Bharath
INSTITUTE OF HIGHER EDUCATION AND RESEARCH
(Declared as deemed to be university under section 3 of UGC Act 1956, vide notification No.F.9-5/2000-U.3)

B. Tech. – AEROSPACE ENGINEERING

(FULL TIME)

SYLLABUS

Regulation 2018

DEPARTMENT OF AERONAUTICAL ENGINEERING

FACULTY OF ENGINEERING AND TECHNOLOGY

BHARATH INSTITUTE OF SCIENCE AND TECHNOLOGY

 # 173, Agaram Road, Selaiyur,

Chennai -600 073, Tamil Nadu.

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF AERONAUTICAL ENGINEERING

B. TECH. - AERONAUTICAL ENGINEERING

(FULL TIME)

DEPARTMENT VISION

Department of Aeronautical Engineering will endeavour to accomplish worldwide recognition with a focal point of Excellence in the field of Aeronautics by providing quality Education through world class facilities, enabling graduates turning out to be Professional Experts with specific knowledge in Aeronautical & Aerospace engineering.

DEPARTMENT MISSION

- To be the state of art Teaching and Learning centre with excellent infrastructure and empowered Faculties in Aeronautical & Aerospace Engineering.
- To foster a culture of innovation among students in the field of Aeronautics and Aerospace with updated professional skills to enhance research potential for sponsored research and innovative projects.
- To Nurture young individuals to be knowledgeable, skilful, and ethical professionals in their pursuit of Aeronautical & Aerospace Engineering.

B. Tech. - Aerospace Engineering

Program Educational Objectives (PEOs)

PEO 1: Demonstrate a solid grasp of fundamental concepts in Mathematics, Science, and Engineering, essential for effectively addressing engineering challenges within the Aerospace industry.

PEO 2: Involve in process of designing, simulating, fabricating, testing, and evaluating in the field of Aerospace.

PEO 3: Obtain advanced skills to actively engage in research and development endeavors within emerging domains, while also pursuing further education opportunities.

PEO 4: Demonstrate efficient performance both as independent contributors and as valuable team members in diverse multidisciplinary projects.

PEO 5: Embrace lifelong learning and career advancement while adapting to the evolving social demands and needs.

B. Tech. - Aerospace Engineering

Program Outcomes (POs)

PO1- Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2- Problem analysis: Identify, formulate, research literature, and analyze engineering problems to arrive at substantiated conclusions using first principles of mathematics, natural, and engineering sciences.

PO3- Design/development of solutions: Design solutions for complex engineering problems and design system components, processes to meet the specifications with consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4- Conduct investigations of complex problems: Use research-based knowledge including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5- Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6- The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7- Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8- Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9- Individual and teamwork: Function effectively as an individual, and as a member or leader in teams, and in multidisciplinary settings.

PO10- Communication: Communicate effectively with the engineering community and with society at large. Be able to comprehend and write effective reports documentation. Make effective presentations and give and receive clear instructions.

PO11- Project management and finance: Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team. Manage projects in multidisciplinary environments.

PO12- Life-long learning: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

B. Tech. - Aerospace Engineering

Program Specific Outcomes (PSOs)

PSO1: Create, Select, and Apply aerospace modelling, analysis, and design, as well as team working skills in the design and integration of Spacecraft systems.

PSO2: Apply principles of aerodynamics, space propulsion, aerospace structures and control systems to design and analyze aircraft and spacecraft with desired performance characteristics.

B. Tech. - Aerospace Engineering

SYLLABUS (R-2018)

I – VIII SEMESTERS

Subject code: U18HSEN101	**Subject Name : COMMUNICATIVE ENGLISH (Common to B. Tech - Mech, Mechatronics, Automobile, Aero, EEE, EIE, ECE, CSE, IT, Civil & Bio Medical admitted from July 2018)**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course – School Level English				
	Course Coordinator Name & Department:- Mr. M. Gopinath & Dept. of English				
COURSE OBJECTIVES	➢ Enhance the learner's communication skills by giving adequate exposure in LSRW – Listening, Speaking, Reading, Writing skills and the related sub-skills. ➢ Help the learners recognize and operate in various styles and registers in English.				

UNIT I SPEAKING

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

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

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

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 - Pre

UNIT V LANGUAGE DEVELOPMENT

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

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 Rajeevan Geeta. Basic Communication Skills, Foundation Books: 2013
4. Means, L. 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 (COs)	
CO1	Enable students to learn and identify faulty pronunciation, grammar and vocabulary. (Understand)
CO2	Help students develop the knowledge, skills and strategies to become proficient and independent readers and make them to interact and construct meaning from the content.(Analyze)
CO3	Develop listening abilities of the students, and teach basic listening strategies and expose them to a number of different listening situations through activities. (Remember)
CO4	Impart writing skills by sensitizing the learners to the dynamics of effective writing. (Create)
CO5	Recognize culture-specific perspectives and values embedded in language behavior to make students interpret authentic texts of different genres. (Analyze)
CO6	Communicate effectively using verbal and non-verbal communication skills. (Apply)

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H - High; M - Medium; L – Low

1	**COs/ POs**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
2	CO1		H										M
	CO2			M							M		
	CO3				H							H	
	CO4					H		M					
	CO5						H		H	L			
	CO6												
3	Category		Basic Sciences (BS)										
4	Approval		47th Academic Council Meeting held in Aug, 2018										

Subject code: U18BSMA101	**Engineering Mathematics – I (Common to B. Tech - Mech, Mechatronics, Automobile, Aero, EEE, EIE, ECE, CSE, IT, Civil & Bio Medical admitted from July 2018)**	**L**	**T**	**P**	**C**
	Total Contact Hours – 60	3	1	0	4
	Prerequisite Course– School Level Mathematics				
	Course Coordinator Name & Department – Ms. J. Aiswarya & Department of Mathematics				
COURSE OBJECTIVES	➢ 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 DIFFERENTIAL CALCULUS - One Variable (9+3) Hrs

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) Hrs

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) Hrs

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) Hrs

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) Hrs

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.

TEXTBOOKS

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	Analyze the optimum solution of various engineering problems involving single variables.
CO2	Know the basic concepts of integration and evaluating the problems which involves Beta and Gamma functions.
CO3	Solve the differential functions and optimizes the problems with two variables functions.
CO4	Apply multiple integrals to compute area and volume over curves, surface and domain in two dimensional and three-dimensional spaces.
CO5	Evaluate Eigenvalue and eigen vector problems from practical areas using transformations;
CO6	Construct the eigen vector for the problem in engineering field and Diagonalizing the matrix

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H - High; M - Medium; L – Low

1	**COs/ POs**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
2	CO1	H	H										L
	CO2	H	H			M							M
	CO3	H	H	M		M							M
	CO4	H	H			M							M
	CO5	H	H	M									L
	CO6	H	H										L
3	Category		Basic Sciences (BS)										
4	Approval		47th Academic Council Meeting held in Aug, 2018										

U18BSPH101	WAVES AND OPTICS (For B. Tech. –Common to all branches)	L	T	P	C
	Total contact hours -45	3	0	0	3
	Prerequisite: +2				
	Course offered by –Department of Physics				
	Data Book/Codes /Standards : Higher Secondary				

