. P. Singh, "Mechanics of Vibration", (Units 1 to 4)
2. Y.C. Fung, "An Introduction to the Theory of Aeroelasticity", John Wiley & Sons Inc., New York, 2008. (Unit 5)

REFERENCES:

1. Leonard Meirovitch, "Fundamentals of Vibrations", McGraw Hill International Series, 2001
2. Bisplinghoff R.L., Ashely H and Hogman R.L., Aeroelasticity – Addison Wesley Publication, New York, 1983.
3. R.H. Scanlan and R.Rosenbaum, "Introduction to the study of Aircraft Vibration and Flutter", Macmillan Co., New York, 1981.
4. R.D.Blevins, "Flow Induced Vibrations", Krieger Pub Co., 2001
5. Thomson W T, 'Theory of Vibration with Application' - CBS Publishers, 1990.
6. Timoshenko S., Vibration Problems in Engineering – John Wiley and Sons, New York, 1993.

WEBLINKS:

https://swayam.gov.in/course/4531-introduction-to-mechanical-vibration

COURSE OUTCOMES	
CO 1	Students will know about different types of vibration and basic fundamental of vibrations
CO 2	Students will be able to develop mathematical models and deriving equations to solve for natural frequency
CO 3	Students will be able to solve the single and multiple degree of freedom problems for natural frequency and mode shapes
CO 4	Students will be able to solve for the natural frequency of continuous systems
CO 5	Students will understand the effects of aeroelasticity

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO 1	H	H	H	H	H									
CO 2	H	H	H	H	H								**M**	
CO 3	H	H	M	H	H									
CO 4	H	M	M	L	H								**M**	
CO 5	H		L		L									
Category	**Professional Elective (PE)**													

Approval	49th Academic Council Meeting

U18PEAE032	**AIRCRAFT ENGINE REPAIR AND MAINTENANCE**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Fundamentals of Aeronautics and Astronautics				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To familiarize with the inspection, overhaul and maintenance of aircraft piston engines and jet engines.					

UNIT I INSPECTION AND TROUBLE SHOOTING OF PISTON ENGINES 9

Need for Inspection, maintenance and trouble shooting in Piston engine – Inspection of all components – Daily and routine checks – Overhaul procedures – Compression testing of cylinders – Special inspection schedules – Engine fuel, control and exhaust systems – Engine mount and super charger – Details of carburetion and injection systems for small and large engines – Ignition system components – Spark plug – Maintenance and inspection check to be carried out.

UNIT II INSPECTION AND TROUBLE SHOOTING OF PROPELLER 9

Propeller theory - operation, construction assembly and installation -Pitch change mechanism- Propeller axially system- Damage and repair criteria - General Inspection procedures - Checks on constant speed propellers - Pitch setting, Propeller Balancing, Blade cuffs, Governor/Propeller operating conditions.

UNIT III OVERHAULING OF PISTON ENGINES 9

Symptoms of failure - Fault diagnostics - Case studies of different piston engine systems - Rectification during testing equipments for overhaul: Tools and equipments requirements for various checks and alignment during overhauling - Tools for inspection - Tools for safety and for visual inspection - Methods and instruments for non destructive testing techniques - Equipment for replacement of parts and their repair. Engine testing: Engine testing procedures and schedule preparation - Online maintenance

UNIT IV INSPECTION AND TROUBLE SHOOTING OF GAS TURBINE ENGINES 9

Gas turbine engine inspection & checks – Use of instruments for online maintenance – Maintenance procedures of gas turbine engines – Trouble shooting and rectification procedures – Component maintenance procedures – Systems maintenance procedures. Special inspection procedures: Foreign Object Damage – Blade damage – etc. Gas turbine testing procedures – test schedule preparation – Storage of Engines – Preservation and de-preservation procedures.

UNIT V OVERHAULING OF GAS TURBINE ENGINES 9

Gas turbine Engine Overhaul procedures – Inspections and cleaning of components – Repairs schedules for overhaul – Balancing of Gas turbine components. Trouble Shooting - Procedures for rectification – Condition monitoring of the engine on ground and at altitude – engine health monitoring and corrective methods.

TEXTBOOKS:

1. Kroes& Wild, “Aircraft Power plants”, 7th Edition – McGraw Hill, New York, 1994.

REFERENCES:

1. Turbomeca, “Gas Turbine Engines”, The English Book Store, New Delhi, 1995.
2. United Technologies Pratt & Whitney, “The Aircraft Gas turbine Engine and its Operation”, The English Book Store, New Delhi.

WEBLINKS:
https://onlinecourses.nptel.ac.in/noc19_ae02

COURSE OUTCOMES	
CO 1	The student will have an understanding of basic inspection procedures of a piston engine
CO 2	The student will have an understanding of basic overhaul and troubleshooting procedures of a piston engine
CO 3	The student will have an understanding of basic overhauling procedures of a piston engine
CO 4	The student will have an understanding of basic inspection procedures of a gas turbine engine
CO 5	The student will have an understanding of basic overhauling procedures of a gas turbine engine

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO 1			M	M	M			H	H	M		L		
CO 2			H	H	M			H	H	M		M	**M**	
CO 3			M	M	M			H	H	M		L		
CO 4			M	M	M			H	H	M		L	**M**	
CO 5			H	H	M			H	H	M		M		

Category	**Professional Elective (PE)**
Approval	**49th Academic Council Meeting**

U18PEAE033	**MISSILE AERODYNAMICS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Low Speed Aerodynamics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVE: To make the students learn the basics of missile aerodynamics, aerodynamic design and analysis of missile components.

UNIT I BASICS ASPECTS OF MISSILE AERODYNAMICS 9

Classification of missiles-Aerodynamics characteristics and requirements of air to air missiles, air to surface missiles and surface to air missiles-Missile trajectories-fundamental aspects of hypersonic aerodynamics.