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

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. **(Contact Hours - 9)**

UNIT 2 ULTRASONIC WAVES

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.**(Contact Hours - 9)**

UNIT 3 THE PROPAGATION OF LIGHT AND GEOMETRIC OPTICS

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 .**(Contact Hours - 9)**

UNIT 4 WAVE OPTICS

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. **(Contact Hours - 9)**

UNIT 5 LASERS

Einstein's theory of matter radiation interaction and A and 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.**(Contact Hours - 9)**

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
9)

COURSE OUTCOMES(COs)	
CO1	Describe the basic concept of waves (Understand)
CO2	Identify the importance of Ultrasonic waves (Understand)
CO3	Recognizethe propagation of light and geometrical optics (Remember)
CO4	Discuss the optical phenomenon like interference, diffraction and superposition of waves (Understand)
CO5	Observe the concept of laser and its applications (Understand)
CO6	Examine the properties of light and sound waves and its wide range of applications (Apply)

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H - High; M - Medium; L – Low													
1	**COs/POs**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
2	CO1	H	M										
	CO2	H	M	H									
	CO3	H	M										
	CO4	H	M	L									
	CO5	H	M	H									
	CO6	H	M	H									
3	Category	Basic Sciences (BS)											
4	Approval	47th Academic Council Meeting held in Aug, 2018											

U18BSCH101	Subject Name: ENGINEERING CHEMISTRY	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite course: +2				
	Course Offered by: Dept. of. Chemistry				
	Data Book/ Codes/ Standards : Periodic Table				

UNIT I WATER TECHNOLOGY (Contact Hours – 09)

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 (Contact Hours – 09)

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 (Contact Hours – 09)

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 (Contact Hours – 09)

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 (Contact Hours – 09)

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" Dhanpat Rai 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	Discuss boiler feed water requirements and water treatment techniques **(Understand)**
CO2	Explain the industrial importance of Phase rule and its applications to one and two component systems **(Apply)**
CO3	Illustrate the principles of Conventional and non- conventional energy sources and energy storage devices **(Understand)**
CO4	Describe the Chemistry of Fuels and calorific value, manufacture of solid, liquid and gaseous fuels **(Remember)**
CO5	Classify Nanomaterials and state their applications in biology and medicine **(Understand)**

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H - High; M - Medium; L – Low													
1	**COs/ POs**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
2	CO1	H			M		H		H				
	CO2		L	H		M		H		M	H		
	CO3		M		H		L						
	CO4	H		M	L			M					
	CO5		H		L		M				M		
	CO6	M									H		
3	Category		Basic Sciences (BS)										
4	Approval		47th Academic Council Meeting held in Aug, 2018										

U18ESCS101	PROBLEM SOLVING AND PYTHON PROGRAMMING	L	T	P	C
	Total Contact Hours: 45	3	0	0	3
	Prerequisite: NIL				
	Course Designed by : Dept. of Computer Science and 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	Understand basic of algorithmic solutions to find simple computational problems.
CO2	Execute basic syntax, data expressions and programs in Python.
CO3	Apply conditional statements and functional parameters to read and write input/output files in Python
CO4	Analyze list operations, tuples assignments, various dictionaries and sorting methods.
CO5	Remember user-defined functions, modules and packages.
CO6	Implement the exception and file handling operations using various list parameters.

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping H - High; M - Medium; L – Low

1	COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
2	CO1	H	L										
	CO2	H	M										
	CO3	M	M	M									
	CO4	H	H	H	L	L							
	CO5	H		M		M							
	CO6	M	M										
3	Category		Engg Sciences (ES)										
4	Approval		47th Meeting of Academic Council held in Aug, 2018										

U18ESME101	Engineering Graphics & Design	L	T	P	C
	Total Contact Periods – 45	3	0	0	3
	Prerequisite – +12 Level Mathematics				
	Course Designed by – Department of Mechanical Engineering				
OBJECTIVES	To Prepare students to design a system, component, or process to meet desired ne using the techniques, skills, and modern engineering tools necessary for enginee practice				

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;

MODULE 3: PROJECTIONS OF REGULAR SOLIDS& ISOMETRIC PROJECTIONS (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
5. (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
CO6	Crete 3D part models. Develop its surfaces with solid modelling software for assembly of

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H - High; M - Medium; L – Low

1	**COs/POs**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
2	CO1	H			M			H					H
	CO2	H	H	L		H	M						H
	CO3			H									
	CO4											H	
	CO5	H						L					H
	CO6	M		H		H					H		M
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
	Total contact hours - 60	0	0	4	2
	Prerequisite: +2				
	Course offered by – Department of Physics				
	Data Book/Codes /Standards : Higher Secondary				

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 OUTCOMES(COs)	
CO1	Achieve the fundamental concept of optics (Precision)
CO2	Demonstrate the concept of production of ultrasonic waves (Manipulate)
CO3	Achieve the basic concept of mechanics (Precision)

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H - High; M - Medium; L – Low													
1	**COs/POs**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
2	CO1	H		H	H						H		
	CO2	H		H									
	CO3	H		M	H						H		
3	Category		**Basics Sciences(BS)**										
4	Approval		47th Meeting of Academic Council held in Aug, 2018										

U18BSCH2L4	CHEMISTRY LABORATORY	L	T	P	C
	Total Contact Hours – 60	0	0	4	2
	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	Estimate certain properties of water, standardize solutions using titration, conductivity meter, pH-meter **(Understand)**
CO2	Recognize basic principle of spectrophotometric method **(Remember)**
CO3	Analyze some important physical properties like viscosity and rate of Corrosion of the samples **(Analyze)**

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H - High; M - Medium; L – Low													
1	**COs/POs**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
2	CO1	M		H									
	CO2	M			M	H							
	CO3	H	H	H			H	H	M				
3	Category		**Basics Sciences(BS)**										
4	Approval		47th Meeting of Academic Council held in Aug, 2018										

U18ESCS1L1	PROBLEM SOLVING AND PYTHON PROGRAMMINGLABORATORY	L	T	P	C
	Total Contact Hours – 60	0	0	4	2
	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. ExSOnentiation (SOwer 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

PLATFORM NEEDED

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
CO6	To Understand about Simulate bouncing ball using Pygame.

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H - High; M - Medium; L – Low

1	COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
2	CO1	M		M		M				M			
	CO2	M		M	H	M				M			
	CO3	M		M	H	M				M			
	CO4	M		M		M				M			
	CO5	M		M		M				M			
	CO6	M		M	H	M				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	3	0	0	3
	Prerequisite course –1 Semester English				
	Course Coordinator Name & Department:- Mr. M. Gopinath & Dept. of English				
OBJECTIVES	➢ Train the students in technical writing in English in writing descriptions of gadgets, preparing texts and reports as well as comprehending technical texts. ➢ Prepare the students in content writing and copy editing				

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- dependent, 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	Develop global listening abilities of the students, and teach them a few basic listening strategies and expose them to a number of different listening situations through activities. (Understand)
CO2	Help students develop the knowledge, skills and strategies they must possess to become proficient and independent readers who is able to interact and construct meaning from the content. (Apply)
CO3	Use technical information and knowledge in practical documents for a variety of professional audiences, including peers and colleagues or management, and public audiences.(Apply)
CO4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (Create)
CO5	Help students recognize culture-specific perspectives and values embedded in language behavior. Decode, analyze, and interpret authentic texts of different genres. (Evaluate)
CO6	Designing digital slides. Breaking up a presentation into parts of reasonable length. Using statistics effectively to persuade an audience. Incorporating concrete examples and stories to illustrate points. (Create)

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping H - High; M - Medium; L – Low

1	COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
2	CO1		M										H
	CO2			H							M		
	CO3				H							H	
	CO4					M		H					
	CO5						M		M	L			
	CO6						H						
3	Category	Humanities and Social Studies (HS)											
4	Approval	47th Meeting of Academic Council held in Aug, 2018											

U18BSMA201	**Engineering Mathematics II (Common to B. Tech - Mech, Mechatronics, Automobile, Aero, EEE, EIE, ECE, CSE, IT, Civil & Bio Medical admitted from July 2018)**	**L**	**T**	**P**	**C**
	Total Contact Hours – 60	**3**	**1**	**0**	**4**
	Prerequisite Course– School Level Mathematics				
	Course Coordinator Name & Department – Dr. N. Ramya & Department of Mathematics				
COURSE 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	Solve the higher order differential equations with constant and variable coefficients.
CO2	Apply Green's, Stoke's and Gauss Theorems in the application of engineering problems which involves line, surface and volume integrals .
CO3	Understand the analytic functions and able to construct an analytic function, solve the conformal mapping
CO4	Evaluate real and complex integrals using the Cauchy's integral formula and Residue theorem.
CO5	Apply the concept of Laplace Transformation in analysis.
CO6	Use Laplace transform methods to solve differential equations.

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H - High; M - Medium; L – Low

1	**COs/POs**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
2	CO1	H	H			M							L
	CO2	H	H	L		L							M
	CO3	H	H	M		M							M
	CO4	H	H	M		L							H
	CO5	H	H	M									H
	CO6	H	H										H
3	Category		**Basics Sciences(BS)**										
4	Approval		47th Meeting of Academic Council held in Aug, 2018										

U18BSPH201	**INTRODUCTION TO MECHANICS (Common to B.Tech. –Civil, Mech, Mechatronics, Aero, Aerospace & Auto)**	**L**	**T**	**P**	**C**
	Total contact hours -45	3	0	0	3
	Prerequisite: +2				
	Course offered by –Department of Physics				
	Data Book/Codes /Standards : Higher Secondary				

UNIT I -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 **(Contact Hours – 9)**

UNIT II - 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. **(Contact Hours – 9)**

UNIT III - Harmonic oscillator; Damped harmonic motion – over-damped, critically damped and lightly-damped oscillators; Forced oscillations and resonance **(Contact Hours – 9)**

UNIT IV - 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 **(Contact Hours – 9)**

UNIT V - 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 centre of mass fixed. **(Contact Hours – 9)**

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" Dhanpat Rai 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&RKolenkow, "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.

Online References: Wikipedia org

COURSE OUTCOMES(COs)	
CO1	Identify and solve the various equation of motions in different coordinate systems (Remember)
CO2	Generalize the idea of conservation of energy and angular momentum (Understand)
CO3	Visualize the concept of harmonic motion in different damped conditions (Remember)
CO4	Discuss the motion of a rigid body under different criteria (Understand)
CO5	Describes the motion of a rigid body in three dimensions (Understand)
CO6	Demonstrates the basics of particle motion and kinematics in 1D, 2D and 3D (Apply)

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H - High; M - Medium; L – Low

1	COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
2	CO1	H	M										
	CO2	H											
	CO3	H	M										
	CO4	H	H	M	H								
	CO5	H	H	M	H	H					H		H
	CO6	H			M						H		
3	Category		**Basics Sciences(BS)**										
4	Approval		47th Meeting of Academic Council held in Aug, 2018										

U18BSCH201	ENVIRONMENTAL SCIENCES	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite: +2				
	Course Offered by Dept 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 (COs)	
CO1	Observe the overutilization of water and energy from different sources, conserve water and identify alternative energy sources **(Remember)**
CO2	Explain different ecosystem, identify possible solutions to environment issues
CO3	Describe the biodiversity, its importance and conservation **(Remember)**
CO4	Explain various forms of environment pollution and realize the responsibilities of individuals in prevention of pollution **(Apply)**
CO5	Identify the social and environmental issues and predict the possible engineering solutions **(Understand)**
CO6	Describe the social and environmental problems and administer the possible solutions **(Apply)**

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H - High; M - Medium; L – Low

1	**COs/POs**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
2	CO1	H			M								
	CO2	M	H	H		M							L
	CO3		M										
	CO4	H		M	L								M
	CO5		H		L						H		
	CO6										H		
3	Category		**Basics Sciences(BS)**										
4	Approval		47th Meeting of Academic Council held in Aug, 2018										

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.

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	Recall the relationship between structure and function of cells at molecular level
CO2	List the defining characteristics of biological life
CO3	Determine the importance of genetics and immunological response
CO4	Categorize the mechanism of infection about diseases and disorders affecting specific organs
CO5	Demonstrate the techniques from multiple disciplines and apply to biological problems
CO6	Discuss the biological science related to different disciplinary areas.

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H - High; M - Medium; L – Low

1	COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
2	CO1	L											L
	CO2	L											
	CO3	M											
	CO4	L											
	CO5	H					L						L
	CO6	M											L
3	Category		**Basics Sciences(BS)**										
4	Approval		47th Meeting of Academic Council held in Aug, 2018										

U18ESEE101	Basic Electrical and Electronics Engineering	L	T	P	C
	Total contact hours-45	3	0	0	3
	Prerequisite: School Level Physics				
	Course offered by –Department of Electrical and Electronics Engineering				
OBJECTIVES	To gain fundamental knowledge of Electrical and Electronics Engineering and its applications.				

MODULE 1: DC CIRCUITS (12 periods)

Electrical circuit elements, voltage and current sources, Fundamentals 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 Periods)

Representation of sinusoidal waveforms, peak and rms values, phasor representation, realpower, 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 Periods)

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

MODULE 4: SEMICONDUCTOR DEVICESANDAPPLICATIONS (9 periods)

CharacteristicsofPNJunctionDiode–ZenerEffect–ZenerDiodeanditsCharacteristics–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 toOP-AMP.

MODULE 5: DIGITAL ELECTRONICS (6 Periods)

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	Apply simple electrical circuits and verify DC network theorems.**(Apply)**
CO2	Obtain electrical parameters like voltage, current, power and sketch phase diagram of a given ac circuits. .**(Understand)**
CO3	Explain the working principle of DC, AC Machines and transformer.**(Understand)**
CO4	Draw the characteristics of semiconductor devices and to obtain signal analysis of BJT **(Understand)**
CO5	Perform the basic Boolean operations. **(Remember)**

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H - High; M - Medium; L - Low													
1	**COs/POs**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
2	CO1	H	H	L	L								
	CO2	H	M	L	L								
	CO3	H	L										
	CO4	H		L	L								
	CO5	H	M	M	L								
	CO6	H	H	L	L								
3	Category		**Engineering Science(ES)**										
4	Approval		47th Meeting of Academic Council held in Aug, 2018										

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.