UNIT II MISSILE CONFIGURATIONS AND DRAG ESTIMATION 9

Types of Rockets and missiles-various configurations-components-forces on the vehicle during atmospheric flight-nose cone design and drag estimation

UNIT III AERODYNAMICS OF SLENDER AND BLUNT BODIES 9

Aerodynamics of slender and blunt bodies, wing-body interference effects-Asymmetric flow separation and vortex shedding-unsteady flow characteristics of launch vehicles-determination of aero elastic effects

UNIT IV AERODYNAMIC ASPECTS OF LAUNCHING PHASE 9

Booster separation-cross wind effects-specific considerations in missile launching-missile integration and separation-methods of evaluation and determination- Wind tunnel tests – Comparison with CFD Analysis.

UNIT V STABILITY AND CONTROL OF MISSILES 9

Forces and moments acting on missiles-Lateral, rolling and longitudinal moments-missile dispersion-stability aspects of missile configuration-Aerodynamic control methods-Jet control methods-Stability derivatives.

TEXTBOOKS:

1. Nielson, Jack N, Stever, Gutford, "Missile Aerodynamics", McGraw Hill, New York,1960.

REFERENCES:

1. Anderson, J.D., "Hypersonic and High Temperature Gas Dynamics", AIAA Education Series.
2. Chin SS, "Missile Configuration Design", McGraw Hill, New York, 1961.
3. Micheal J Hemsch, "Tactical Missile Aerodynamics", Progress in Aeronautics and Astronautics, AIAA, 1992.

WEBLINKS:

https://searchworks.stanford.edu/view/8798442

COURSE OUTCOMES	
CO 1	The student will understand the basic concepts of missile aerodynamics
CO 2	The student will know about the different configurations of missiles and will be able to estimate the drag of missiles
CO 3	The student will be able to design the missile body in order to optimize performance
CO 4	The student will understand the significance of aerodynamics during the launching phase
CO 5	The student will be able to design appropriate stabilizers and control surfaces to fulfill the stability and control requirements of the missile.

CO / PO MAPPING::L –LOW, M – MEDIUM, H – HIGH

COs / POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO 1	H	M	M	L										
CO 2	H	H	M	L	M								**M**	
CO 3	H	H	M	M	M									
CO 4	H	H	M	M	L								**M**	
CO 5	H	M	M	L										
Category	**Professional Elective (PE)**													
Approval	**49th Academic Council Meeting**													

U18PEAE034	**HYPERSONIC AERODYNAMICS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Gas Dynamics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVE: To study the environment around hypersonic vehicles and bodies created by strong shock waves.

UNIT I FUNDAMENTALS OF HYPERSONIC AERODYNAMICS 9

Introduction to hypersonic aerodynamics-differences between hypersonic aerodynamics and supersonic aerodynamics-concept of thin shock layers-hypersonic flight paths – hypersonic similarity parameters-shock wave and expansion wave relations of inviscid hypersonic flows.

UNIT II SIMPLE SOLUTION METHODS FOR HYPERSONIC IN VISCID FLOWS 9

Local surface inclination methods-Newtonian theory-modified Newtonian law-tangent wedge and tangent cone and shock expansion methods-approximate theory-thin shock layer theory.

UNIT III VISCOUS HYPERSONIC FLOW THEORY 9

Boundary layer equation for hypersonic flow-hypersonic boundary layers-self similar and non self similar boundary layers-solution methods for non self similar boundary layers aerodynamic heating.

UNIT IV VISCOUS INTERACTIONS IN HYPERSONIC FLOWS 9

Introduction to the concept of viscous interaction in hypersonic flows-strong and weak viscous interactions-hypersonic viscous interaction similarity parameter-introduction to shock wave boundary layer interactions.

UNIT V INTRODUCTION TO HIGH TEMPERATURE EFFECTS 9

Nature of high temperature flows-chemical effects in air-real and perfect gases-Gibb's free energy and entropy-chemically reacting mixtures-recombination and dissociation.

TEXTBOOKS:

1. Ethirajan Rathakrishnan., "High Enthalpy Gas Dynamics", John Wiley and Sons, 2015

REFERENCES:

1. John. D. Anderson. Jr., "Hypersonic and High Temperature Gas Dynamics", AIAA Series, New York, 2006.
2. John. D. Anderson. Jr., "Modern compressible flow with historical perspective", McGraw Hill Publishing Company, New York, 1996.
3. John. T Bertin, "Hypersonic Aerothermodynamics", published by AIAA Inc.,Washington. D.C., 1994.

WEBLINKS:

https://nptel.ac.in/courses/101103003/

COURSE OUTCOMES	
CO 1	The student will be able to analyze the trajectories of ballistic missiles, space planes, and air-breathing hypersonic vehicles.
CO 2	The student will be able to perform perfect and real gas analyses of shock waves.
CO 3	The student will be able to determine the stagnation properties of a hypersonic vehicle.
CO 4	The student will be able to determine profiles of pressure, skin friction, and heat transfer around a vehicle.
CO 5	The student will be able to determine of heat transfer and skin friction around a general vehicle shape.
CO / PO MAPPING **L –LOW, M – MEDIUM, H – HIGH**	

COs / POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO 1	M	L	L	L										
CO 2	M	H	M	H	M								**M**	
CO 3	H	M	M	H	M									
CO 4	M	M	M	H	M								**M**	
CO 5	M	L	L	M	M									
Category	**Professional Elective (PE)**													
Approval	**49th Academic Council Meeting**													

OPTIONS FOR PROFESSIONAL ELECTIVE (PE) IV

U18PEAE041	**AN INTRODUCTION TO COMBUSTION**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Fundamentals of Aero – Thermodynamics				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To acquaint the student with the basics of combustion in aircraft and rocket engines.					

UNIT I INTRODUCTION TO COMBUSTION 9

Thermochemical equations – heat of reaction- first, second and third order reactions – premixed flames – diffusion flames – Stoichiometric ratio, equivalence ratio – measurement of burning velocity – various methods – effect of various parameters on burning velocity – flame stability – deflagration – detonation – Rankine-Hugoniot curves – radiation by flames

UNIT II COMBUSTION IN AIRCRAFT PISTON ENGINES 9

Introduction to combustion in aircraft piston engines – various factors affecting the combustion efficiency - fuels used for combustion in aircraft piston engines and their selection – detonation in piston engine combustion and the methods to prevent the detonation

UNIT III COMBUSTION IN GAS TURBINE ENGINES 9

Combustion in gas turbine combustion chambers - recirculation – combustion efficiency, factors affecting combustion efficiency, fuels used for gas turbine combustion chambers – combustion stability – ramjet combustion – differences between the design of ramjet combustion chambers and gas turbine combustion chambers- flame holders types – numerical problems.