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 (POs) CO/SO Mapping: H – High, M – Medium, L – Low

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 ELECTRONIC ENGINEERING PRACTICES LABORATORY	L	T	P	C
	Total Contact Hours – 60	**0**	**0**	**4**	**2**
	Prerequisite – School Level Physics & Basic Electrical and Electronic 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. Staircasewiring.
5. Measurement of energy using single phase energy meter.
6. Observationoftheno-loadcurrentwaveformonanoscilloscopeandMeasurementofPrimary 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. Demonstrationof(a)dc-dcconverters(b)dc-acconverters–PWMwaveform(c)theuseofdc-acconverter for speed control of an induction motor and (d) Components of LTswitchgear.

LIST OF EXPERIMENTS FOR BASIC ELECTRONICS ENGINEERING LAB

1. Measurement of ac signal parameters using cathode ray oscilloscope and functiongenerator.
2. Characteristics – Half wave and Full wave Rectifiers.
3. Characteristics – Common Base transistorconfiguration.
4. Verification of truth tables of OR, AND, NOT, NAND, NOR gates and Flip-flops - JK andRS.
5. Applications of OperationalAmplifier.

REFERENCE BOOKS:

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

COURSE OUTCOMES(COs)	
CO1	Implementation of circuits for verification of basic laws and theorems **(Imitation)**
CO2	Perform the different types of residential wiring and to measure the electrical quantities like voltage ,current and power.**(Manipulation)**
CO3	Draw the characteristics of semiconductor devices **(Imitation)**

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H - High; M - Medium; L – Low

1	COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
2	CO1	L	L	M	H	L				M			
	CO2	L	L	M	H	L				M			
	CO3	L	L	M	H	L				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 (Common to B. Tech – Mech, Mechatronics, Automobile, Aeronautical and Aerospace Engineering admitted from July 2018)**	**L**	**T**	**P**	**C**
	Total Contact Hours – 60	**3**	**1**	**0**	**4**
	Prerequisite Course– Engineering Mathematics I & II				
	Course Coordinator Name & Department – K.L. Rajashree & 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 (COs)	
CO1	Apply Fourier series method to engineering problems. (Apply)
CO2	Solve PDE and higher order with constant coefficients and physically interpret the results. (Apply)
CO3	Analyze the solutions of one dimensional and two dimensional boundary value problems in partial differential equations.(Analyze)
CO4	Apply the concept of probability to various distributions in engineering problems. (Apply)
CO5	Evaluate the statistical problems including measures of central tendency, correlation and regression. (Evaluate)
CO6	Analyse the testing of hypothesis to statistical data. (Analyze)

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H – High, M – Medium, L – Low

1	**COs/ POs**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
2	CO1	H	H	M	M	L							M		
	CO2	H	H	M	M	L							M		
	CO3	H	H	M	M	L							M		
	CO4	H	H	M	M	L					H		M		
	CO5	H	H	M	M	L							M		
	CO6	H	H	M	M	L					H		M		
3	**Category**	**Basics Sciences (BS)**													
4	**Approval**	**48th Academic Council Meeting**													

U18PCAS301	INTRODUCTION TO AEROSPACE ENGINEERING	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, spacecraft, 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 AEROSPACE STRUCTURES 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 AEROSPACE PROPULSION 8

Propeller Engine – Gas Turbine Engine – Turbo prop, Turbo jet, Turbo fan Engines -variation of thrust, power and 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, 6thedition 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:

COURSE OUTCOMES	
CO 1	Describe the basic components of airplane and various flight vehicles (Understand)
CO 2	Summarize the variation of aircraft performance at various altitudes. (Understand)
CO3	Explain the structural components of airplane and materials used for aircraft construction. (Understand)
CO4	Describe the working of different types of aircraft engines and their performances. (Understand)
CO5	Discuss the theory behind rocket propulsion and the problems associated with hypersonic vehicle operation. (Understand)

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H – High, M – Medium, L – Low

1	**COs/ POs**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
2	CO1	H									M				H
	CO2	H				M									H
	CO3	H									M		H		H
	CO4	H											H		H
	CO5	H											H		H
3	**Category**	**Program Core (PC)**													
4	**Approval**	**48th Academic Council Meeting**													

U18PCAS302	APPLIED DYNAMICS AND VIBRATION	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 AND FORCE ANALYSIS 10

Frictional force, Laws of Coulomb Friction, Cone of Friction, Angle of Repose, 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. Introduction to force analysis –Static and dynamic balancing Single and several masses in different planes –Balancing of reciprocating masses- primary balancing and concepts of secondary balancing

UNIT V INTRODUCTION TO VIBRATIONS 8

Free, forced and damped vibrations of single degree of freedom systems – Force transmitted to supports – Vibration isolation –Vibration absorption –Torsional vibration of shaft –Single and multi-rotor systems – Geared shafts–Critical speed of shaft.

TEXTBOOKS:

1. F. P. Beer, E.R. Johnston, and J.T. Dewolf, Mechanics of Materials, McGraw-Hill, 2006.
2. Rattan.S.S., Theory of Machines, Tata McGraw–Hill Publishing Co, New Delhi, 2004.

REFERENCES:

1. Rao, J.S and Dukkipati, R.V, "Mechanism and Machine Theory", Second Edition, WileyEastern Ltd., 1992.
2. Malhotra, D.R and Gupta, H.C., "The Theory of Machines", SatyaPrakasam, Tech. IndiaPublications, 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:

https://onlinecourses.nptel.ac.in/noc19_me29/preview

COURSE OUTCOMES	
CO1	Identify the forces and its magnitude. (Remember)
CO2	Discuss the moment under area consideration with C.G Locations. (Understand)
CO3	Describe the working of different mechanisms along with inversion and their corresponding velocity and acceleration diagrams. (Apply)
CO4	Determine the Power transmission in machine elements using fundamentals of friction and the unbalanced forces acting on rotating and reciprocating parts in engine. (Apply)
CO5	Determine the Cause of vibration in machine parts and its effects (Apply)

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H – High, M – Medium, L – Low

1	**COs/ POs**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
2	CO1	H				H									H
	CO2	H													H
	CO3	H				H					H				H
	CO4	H				H					H				H
	CO5	H													H
3	**Category**	**Program Core (PC)**													
4	**Approval**	**48th Academic Council Meeting**													

U18ESAS301	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:

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

COURSE OUTCOMES	
CO1	**Recall** the concepts of fluids, properties of fluids and its cla ssification. (**Remember**)
CO2	**Calculate** the flow properties using the fundamental equations of fluid motion. (**Apply**)
CO3	**Solve** problems based on dimensional analysis and fluid flow analysis. (**Apply**)
CO4	**Examine t**he pipe line system for minimum head loss. (**Apply**)
CO5	**Calculate** the performance and operating characteristics of turbines and pumps. **(Apply)**

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H – High, M – Medium, L – Low															
1	**COs/ POs**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
2	CO1	H											L		H
	CO2	H											L		H
	CO3	H									H		L		H
	CO4	H											L		H
	CO5	H									H		L		H
3	**Category**		**Engineering Science (ES)**												
4	**Approval**		**48th Academic Council Meeting**												

	FUNDAMENTALS OF AERO – THERMODYNAMICS	L	T	P	C
U18ESAS302	Total Contact Hours – 45	3	0	0	3
	Prerequisite – +2 Physics				
	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.					

(Use of Steam Tables is Permitted)

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, energy

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:

COURSE OUTCOMES	
CO1	**Discuss** the fundamental laws of thermodynamics and its relations. **(Understand)**
CO2	**Solve** thermodynamic problems on first law of thermodynamics. **(Apply)**
CO3	**Solve** thermodynamic problems on Second law of thermodynamics. **(Apply)**
CO4	**Compute** the air standard efficiencies using P-V and T-S diagram of various air power cycles. (**Apply**)
CO5	**Calculate** the efficiency of jet propulsion cycles. (**Apply**)

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H – High, M – Medium, L – Low

1	**COs/ POs**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
2	CO1	H											H		H
	CO2	H											H		H
	CO3	H											H		H
	CO4	H									H		H		H
	CO5	H									H		H		H
3	**Category**	**Engineering Science (ES)**													
4	**Approval**	**48th Academic Council Meeting**													

U18ESAS303	**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, 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:

https://onlinecourses.nptel.ac.in/noc17_ce22/preview

COURSE OUTCOMES	
CO1	**Compute** the stress developed in statically determinate and indeterminate structures subjected to axial load. (**Apply**)
CO2	**Sketch** shear force and bending moment diagram for a given beam. (**Apply**)
CO3	**Determine** the deflection of beams using various methods (**Apply**)
CO4	**Compute** the shear stress developed in circular shafts and springs subjected to torsional and axial load. (**Apply**)
CO5	**Determine** principal stresses developed in structural components using Mohr's Circle (**Apply**).

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H – High, M – Medium, L – Low

1	**COs/ POs**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
2	CO1	H				H					H		M		H
	CO2	H				H							M		H
	CO3	H				H					H		M		H
	CO4	H				H							M		H
	CO5	H				H							M		H
3	**Category**	**Engineering Science (ES)**													
4	**Approval**	**48th Academic Council Meeting**													

U18PCAS3L1	STRENGTH OF MATERIALS LABORATORY	L	T	P	C
	Total Contact Hours – 30	0	0	2	1
	Pre-requisite- Introduction to Mecahnics; Co-requisite– Fundamentals of Structural Mechanics				
	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. Torsion test on mild steel rod
3. Hardness test (a) Brinell & (b) Rockwell.
4. Estimation of Stiffness of a Helical Spring (a) Open Coil & (b) Closed Coil
5. Block compression test
6. Flexural test by 3-point bending method
7. Four-point beam bending experiment
8. Determination of fracture strength and fracture pattern of ductile and brittle material

REFERENCES:

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

WEBLINKS:

COURSE OUTCOMES	
CO 1	**Carry out** elementary mechanical coupon testing of materials as per the given procedure. **(Imitation)**
CO 2	**Acquire** data using the available measuring devices. **(Manipulation)**
CO 3	**Perform** basic mathematical calculation using the appropriate formulae and represent the results in form of graph and table **(Precision)**.

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H - High; M - Medium; L – Low

1	COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
2	CO1	H								H	H				H
	CO2	H								H	H				H
	CO3	H								H	H				H
3	Category	Program Core (PC)													
4	Approval	48th Academic Council Meeting													

	COMPUTER AIDED DESIGNING AND DRAFTING	L	T	P	C
U18PCAS3L2	Total Contact Hours – 30	0	0	2	1
	Prerequisite – Engineering Graphics & Design				
	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. Exercise on 2D drawing
2. Exercise on pad and groove
3. Exercise on shaft, mirror and array
4. Exercise on threading, bores and tappings
5. Exercise on part assembly
6. Exercise on drafting
7. Exercise on surface modeling
8. Exercise on kinematics

REFERENCES:

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

WEBLINKS:

COURSE OUTCOMES	
CO 1	**Master** the geometrical profile and modification tools. **(Precision)**
CO 2	**Create** 3-Dimensional models from 2-Dimensional geometries. **(Naturalization)**
CO 3	**Design** basic Aerospace components using CADD. **(Articulation)**

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H – High, M – Medium, L – Low

1	COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
2	CO1	H	H							H	H			H	H
	CO2	H	H							H	H			H	H
	CO3	H	H							H	H			H	H
3	Category	Program Core (PC)													
4	Approval	48th Academic Council Meeting													

U18ESAS3L1	FLUID MECHANICS AND MACHINERIES LABORATORY	L	T	P	C
	Total Contact Hours – 30	0	0	2	1
	Pre-requisite- Introduction to Mechanics; Co-requisite – 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 Verification of Bernoulli's Equation.
6 Performance characteristics of centrifugal pump.
7 Performance characteristics of submergible pump.
8 Performance characteristics of jet pump.
9 Characteristics of impulse turbine – Pelton wheel turbine.
10 Characteristics of reaction turbine – Francis turbine

REFERENCES:

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

WEBLINKS:

COURSE OUTCOMES	
CO 1	**Observe** the flow characteristics in a pipeline system. **(Imitation)**
CO 2	**Demonstrate** the Bernoulli's Equation. **(Manipulation)**
CO 3	**Conduct** the Performance test of different Pumps and Turbines. **(Precision)**

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H - High; M - Medium; L – Low

1	COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
2	CO1	H								H	H				H
	CO2	H								H	H				H
	CO3	H								H	H				H
3	Category	Engineering Science (ES)													
4	Approval	48th Academic Council Meeting													

SEMESTER IV

	Numerical Methods (Common to B. Tech - Mech, Mechatronics, Automobile, Aero admitted from July 2018)	L	T	P	C
U18BSMA401	Total Contact Hours- 60	**3**	**1**	**0**	**4**
	Prerequisite Course – Engineering Mathematics I & II				
	Course Coordinator Name & Department– P. Bhathmanaban & 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 (COs)	
CO1	Solve algebraic and transcendental equation using Newton Raphson and regula-Falsi methods and system of linear equations by various methods.
CO2	Apply method of interpolation and extrapolation for numerical data.
CO3	Describe the concept of numerical methods to differentiation and integration using Trapezoidal and Simpson's rules.
CO4	Solve initial value problems of ODE by applying Taylor's series and runge-Kutta methods.
CO5	Analyse the two dimensional Laplace, Poisson equations and one dimensional heat and wave equations of PDE.
CO6	Develop one dimensional and two dimensional problems in engineering field.