UNIT IV COMBUSTION IN SCRAMJET ENGINES 9

Introduction to supersonic combustion – need for supersonic combustion for hypersonic air-breathing propulsion- supersonic combustion controlled by diffusion, mixing and heat convection – analysis of reactions and mixing processes - supersonic burning with detonation shocks - various types of supersonic combustors.

UNIT V COMBUSTION IN ROCKET ENGINES 9

Solid propellant combustion - double and composite propellant combustion – various combustion models – combustion in liquid rocket engines – single fuel droplet combustion model – combustion hybrid rockets

TEXTBOOKS:

1. Stephen R turns, ”An Introduction to Combustion”, Tata Mc. Graw Hill Publishing Co., Ltd., New Delhi, Reprint 2013. (Units 1 & 2)
2. Lefebvre AG and Dilip R ballal, “Gas Turbine Combustion”, CRC press, Third Edition, 2010. (Unit 3)
3. Corin Segal, “The Scramjet engine”, Cambridge University Press, 2009 (Unit 4)
4. Sutton, G.P., “Rocket Propulsion Elements”, John Wiley & Sons Inc., New York, 7th Edition, 2001 (Unit 5)

REFERENCES:

1. Warnatz J, Maas U and Dibble RW, ”Combustion”, Springer, Fourth Edition,2006.
2. Beer, J.M., and Chiger, N.A. “Combustion Aerodynamics”, Applied Science Publishers Ltd., London, 1981.
3. Sharma, S.P., and Chandra Mohan, “Fuels and Combustion”, Tata Mc. Graw Hill Publishing Co., Ltd., New Delhi, 1987

WEBLINKS:

https://swayam.gov.in/course/4339-fundamentals-of-combustion-i

COURSE OUTCOMES	
CO 1	Students learn the basics of combustion.
CO 2	Students learn the combustion process in aircraft piston engines.
CO 3	Students learn the combustion process in gas turbine engines.
CO 4	Students get an understanding of the combustion process in scramjet engines.
CO 5	Student acquaint with the combustion process in rocket engines.

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO 1	L		L	L										
CO 2	L	L	M	L									**M**	
CO 3	L	L	M	L										
CO 4	L		L										**M**	
CO 5	L													
Category	**Professional Elective (PE)**													
Approval	**49th Academic Council Meeting**													

U18PEAE042	**NANO SCIENCE AND TECHNOLOGY**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Fundamentals of Structural Mechanics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVE: To acquaint about the applications and significance of nanomaterials in aerospace engineering.

UNIT I INTRODUCTION 9

Introduction to nanoscale materials - atomic & molecular size. Scientific revolutions-nanotechnology application area. Scope of nanoscience and technology

UNIT II NANOSTRUCTURES AND DIMENSIONS 9

Classification of nanostructures-zero, one, two and three dimensional nanostructures. Size Dependency in Nanostructures-quantum size effects in nanostructures.

UNIT III NANOMATERIAL SYNTHESIS 9

Synthesis of nanomaterials-top down and bottom up approach. Method of nanomaterials preparation – wet chemical synthesis-mechanical grinding-gas phase synthesis.

UNIT IV NANOMATERIAL PROPERTIES 9

Surface to volume ratio. Surface properties of nanoparticles. Mechanical, optical, electronic, magnetic, thermal and chemical properties of nanomaterials. Size dependent properties-size dependent absorption spectra.Shape impact.

UNIT V PHYSICAL PROPERTIES OF NANOSTRUCTURED MATERIALS 9

Quantum dots-optical properties and applications. Carbon nanotubes-physical properties and applications. Magnetic behavior of nanomaterials. Electronic transport in quantum wires.

TEXTBOOKS:

1. T. Pradeep, "Nano the Essential Nanoscience and Nanotechnology", Tata McGraw hill, 2007.

REFERENCES:

1. Charles P. Poole, Frank J. Owens, "Introduction to Nanotechnology", Wiley Interscience, 2003.
2. Mark A. Ratner, Daniel Ratner, "Nanotechnology: A gentle introduction to the next Big Idea", Prentice Hall P7R:1st Edition, 2002.
3. J. Dutta, H. Hoffmann, "Nanomaterials", Topnano-21, 2003.
4. Mick Wilson, KamaliKannargare., Geoff Smith, "Nano technology: Basic Science and Emerging technologies", Overseas Press, 2005.

WEBLINKS:

https://www.edx.org/learn/nanotechnology

COURSE OUTCOMES	
CO 1	Student able to get introductory idea of nano science and technology.
CO 2	Student can learn the nano structure and shapes.
CO 3	Student can learn the nano material synthesis process.
CO 4	Student can understand various properties of nano material.
CO 5	Student can acquaint with the physical properties of nano structured materials.

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO 1	H		L		M									
CO 2	M		H		H								**M**	
CO 3	M		L		H									
CO 4	M		M		H								**M**	
CO 5	M		M		M									

Category	Professional Elective (PE)
Approval	49th Academic Council Meeting

U18PEAE043	AIRPORT ENGINEERING	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Nil				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To acquaint about the systems, processes, standards in airport engineering.					

UNIT I INTRODUCTION 9

History, development, policy of air transport, Advantages and limitations of air transportation, aircrafts, aerodromes, air transport authorities, air transport activities, aircraft and its characteristics, airport classifications as per ICAO.

UNIT II AIRPORT PLANNING 9

Regional planning-concepts and advantages, location and planning of airport as per ICAO and F.A.A. recommendations, airport Elements -airfield, terminal area, obstructions, approach zone, zoning laws, airport capacity, airport size and site selection, estimation of future air traffic, development of new airport, requirements of an ideal airport layout.