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H - High; M - Medium; L – Low

1	**COs/ POs**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
2	CO1	H	H			M							M		
	CO2	H	H	M									M		
	CO3	H	H	M							M		M		
	CO4	H	H			M							M		
	CO5	H	H										M		
	CO6	H	H	M		M					M		M		
3	**Category**	Basic Science (BS)													
4	**Approval**	**48th Academic Council Meeting**													

U18PCAS401	ELEMENTS OF AEROSPACE STRUCTURES	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 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:

COURSE OUTCOMES	
CO 1	**Determine** the forces acting in the members of statically determinate truss and frames. (**Apply**)
CO 2	**Calculate** the slope and deflection of statically indeterminate beams. (**Apply**)
CO 3	**Calculate** the deflection and strain energy of statically determinate and indeterminate structures. (**Apply**)
CO 4	**Compute** the buckling load and crippling stress of columns with different end conditions. (**Apply**)
CO 5	**Determine** the safe stress of the structural component using failure theories. (**Apply**)

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H - High; M - Medium; L – Low

1	**COs/ POs**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
2	CO1	H									M				H
	CO2	H											H		H
	CO3	H											H		H
	CO4	H													H
	CO5	H									M				H
3	**Category**	**Program Core (PC)**													
4	**Approval**	**48th Academic Council Meeting**													

U18PCAS402	AERODYNAMICS	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite –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 characteristics over bluff & slender bodies and flow around low speed aircrafts					

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, Kutta Joukowski 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://ocw.mit.edu/courses/aeronautics-and-astronautics/16-100-aerodynamics-fall-2005/

COURSE OUTCOMES	
CO 1	**Recall** the types of flows based on mathematical equations. (**Understand**)
CO 2	**Solve** flow over basic aerodynamic shapes using concept of inviscid flow theory. (**Apply**)
CO 3	**Determine** the geometric features of airfoils with the help of mathematical transformations. (**Apply**)
CO 4	**Describe** the concept of lift generation and the factors for efficient wing design. (**Understand**)
CO 5	**Determine** the skin friction drag over surfaces. (**Apply**)

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H – High, M – Medium, L – Low

1	**COs/ POs**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
2	CO1	H													H
	CO2	H													H
	CO3	H				L					M		M		H
	CO4	H											M		H
	CO5	H									M				H
3	**Category**	**Program Core (PC)**													
4	**Approval**	**48th Academic Council Meeting**													

U18PCAS403	AIRBREATHING 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:

COURSE OUTCOMES	
CO 1	**Compare** the performance characteristics of turbojet, turbofan, turboprop and propeller engines. **(Understand)**
CO 2	**Identify** the engine starting problems associated with inlets. **(Understand)**
CO 3	**Discuss** the types of nozzles and the losses in nozzles. (**Understand**)
CO 4	**Explain** the working principle of axial and centrifugal flow compressors. **(Understand)**
CO 5	**Discuss** important factors affecting combustion chamber design and the problems associated with flame stabilization. (**Understand**)

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H – High, M – Medium, L – Low

1	**COs/ POs**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
2	CO1	H													H
	CO2	H													H
	CO3	H									M		H		H
	CO4	H									M		H		H
	CO5	H											H		H
3	**Category**	**Program Core (PC)**													
4	**Approval**	**48th Academic Council Meeting**													

U18PCAS404	AEROSPACE MATERIALS	L	T	P	C
	Total Contact Hours – 30	2	0	0	2
	Prerequisite – Introduction to Aerospace Engineering				
	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 6

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 6

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 6

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 6

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 6

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:

COURSE OUTCOMES	
CO 1	**Explain** mechanical properties of aircraft structural materials. **(Understand)**
CO 2	**Classify** different types of alloys used in aircraft construction. **(Understand)**
CO 3	**Discuss** the properties of high strength and high temperature resistant alloys used in aerospace applications. **(Understand)**
CO 4	**Describe** the heat treatment processes of alloys and methods to prevent corrosion. **(Understand)**
CO 5	**Summarize** the application of advanced materials in aerospace engineering. **(Understand)**

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H - High; M - Medium; L – Low

1	**COs/ POs**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
2	CO1	H						M							H
	CO2	H						M							H
	CO3	H						M			H				H
	CO4	M						M			H				H
	CO5	M						M							H
3	**Category**	**Program Core (PC)**													
4	**Approval**	**48th Academic Council Meeting**													

U18PCAS405	MANUFACTURING TECHNOLOGY	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	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 9

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 9

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 9

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 9

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 9

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. Hajra Chowdary 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

COURSE OUTCOMES	
CO 1	**Describe** various metal forming process and different types of welding. (**Understand**)
CO 2	**Describe** types of lathe and their construction. (**Understand**)
CO 3	**Explain** the process of shaping, planing and milling operations. (**Understand**)
CO 4	**Discuss** the process involved in drilling, boring, broaching, surface finishing. (**Understand**)
CO 5	**Describe** the working principle of various Non-traditional machining techniques. (**Understand**)

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H - High; M - Medium; L – Low

1	**COs/ POs**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
2	CO1	H									L				
	CO2	H										L			
	CO3	H													
	CO4	H													
	CO5	H									L				
3	**Category**	**Program Core (PC)**													
4	**Approval**	**48th Academic Council Meeting**													

	AERODYNAMICS LABORATORY	L	T	P	C
	Total Contact Hours – 30	0	0	2	1
U18PCAS4L1	Prerequisite – Fundamentals of Fluid Mechanics, Co-requisite – 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. Force measurement on an Airfoil using wind tunnel balance.
7. Pressure distribution over a building model.
8. Aerodynamic studies of automotive models.
9. Flow visualization at subsonic velocity using (a) Smoke (b) Oil.

REFERENCES:

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

WEBLINKS:

COURSE OUTCOMES	
CO 1	**Carry out** flow analysis over various aerodynamic models. (**Manipulation**)
CO 2	**Demonstrate** the usage of mechanical and electronic instruments in data acquisition. (**Manipulation**)
CO 3	**Conduct** experiments at various orientation of models to characterize the flow. (**Articulation**)

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H - High; M - Medium; L – Low

1	COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
2	CO1	H								H	H				H
	CO2	H								H	H				H
	CO3	H								H	H				H
3	Category	Program Core (PC)													
4	Approval	48th Academic Council Meeting													

U18PCAS4L2	MANUFACTURING TECHNOLOGY LABORATORY	L	T	P	C
	Total Contact Hours – 30	0	0	2	1
	Prerequisite – Engineering Graphics & Design; 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. Exercise on setting the work piece and the tool in the lathe.
2. Plane turning and step turning.
3. Taper turning and knurling.
4. Eccentric Turning.
5. Thread cutting and grooving.
6. Drilling and reaming.
7. Drilling and boring.
8. Surface grinding

REFERENCES:

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

WEBLINKS:

COURSE OUTCOMES	
CO 1	**Carry out** different machining operations on center lathe **(Manipulation)**
CO 2	**Perform** drilling, reaming and boring processes. **(Precision)**
CO 3	**Observe** the working of Planner shaper miller and grinder. **(Imitation)**

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H - High; M - Medium; L – Low

1	COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
2	CO1	H								H	H		H		
	CO2	H								H	H		H		
	CO3	H								H	H		H		
3	Category	Program Core (PC)													
4	Approval	48th Academic Council Meeting													

U18PCAS4L3	INTRODUCTION TO MATLAB	L	T	P	C
	Total Contact Hours – 30	0	0	2	1
	Prerequisite – Mathematics I & II, Problem Solving and Python Programming Laboratory				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To acquaint students with the MATLAB software for solving various engineering problems.					

LIST OF EXPERIMENTS

1. Relational and Logical Expressions in MATLAB
2. Working with Matrices
3. Plotting using MATLAB
4. Exercise on Curve Fitting
5. Exercise on Complex and Statistical Analysis
6. Program Flow Control in MATLAB
7. Input and Output of Variables
8. Exercise on solving ODE's and PDE's
9. 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	**Master** the basic computing and programming features of MATLAB **(Precision).**
CO 2	**Perform** data plotting, curve fitting and statistical analysis in MATLAB **(Precision).**
CO 3	**Adapt** MATLAB to solve engineering-related problems using numerical methods and in performing dynamic simulation **(Articulation).**

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H - High; M - Medium; L – Low

1	COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
2	CO1	H				H			H	H	H			H	H
	CO2	H				H			H	H	H			H	H
	CO3	H				H			H	H	H			H	H
3	Category	Program Core (PC)													
4	Approval	48th Academic Council Meeting													

SEMESTER V

U18PCAS501	AEROSPACE 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 acquaint students with the analysis of beams subjected to unsymmetrical bending and to obtain shear flow distribution in open and closed sections					

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:

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	**Compute** the bending stress distribution in beams of symmetric and unsymmetrical sections. (**Apply**)
CO 2	**Calculate** the shear flow distribution in symmetrical and unsymmetrical thin-walled open section and its shear center. (**Apply**)
CO 3	**Calculate** the shear flow distribution in thin walled single and multi-cell structures subjected to combined loading. (**Apply**)
CO 4	**Compute** the crippling strength of thin plates and effective width of sheet stiffener panels. (**Apply**)
CO 5	**Analyze** the stress developed in aircraft wings and fuselage. (**Analyze**)

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H - High; M - Medium; L – Low

1	**COs/ POs**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
2	CO1	H									H				H
	CO2	H									H				H
	CO3	H									H				H
	CO4	H													H
	CO5	H													H
3	**Category**	**Program Core (PC)**													
4	**Approval**	**48th Academic Council Meeting**													

U18PCAS502	COMPRESSIBLE FLOW	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – 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 vehicles 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	**Apply** the concepts of isentropic flow for problems related to variable area ducts. (**Apply**)
CO 2	**Calculate** the properties of flow through shock and expansion waves. (**Apply**)
CO 3	**Determine** the aerodynamic coefficients of compressible flows based on linearized flow theory. (**Apply**)
CO 4	**Categorize** various aircrafts intended for subsonic and supersonic regimes based on wing and fuselage design. (**Analyze**)
CO 5	**Describe** flow measurement and visualization techniques for high-speed flows. **(Understand)**

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H - High; M - Medium; L – Low

1	**COs/ POs**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
2	CO1	H											H		H
	CO2	H											H		H
	CO3	H		L							L		H		H
	CO4	H				M					L		H		H
	CO5	H				M							H		H
3	**Category**	**Program Core (PC)**													
4	**Approval**	**48th Academic Council Meeting**													

U18PCAS503	ROCKET PROPULSION	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Air-breathing Propulsion				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To enable the student to understand about the rocket engines, electric engines, components and functions.					

UNIT I THEORY OF ROCKET PROPULSION 8

Brief History – Classification – Rocket Principle and Rocket Equation – Mass Ratio – Specific Impulse – Desirable Parameters of Rockets – Propulsive Efficiency – Performance Parameters – Staging and Clustering of Rockets – Statics Testing of Rockets

UNIT II SOLID PROPELLANT ROCKETS 9

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

UNIT III LIQUID PROPELLANT ROCKETS 10

Liquid propellant rockets – selection of liquid propellants – performance and choice of various feed systems for liquid propellant rockets – hydrazine monopropellant rockets–basics of cryogenic techniques – Cooling in liquid rockets and the associated heat transfer problems – advantages of liquid rockets over solid rockets –draining of propellant tanks under microgravity conditions

UNIT IV MODERN PROPULSION TECHNIQUES 8

Hybrid Rockets, Burning Mechanism, Advantages of Hybrid Rockets over Solid and Liquid Propellant Rockets – Nuclear Rockets – Pulse Detonation Rockets – Beamed Rockets and Sail Propulsion – Basics of Electrothermal, Electrostatic and Electromagnetic Thrusters

UNIT V ROCKET NOZZLE AND PERFORMANCE 10

Nozzle types – Effect of Shape and Area Ratio – Performance Losses, Flow Separation in Nozzles – Mass Flow Rate and Characteristic Velocity – Thrust Coefficient – Bell Nozzle – Unconventional Nozzles, SERN nozzle – Aerospike nozzle, annular nozzles.

TEXTBOOKS:

1. Ramamurthi, K., “Rocket Propulsion”, Trinity Press, First Edition, 2010

REFERENCES:

1. 2. Sutton, G.P., “Rocket Propulsion Elements”, John Wiley & Sons Inc., New York, 8th Edition, 2010.
2. J D Mattingly, “Elements of Propulsion - Gas Turbines and Rockets “, AIAA Education Series, 2006.
3. Thomas A Ward, “Aerospace Propulsion Systems”, John Wiley & Sons Inc., New York,2010.
4. DanM.Goebel, Ira Katz, ‘Fundamentals of Electric Propulsion’, John Wiley & Sons Inc, New York, 2003.

WEBLINKS:

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

COURSE OUTCOMES	
CO 1	**Analyze** the propulsion system with performance parameters. (**Analyze**)
CO 2	**Describe** performance parameters used in solid rocket motor engines. (**Understand**)
CO 3	**Explain** the fundamental concept of a liquid rocket engine performance. (**Understand**)
CO 4	**Comprehend** and illustrate the basics of hybrid, nuclear rockets in terms of their designing approach. (**Understand**)
CO 5	**Relate** the significance of nozzle design. (**Understand**)

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping H - High; M - Medium; L – Low

1	**COs/ POs**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
2	CO1	H													H
	CO2	H													H
	CO3	H									H				H
	CO4	H									H				H
	CO5	H													H
3	**Category**	**Program Core (PC)**													
4	**Approval**	**48th Academic Council Meeting**													

U18PCAS504	AIRCRAFT PERFORMANCE	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Aerodynamics				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To study the performance of airplanes under various operating conditions					

UNIT I THE EQUATIONS OF MOTION 10

The Equations of Motion Steady Unaccelerated Flight Introduction, four forces of flight, General equation of motion, Power available and power required curves. Thrust available and thrust required curves. Conditions for power required and thrust required minimum. Thrust available and maximum velocity, Power available and maximum velocity, Altitude effects on power available and power required; thrust available and thrust required.