UNIT III RUN WAY DESIGN 9

Wind rose and orientation of runway, wind coverage and crosswind component, factors affecting runway length, basic runway length, and corrections to runway length, runway geometrics and runway patterns (configurations). Runway marking.

UNIT IV TAXI WAY DESIGN 9

Controlling factors, taxiway geometric elements, layout, exit taxiway, location and geometrics, holding apron, turnaround facility. Aprons -locations, size, gate positions, aircraft parking configurations and parking systems, hangar-site selection, planning and design considerations, Fuel storage area, blast pads, wind direction indicator

UNIT V AIR TRAFFIC CONTROL AND TERMINAL DESIGN 9

Air traffic control-objectives, control system, control network-visual aids-landing information system, airport markings and lighting. Terminal area elements and requirements, terminal building functions, space requirements, location planning concepts, vehicular parking area and circulation network, passenger requirements at terminal building

TEXTBOOKS:

1. Airport Engineering - Rangawala, Charotar publishing House, Anand 388001 (Gujrat).

REFERENCES:

1. Horonjeff and F X Mckelvy, Planning and design of Airport, Mc-Graw Hill International Editions, 1993.
2. G.V. Rao Airport Engineering, Tata McGraw Hill Pub. Co., New Delhi.
3. “Airport Engineering: Planning and Design” by S C Saxena.
4. Airport planning and design – S.K. Khanna , M.G. Arora , S.S. Jain, Nem Chand and Brothers, Roorkee.

WEBLINKS:

https://www.iata.org/training/courses/Pages/airport-operations-tapp14.aspx

COURSE OUTCOMES	
CO 1	The student will understand the basics of airport engineering
CO 2	The student will be able to layout a basic plan for an airport
CO 3	The student will be able to design a runway
CO 4	The student will be able to design a taxiway
CO 5	The student will be able to design a the air traffic control tower and the terminal

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO 1			M	M		M	H	M	M	M				
CO 2			M	M		M	H	M	M	M			**M**	
CO 3	M	M	M	M		M	H	M	M	M				
CO 4	M	M	M	M		M	H	M	M	M			**M**	
CO 5	M	M	M	M		M	H	M	M	M				

Category	**Professional Elective (PE)**
Approval	**49th Academic Council Meeting**

U18PEAE044	**THEORY OF PLATES AND SHELLS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Fundamentals of Structural Mechanics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES
To acquaint about the classic plate theory, method of analysis various shapes and concept of shell.

UNIT I CLASSICAL PLATE THEORY 9
Classical Plate Theory – Assumptions – Differential Equations – Boundary Conditions – Axi-Symmetric Loading.

UNIT II PLATES OF VARIOUS SHAPES **9**
Navier's Method of Solution for Simply Supported Rectangular Plates – Levy's Method of Solution for Rectangular Plates under Different Boundary Conditions – Annular Plates – Plates of other shapes.

UNIT III EIGEN VALUE ANALYSIS **9**
Stability and Free Vibration Analysis of Rectangular Plates.

UNIT IV APPROXIMATE METHODS **9**
Rayleigh – Ritz, Galerkin Methods– Finite Difference Method – Application to Rectangular Plates for Static, Free Vibration and Stability Analysis.

UNIT V SHELLS **9**
Basic Concepts of Shell Type of Structures – Membrane and Bending Theories for Circular Cylindrical Shells.

TEXT BOOKS:

1. Timoshenko, S.P. Winowsky. S., and Kreger, Theory of Plates and Shells, McGraw Hill Book Co., 1990.
2. Varadhan. T. K. &Bhaskar.K., "Analysis of Plates – Theory and Problems", Narosa Publishing House, 2000

REFERENCES:

1. Flugge, W. Stresses in Shells, Springer – Verlag, 1985.
2. Timoshenko, S.P. and Gere, J.M., Theory of Elastic Stability, McGraw Hill Book Co.1986.
3. Harry Kraus, 'Thin Elastic Shells', John Wiley and Sons, 1987.
4. Llyod Hamilton, Donald, "Beams, Plates and Shells", McGraw Hill, 1976.
5. Ansel Ugural, Stresses in Plates & Shells, McGraw Hill, 1981
6. Reddy.J.N., "Theory & Analysis of Elastic Plates", CRC, I Edition, 1999

COURSE OUTCOMES	
CO 1	The student will understand the classical plate theory.
CO 2	The student will be able to analyze the plates of various shapes.
CO 3	The student will learn the concept of Eigen value analysis.
CO 4	The student will be able to learn various numerical approximation method for plate analysis.
CO 5	The student will be able to acquaint the concept of shell structures.

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO 1	M		M	M		M								
CO 2	M			M								M	M	
CO 3	L	M	M										M	
CO 4		M				M						M		
CO 5		M	M	M		M								

Category	**Professional Elective (PE)**
Approval	**49th Academic Council Meeting**

ELECTIVE (PE) V

	COMPOSITE MATERIALS AND STRUCTURES	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
U18PCAE051	Prerequisite – Fundamentals of Mechanics and Machines, Fundamentals of Structural Mechanics				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To introduce the student about significance of composite materials, and their design and analysis using different approaches.					

UNIT I INTRODUCTION TO COMPOSITES AND MICROMECHANICS 10

Introduction – advantages, limitations and application of composite materials – types of reinforcements and matrices, natural fibers and fillers - micro mechanics – mechanics of materials approach, elasticity approach- bounding techniques – fiber volume ratio – mass fraction – density of composites – effectof voids in composites.

UNIT II MACROMECHANICS 10

Generalized Hooke's Law - elastic constants for anisotropic, orthotropic and isotropic materials -macro mechanics – stress-strain relations with respect to natural axis, arbitrary axis

– determination ofin plane strengths of a lamina - experimental characterization of lamina – failure theories of a lamina – hygrothermal effects on lamina.

UNIT III LAMINATE THEORY 10

Governing differential equation for a laminate, stress – strain relations for a laminate, different types of laminates, in plane and flexural constants of a laminate, hygrothermal stresses and strains in a laminate, failure analysis of a laminate, impact resistance and interlaminar stresses, netting analysis

UNIT IV FABRICATION AND REPAIR OF COMPOSITES 8

Various open and closed mould processes, manufacture of fibers, importance of repair and differenttypes of repair techniques in composites – autoclave and non-autoclave methods.

UNIT V SANDWICH CONSTRUCTION 7

Basic design concepts of sandwich construction - materials used for sandwich construction – failure modes of sandwich panels - bending stress and shear flow in composite beams.

TEXTBOOKS:

1. Autar K Kaw, 'Mechanics of Composite Materials', CRC Press, 2005.

REFERENCES:

1. Agarwal, B.D., and Broutman, L.J., "Analysis and Performance of Fibre Composites," John Wiley and sons. Inc., New York, 1995.
2. Lubin, G., "Handbook on Advanced Plastics and Fibre Glass", Von Nostrand Reinhold Co., New York, 1989.
3. Calcote, L R. "The Analysis of laminated Composite Structures", Von – Nostrand Reinhold Company, New York 1998.
4. MadhujiMukhapadhyay, Mechanics of Composite Materials and Structures, University Press, 2004
5. Allen Baker, "Composite Materials for Aircraft Structures", AIAA Series, II Edition, 1999.

WEBLINKS:

https://online.stanford.edu/courses/aa256-mechanics-composites

COURSE OUTCOMES	
CO 1	Students acquaint the knowledge of various types of aerospace composite materials.
CO 2	Students will get an understanding of composite mechanics and its application.
CO 3	Students will understand different theories of laminate design.
CO 4	Students will have knowledge of failure analysis.
CO 5	Students will learn various fabrication processes and will be able to fabricate composites based on their own concept.

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO 1	H	H	M									M		
CO 2	H	H	L	M								H	**M**	
CO 3	H	H	L	M								M		

CO 4	M	H	H	H	M								**M**	
CO 5	M		H		H							H		
Category	**Professional Core (PC)**													
Approval	**49th Academic Council Meeting held in Oct, 2018**													

U18PEAE052	**EXPERIMENTAL STRESS ANALYSIS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Fundamentals of Mechanics and Machines, Fundamentals of Structural Mechanics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVE:
To make the student understand on experimental method of finding the response of the structure to different types of load.

UNIT I MEASUREMENTS AND EXTENSOMETERS 9
Principles of measurements, Accuracy, Sensitivity and range of measurements, Mechanical, Optical, Acoustical and Electrical extensometers and their uses, Advantages and disadvantages.

UNIT II ELECTRICAL RESISTANCE STRAIN GAUGES 9
Principle of operation and requirements, Types and their uses, Materials for strain gauge, Calibration and temperature compensation, cross sensitivity, Rosette analysis, Wheatstone bridge and potentiometer circuits for static and dynamic strain measurements, strain indicators.

UNIT III PHOTOELASTICITY 9
Two dimensional photo elasticity, Photo elastic materials, Concept of light - photoelastic effects, stress optic law, Transmission and Reflection polariscopes, Interpretation of fringe pattern, Compensation and separation techniques, Introduction to three dimensional photo elasticity.

UNIT IV BRITTLE COATING AND MOIRE METHODS 9
Introduction to Moiré techniques, Brittle coating methods and Holography

UNIT V NON – DESTRUCTIVE TESTING 9
Fundamentals of NDT, Radiography, Ultrasonics, Eddy Current testing, Fluorescent Penetrant Testing, Acoustic Emission Technique

TEXTBOOKS:
1. Sadhu Singh, "Experimental Stress Analysis", Khanna Publishers, 2009.

REFERENCES:
1. Hetenyi, M., "Hand book of Experimental Stress Analysis", John Wiley and Sons Inc., New York, 1972.
2. Max Mark Frocht," Photo Elasticity", John Wiley and Sons Inc., New York, 1968
3. A.J.Durelli, "Applied Stress Analysis", Prentice Hall of India Pvt Ltd., New Delhi, 1970
4. Srinath, L.S., Raghava, M.R., Lingaiah, K., Garagesha, G., Pant B., and Ramachandra, K., "Experimental Stress Analysis", Tata McGraw Hill, New Delhi, 1984.
5. James F. Doyle ,"Modern Experimental Stress Analysis ",John Wiley & Sons, 2004.
6. Ramesh, K., " Experimental Stress Analysis", Indian Institute of Technology Madras, India,E-book,2009.

WEBLINKS:
https://onlinecourses.nptel.ac.in/noc18_me39/preview

COURSE OUTCOMES	
CO 1	Student acquaint with the basics of measurement.
CO 2	Students learn the principle of extensometers, electrical resistance strain gauges and their application in stress analysis.
CO 3	Students learn the principle of photo elasticity and their application in stress analysis.
CO 4	Students get an understanding of the Moire and brittle coating methods in stress analysis.
CO 5	Student acquaint with the non-destructive testing methods.

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO 1	H	H	H	H	H									
CO 2	H	H	H	H	H								**M**	
CO 3	M	M	L	H	H									
CO 4	M	M	L	H	H								**M**	
CO 5	M	M		H	H									
Category	**Professional Elective (PE)**													
Approval	**49th Academic Council Meeting**													

U18PEAE053	HELICOPTER MAINTENANCE	L	T	P	C
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Aircraft Systems and Instrumentation				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVE: To acquaint the student with the fundamentals of helicopter components, functions and their maintenance.

UNIT I HELICOPTER FUNDAMENTALS 6

Basic components of helicopters and working – Ground handling, bearing – Gears.

UNIT II MAINTENANCE OF MAIN ROTOR SYSTEM 12

Head maintenance – blade alignment – Static main rotor balance – Vibration – Tracking – Span wise dynamic balance – Blade sweeping –Electronic balancing – Dampener maintenance – Counter weight adjustment – Auto rotation adjustments – Mast & Flight Control Rotor - Mast – Stabilizer, dampeners – Swash plate flight control systems collective – Cyclic – Push pull tubes – Torque tubes – Bell cranks – Mixer box – Gradient unit control boosts – Maintenance & Inspection control rigging.

UNIT III MAINTENANCE OF MAIN ROTOR TRANSMISSION 12

Engine transmission coupling – Drive shaft – Maintenance clutch – Free wheeling units – Spray clutch – Roller unit – Torque meter – Rotor brake – Maintenance of these components – vibrations – Mounting systems – Transmissions.

UNIT IV MAINTENANCE OF POWERLANT AND TAIL ROTOR 9

Fixed wing power plant modifications – Installation – Different type of power plant maintenance. Tail rotor system – Servicing tail rotor track – System rigging.

UNIT V AIRFRAME AND RELATED SYSTEMS 6

Fuselage maintenance – Airframe Systems – Special purpose equipment.

TEXTBOOKS:

1. Jeppesen, "Helicopter Maintenance", Jeppesens and Sons Inc., 2000.

REFERENCES:

1. "Civil Aircraft Inspection Procedures", Part I and II, CAA, English Book House, New Delhi, 1998.
2. Larry Reithmier, "Aircraft Repair Manual", Palamar Books Marquette, 1992.

WEBLINKS:

http://www.aviationmaintenance.edu/programs/

COURSE OUTCOMES	
CO 1	The student will understand the fundamentals of helicopters, its components and controls
CO 2	The student will have a basic idea about the maintenance of the main rotor system of the helicopter
CO 3	The student will have a basic idea about the maintenance of the main rotor transmission system of the helicopter
CO 4	The student will have a basic idea about the maintenance of the power plant and tail rotor system of the helicopter
CO 5	The student will know about the parts of the airframe and the systems associated with a helicopter

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO 1	L	L		M										
CO 2	L	M		H				H	M				**M**	
CO 3	L	M		H				H	M					
CO 4	L	M		H				H	M				**M**	
CO 5	L	L		M										

Category	**Professional Elective (PE)**				
Approval	**49th Academic Council Meeting**				
U18PEAE054	**HEAT TRANSFER IN AEROSPACE APPLICATIONS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Fundamentals of Aero – Thermodynamics, Fluid Mechanics				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVE: To familiarize the student with the various modes of heat transfer, estimation of heat transfer parameters and design of heat transfer devices, insulators and heat shields.

(Use of Heat and Mass Transfer Data Book is permitted)

UNIT I CONDUCTION HEAT TRANSFER – STEADY STATE 7

Modes of heat transfer: One dimensional steady state heat conduction: Composite Medium – Critical thickness – Effect of variation of thermal Conductivity – Extended Surfaces.

UNIT II CONDUCTION HEAT TRANSFER – TRANSIENT 10

Heat Conduction: Lumped System Analysis – Heat Transfer in Semi-infinite and infinite solids – Transient Heat Transfer – Temperature charts

UNIT III CONVECTIVE HEAT TRANSFER 8

Introduction – Free convection in atmosphere - free convection on a vertical flat plate – Empirical relation in free convection – Forced convection – Laminar and turbulent - convective heat transfer analysis in flows between parallel plates, over a flat plate and in a circular pipe. Empirical relations.

UNIT IV RADIATIVE HEAT TRANSFER AND HEAT EXCHANGERS 10

Concept of black body-Intensity of radiation-Laws of Black body Radiation-Radiation from non-black surfaces- real surfaces – Radiation between surfaces-Radiation shape factors-Radiation shields.

Types of heat exchangers -overall heat transfer coefficient- LMTD- NTU method of heat exchanger Analysis.

UNIT V HEAT TRANSFER PROBLEMS IN AEROSPACE ENGINEERING 10

Heat transfer problems in gas turbine engines, rocket nozzles and re-entry vehicles – Numerical techniques to solve heat transfer problems in aerospace engineering –numerical problems using software and programming.

TEXTBOOKS:

1. Sachdeva, S.C. “Fundamentals of Engineering, Heat and Mass Transfer, Wiley Eastern Ltd. Fourth Edition, New Delhi, 2012. (Units 1 to 4)
2. Sunden B, Juan Fu, “Heat Transfer in Aerospace Applications”, Academic Press, First Edition, 2016 (Unit 5)

REFERENCES:

1. Sutton, G.P., "Rocket Propulsion Elements ", John Wiley and Sons, 8th Edition.2010.
2. Lienhard J. H., “A Heat Transfer Text Book”, Phlogiston Press, U.S.A., 2008.
3. Ozisik M.N., “Heat Transfer A Basic Approach”, The McGraw-Hill Company, reprint 1995.
4. Holman, J.P., "Heat Transfer ", McGraw Hill Book Co., Inc., New York, TenthEdition.,2009.

WEBLINKS:

https://onlinecourses.nptel.ac.in/noc18_ch08/course

COURSE OUTCOMES	
CO 1	Students will be able to calculate heat transfer rate through plane wall, cylinder and sphere
CO 2	Student will be able to solve problem involving unsteady heat transfer by conduction
CO 3	Students will be able to design and analysis system involving convective heat transfer
CO 4	Student will be able to calculate the amount of heat transfer by radiation
CO 5	Student will be able to solve the heat transfer problem in gas turbine, reentry vehicle
CO / PO MAPPING L –LOW, M – MEDIUM, H – HIGH	

COs / POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO 1	L	M	L	L	M	L								
CO 2	L	M	M	L	H								**M**	
CO 3	L	M	M	L	H									
CO 4	L	M	M	L	H								**M**	
CO 5	L	L	M	L	H	L								
Category	**Professional Elective (PE)**													
Approval	**49th Academic Council Meeting**													

PROFESSIONAL ELECTIVE (PE) VI

U18PEAE061	HIGH TEMPERATURE MATERIALS	L	T	P	C
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Fundamentals of Structural Mechanics				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To acquaint the student with the fundamentals of creep, hot corrosion, fracture mechanisms under high temperature and alloys for high temperature applications.					

UNIT I INTRODUCTION TO HIGH TEMPERATURE MATERIALS 6

Components exposed to high temperatures, significance of high temperature materials, recent trends in high temperature material research

UNIT II CREEP AND DESIGN FOR CREEP RESISTANCE 12

Factors influencing functional life of components at elevated temperatures, definition of creep curve, various stages of creep, metallurgical factors influencing various stages, effect of stress, temperature and strain rate. Design of transient creep time, hardening, strain hardening, expressions of rupture life of creep, ductile and brittle materials, Monkman-Grant relationship.

UNIT III FRACTURE 9

Various types of fracture, brittle to ductile from low temperature to high temperature, cleavage fracture, and ductile fracture due to micro void coalescence-diffusion controlled void growth; fracture maps for different alloys and oxides.

UNIT IV OXIDATION AND HOT CORROSION 9

Oxidation, Pilling, Bedworth ratio, kinetic laws of oxidation- defect structure and control of oxidation by alloy additions, hot gas corrosion deposit, modified hot gas corrosion, fluxing mechanisms, effect of alloying elements on hot corrosion, interaction of hot corrosion and creep, methods of combat hot corrosion.

UNIT V SUPER ALLOYS AND OTHER MATERIALS 9

Iron base, Nickel base and Cobalt base super alloys, composition control, solid solution strengthening, precipitation hardening by gamma prime, grain boundary strengthening, TCP phase, embrittlement, solidification of single crystals, Intermetallics, high temperature ceramics.

TEXTBOOKS:

1. Raj. R., “Flow and Fracture at Elevated Temperatures”, American Society for Metals, USA, 1985. (Units 1, 2, 3 & 5)
2. David J. Young, “High Temperature Oxidation and Corrosion of Metals”, Second Edition, Elsevier Science Ltd., 2016 (Unit 4)

REFERENCES:

1. Boyle J.T, Spencer J, “Stress Analysis for Creep”, Butterworths, UK, 1983.
2. Bressers. J., “Creep and Fatigue in High Temperature Alloys”, Applied Science, 1981.
3. McLean D., “Directionally Solidified Materials for High Temperature Service”, The Metals Society, USA, 1985.
4. Hertzberg R. W., “Deformation and Fracture Mechanics of Engineering materials”, 4th Edition, John Wiley, USA, 1996.
5. Courtney T.H, “Mechanical Behavior of Materials”, McGraw-Hill, USA, 1990.

WEBLINKS:

https://nptel.ac.in/courses/113105019/

COURSE OUTCOMES	
CO 1	Student will know about the fundamentals of creep.
CO 2	Students will be able to design structures / components with creep resistance.
CO 3	Students will be able to detect and analyze failure by fracture and cracks.
CO 4	Students will understand the mechanism underlying oxidation and hot corrosion that will help in material selection and treatment.
CO 5	Student will be able to select a material appropriate to the application.

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO 1	H	H	H	L										
CO 2	M	H	H	H	L								**M**	
CO 3	M	H	H	H	M									
CO 4	M	L	L	L	L								**M**	
CO 5	L	L	L	L										
Category	**Professional Elective (PE)**													
Approval	**49th Academic Council Meeting**													

U18PEAE062	**FATIGUE AND FRACTURE MECHANICS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Elements of Aerospace Structures				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVE: To enable the student to understand the basic concepts of fatigue and fracture, processes, statistical tools for fatigue life prediction, realizing importance of fatigue and fracture in aerospace industry.

UNIT I FATIGUE OF STRUCTURES 9

S.N. curves - Endurance limits - Effect of mean stress, Goodman, Gerber and Soderberg relations and diagrams - Notches and stress concentrations - Neuber’s stress concentration factors - Plastic stress concentration factors - Notched S.N. curves.

UNIT II STATISTICAL ASPECTS OF FATIGUE BEHAVIOUR 9

Low cycle and high cycle fatigue - Coffin - Manson's relation - Transition life - cyclic strain hardening and softening - Analysis of load histories - Cycle counting techniques -Cumulative damage - Miner's theory - Other theories.

UNIT III PHYSICAL ASPECTS OF FATIGUE 9

Phase in fatigue life - Crack initiation - Crack growth - Final Fracture - Dislocations - fatigue fracture surfaces.

UNIT IV FRACTURE MECHANICS 9

Strength of cracked bodies - Potential energy and surface energy - Griffith's theory - Irwin - Irwin 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.

UNIT V FATIGUE DESIGN AND TESTINIG 9

Safe life and Fail-safe design philosophies - Importance of Fracture Mechanics in aerospace structures - Application to composite materials and structures.

TEXTBOOKS:

1. Matej Billy, "Cyclic Deformation and Fatigue of Metals", Elsevier Science Ltd., 1993. (Units 1 to 3)
2. Prashant Kumar, Elements of Fracture Mechanics, Tata McGraw Hill, New Delhi, India, 2009. (Unit 4)
3. Barrois W, Ripely, E.L., "Fatigue of aircraft structure", Pergamon press. Oxford, 1983 (Unit 5)

REFERENCES:

1. K. R.Y. Simha, Fracture Mechanics for Modern Engineering Design, Universities Press (India) Limited, 2001
2. D. Broek, Elementary Engineering Fracture Mechanics, Kluwer Academic Publishers, Dordrecht, 1986.
3. T.L. Anderson, Fracture Mechanics - Fundamentals and Applications, 3rd Edition, Taylor and Francis Group, 2005

WEBLINKS:

https://ocw.mit.edu/courses/materials-science-and-engineering/3-35-fracture-and-fatigue-fall-2003/

COURSE OUTCOMES	
CO 1	The basic terminologies will be helpful for the student to understand about the concepts of fatigue and fracture mechanics
CO 2	The student will be able to use statistical tools effectively in fatigue analysis and design
CO 3	By understanding the physical processes taking place during fatigue, the student will be able to know the favorable properties of materials during material selection and composite design
CO 4	The student will be able to design appropriate structures that will have higher fracture resistance and redundancy
CO 5	The student will realize the importance of fatigue effects and fracture mechanics in aerospace industry and will design structures accordingly

CO / PO MAPPING L –LOW, M – MEDIUM, H – HIGH														
COs / POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO 1	H	L	M	L										
CO 2	H	H	H	L	H								**M**	
CO 3	M	H	H	M	L									
CO 4	M	L	H	M	L								**M**	
CO 5	L	L	M	L										
Category	**Professional Elective (PE)**													
Approval	**49th Academic Council Meeting**													

U18PEAE063	**CRYOGENIC ROCKET PROPULSION**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Advanced Aerospace Propulsion				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To introduce to the student the basics of cryogenic systems and associated processes and cryogenic rocket technology.					

UNIT I INTRODUCTION TO CRYOGENIC SYSTEMS 9

Cryogenic systems and basic components, Properties of Cryogenic fluids, Liquefaction systems, ideal, Cascade, Linde Hampson and Claude cycles and their derivatives; Refrigerators: Stirling, Gifford-McMahon cycles and their derivatives. Cryogenic Insulations: Foam, Fibre, powder and Multilayer.

UNIT II CRYO FUEL SYSTEMS 9

Cryogenic and semi – cryogenic propellants - Hydrogen - properties, and pretreatment - Liquefaction of hydrogen - Linde, Claude and helium - hydrogen condensing cycles, Ortho-para conversion. Storage and handling of liquefied hydrogen

UNIT III CRYO EQUIPMENT AND ACCESSORIES 9

Mechanical and Thermal Properties of engineering materials at low temperatures; Compressors: types, construction and characteristics; Expansion machines: characteristics of reciprocating and turbine expanders, design of J-T expander; Heat exchangers: types, design approaches and selection criteria, Design of cryogenic storage vessels, transfer devices, insulation system, valves; Characteristics of cryogenic pumps, Instrumentation in cryogenic systems

UNIT IV CRYOGENIC ENGINES 9

Fluid circuits of various cryogenic engines and semi-cryogenic engines; Design of regeneratively cooled combustion chamber, film cooling, dump cooling, transpiration cooling and radiation cooling. Design of expansion nozzle- characteristics, Design of injector–hydraulic characteristics; Engine thrust and mixture ratio control, Igniters, Propellant tanks.

UNIT V CHALLENGES IN CRYOGENIC ROCKET TECHNOLOGY 9

Problems in storage and handling of cryogenic propellants: safety aspects, Thermal protection systems for stage tanks, Thermal stratification- destratification, Geysering effect – geysering elemination, Zero “g” problems – restart mechanism.

TEXTBOOKS:

1. "A text book of Cryogenics", "Valery V. Kostionk", Discovery Publishing House, 2010. (Units 1 to 3)
2. "Operation of a Cryogenic Rocket Engine", "Kitsche, Wolfgang", Springer Publications, 2011. (Units 4 & 5)

REFERENCES:

1. "Rocket Propulsion Elements", "Sutton G. P., Bibliarz"

WEBLINKS:

https://nptel.ac.in/courses/112101004/

COURSE OUTCOMES	
CO 1	The basic knowledge of cryogenic systems will be helpful in designing cryo based processes and equipments.
CO 2	The student will know about the different propellants that can be used in cryogenic propulsion and also about their synthesis and handling.
CO 3	The student will be able to design various accessories related to cryogenic rocket engines.
CO 4	The student will understand the complete process in a cryogenic or semi – cryogenic engine that will help in the design of such engines.
CO 5	Knowing about various challenges, the student will be able to design efficient cryo – engines.

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2
CO 1	M	L	M	M	L									
CO 2	M	L	L										**M**	
CO 3	H	L	L	L	M									
CO 4	H	M	L	L	M								**M**	
CO 5	M	M	L											

Category	**Professional Elective (PE)**
Approval	**49th Academic Council Meeting**

U18PEAE064	**STRUCTURAL DYNAMICS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Nil				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVE: To study the effect of periodic and a periodic forces on mechanical systems with matrix approach and also to get the natural characteristics of large sized problems using approximate methods.

UNIT I FORCE DEFLECTION PROPERTIES OF STRUCTURES 9

Constraints and Generalized coordinates-Virtual work and generalized forces- Force-Deflection influence functions-stiffness and flexibility methods.

UNIT II PRINCIPLES OF DYNAMICS 9

Free and forced vibrations of systems with finite degrees of freedom-Damped oscillations-D" Alembert's principle-Hamilton's principle-Lagrangean equations of motion and applications.

UNIT III NATURAL MODES OF VIBRATION 9

Equations of motion for Multi degree of freedom Systems - Solution of Eigen value problems – Normal coordinates and orthogonality Conditions. Modal Analysis.

UNIT IV ENERGY METHODS 9

Rayleigh's principle-Rayleigh-Ritz method-Coupled natural modes-Effect of rotary inertia and shear on lateral vibrations of beams-Natural vibrations of plates.

UNIT V APPROXIMATE METHODS 9

Approximate methods of evaluating the Eigen values and the dynamic response of continuous systems. Application of Matrix methods for dynamic analysis.

TEXTBOOKS:

1. F. S. Tse, I. E. Morse and H. T. Hinkle, "Mechanical Vibration", Prentice Hall of India Pvt. Ltd, NeW Delhi, 1988.
2. W. C. Hurty and M. F. Rubinstein, "Dynamics of Structures", Prentice Hall of India Pvt. Ltd, New Delhi, 1987.

REFERENCES:

1. R. K. Vierck, "Vibration Analysis" 2nd Edition, Thomas Y. Crowell & Co Harper &Row Publishers, New York, U.S.A. 1989.
2. S. P. Timoshnko ad D. H. Young, "Vinration Problems in Engineering", John Willey & Sons Inc., 1984.
3. von Karman and A. Biot, "Mathematical Methods in Engineering", McGraw-Hill Book Co.,New York, 1985.
4. Ramamurthi. V., "Mechanical Vibration Practice and Noise Control" Narosa Publishing House Pvt. Ltd, 2008

COURSE OUTCOMES	
CO 1	The student will be able to understand the basic parameters of deflection properties.
CO 2	The student will be able to estimate all the important principles of dynamics.
CO 3	The knowledge about wide variety natural modes of vibration.
CO 4	The student will know about the various method of vibration
CO 5	The student will be able to develop approximate methodologies.

CO / PO MAPPING
L –LOW, M – MEDIUM, H – HIGH

COs / POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO 1	M				M	M								
CO 2	H	H	L	M	H								**M**	
CO 3			M		H									
CO 4	H		H	H	H	M							**M**	
CO 5	H	H	H	H	H									

Category	**Professional Elective (PE)**
Approval	**49th Academic Council Meeting**