UNIT II FLIGHT PERFORMANCE 10

Steady Performance-Level Flight, Climb & Glide Performance: Equation of motion for Rate of climb-graphical and analytical approach -Absolute ceiling, Service ceiling, Time to climb-graphical and analytical approach, climb performance graph (hodograph diagram); maximum climb angle and rate of climb Gliding flight, Range during glide, minimum rate of sink and shallowest angle of glide

UNIT III RANGE AND ENDURANCE 10

Propeller-driven Airplane: Physical consideration, Quantitative formulation, Breguet equation for Range and Endurance, Conditions for maximum range and endurance.
Jet Airplane: Physical consideration, Quantitative formulation, Equation for Range and Endurance, Conditions for maximum range and endurance, Effect of headwind tailwind.

UNIT IV ACCELERATED FLIGHT TAKE-OFF PERFORMANCE 8

Aircraft Performance in Accelerated Flight Take-off Performance: Calculation of Ground roll, Calculation of distance while airborne to clear obstacle, Balanced field length Landing Performance and Accelerated Climb: Calculation of approach distance, Calculation of flare distance, Calculation of ground roll, ground effects. Acceleration in climb.

UNIT V MANEUVER PERFORMANCE 7

Maneuver Performance Turning performance: Level turn, load factor, Constraints on load factor, Minimum turn radius, Maximum turn rate. Pull-up and Pull-down manoeuvres: (Turning rate, turn radius). Limiting case for large load factor. The V-n diagram. Limitations of pull up and push over.

TEXTBOOKS:

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

REFERENCES:

1. MiadoSaarlas, 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://nptel.ac.in/courses/101106041

COURSE OUTCOMES	
CO 1	**Describe** basic principles relating to drag polar equation of the aircraft. (**Understand**)
CO 2	**Examine** the aircraft engine performance. (**Apply**)
CO 3	**Calculate** range and endurance for power and thrust producing engine under various flight conditions. (**Apply**)
CO 4	**Examine** climb and glide performance for shallow and steep angles. (**Apply**)
CO 5	**Calculate** take off, landing and turning performance under various flight conditions. (**Apply**)

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H - High; M - Medium; L – Low

1	**COs/ POs**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
2	CO1	H													H
	CO2	H													H
	CO3	H													H
	CO4	H									M				H
	CO5	H									M				H
3	**Category**	**Program Core (PC)**													
4	**Approval**	**48th Academic Council Meeting**													

U18PCAS505	AIRCRAFT STABILITY AND CONTROL	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Aerodynamics; Co-requisite- Aircraft Performance				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To equip the students with the static and dynamic response of aircraft for both voluntary and involuntary changes in flight conditions					

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/101106043

COURSE OUTCOMES	
CO 1	**Describe** criteria of static longitudinal stability under stick fixed and stick free conditions. (**Understand**)
CO 2	**Estimate** the contribution of aircraft components on static directional stability and the rudder effectiveness for different flight conditions. (**Apply**)
CO 3	**Estimate** the contribution of aircraft components on static lateral stability and compute the effectiveness of aileron. (**Apply**)
CO 4	**Estimate** dynamic longitudinal stability derivatives under non equilibrium conditions of aircraft. (**Apply**)
CO 5	**Compute** the stability derivatives for lateral and directional dynamics of aircraft. (**Apply**)

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H - High; M - Medium; L – Low

1	**COs/ POs**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
2	CO1	H													M
	CO2	H													M
	CO3	H													M
	CO4	H									M				M
	CO5	H									M				M
3	**Category**		**Program Core (PC)**												
4	**Approval**		**48th Academic Council Meeting**												

U18PCAS5L1	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 Verification of Maxwell's theorem and principle of superposition.
2 Column – Testing.
3 Testing of riveted joints.
4 Unsymmetrical Bending of a Beam
5 Determination of Shear Centre in open Section
6 Determination of Shear Centre in closed Section
7 Combined bending and Torsion of a Hollow Circular Tube
8 Constant Strength Beams
9 Wagner beam – Tension field beam
10 Material properties test of composite laminate

REFERENCES:

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

WEBLINKS:

COURSE OUTCOMES	
CO 1	**Demonstrate** structural mechanics principles/phenomenon using simple experiments. **(Manipulation)**
CO 2	**Observe** deformation of structural members or/and failure of materials under given loads. **(Imitation)**
CO 3	**Perform** comparative study between the obtained experimental results and theoretical values.**(Precision)**

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H - High; M - Medium; L – Low

1	COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
2	CO1	H								H	H				H
	CO2	H								H	H				H
	CO3	H								H	H				H
3	Category	Program Core (PC)													
4	Approval	48th Academic Council Meeting													

U18PCAS5L2	GAS DYNAMICS LABORATORY	L	T	P	C
	Total Contact Hours – 30	0	0	2	1
	Prerequisite – Aerodynamics; Co-requisite- Compressible flow				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To acquaint the student to the various experimental processes in supersonic flows					

LIST OF EXPERIMENTS

1. Exercise on setting up the shadowgraph system
2. Exercise on setting up the schlieren techniques
3. Demonstrate over Expanded jets by using schlieren techniques
4. Demonstrate under Expanded jets by using schlieren techniques
5. Demonstrate the effect of NPR for different level of expansion
6. Determine the factors affecting the pitot static tube in low and high speed condition
7. Calculate the total and static pressure at low speed condition by using pitot static tube
8. Calculate the total and static pressure at high speed condition by using pitot static tube
9. Determine the centerline decay of over expanded jets
10. Demonstrate the effects tabs on expansion jets by using schiliren techniques

REFERENCES:

1. Gas Dynamics Lab Manual, Department of Aeronautical Engineering, 2018

WEBLINKS:

https://nptel.ac.in/courses/112103021/

COURSE OUTCOMES	
CO 1	Carry out experimentation on high speed flows. .**(Precision)**
CO 2	Conduct pressure distribution experiments on models. **(Precision)**
CO 3	Demonstrate optical flow visualization pattern over the models **(Manipulation)**

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H - High; M - Medium; L – Low

1	COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
2	CO1	H				H				M	M				H
	CO2	H				H				M	M				H
	CO3	H				H				M	M				H
3	**Category**	**Program Core (PC)**													
4	**Approval**	**48th Academic Council Meeting**													

	FLIGHT SIMULATION LABORATORY	L	T	P	C
	Total Contact Hours – 30	**0**	**0**	**2**	**1**
U18PCAS5L3	Prerequisite – Introduction to Aerospace Engineering; Co-requisite – Aircraft Performance, Aircraft Stability and Control				
	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:

COURSE OUTCOMES	
CO 1	**Recognize** features of the flight simulator and observe basic operational procedure (pre-takeoff, takeoff and landing) for flying Cessna – 172 aircraft **(Understand).**
CO 2	**Identify** the basic aircraft instruments and their application during takeoff and landing **(Understand).**
CO 3	**Demonstrate** takeoff, autopilot and landing Cessna-172 **(Understand).**

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H - High; M - Medium; L – Low

1	**COs/ POs**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
2	CO1													L	L
	CO2													L	L
	CO3													L	L
3	**Category**	**Program Core (PC)**													
4	**Approval**	**48th Academic Council Meeting**													

SEMESTER VI

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

OBJECTIVES: To understanding the basic approaches in organization, to gain knowledge on theories of Personality and have clear sight on the decision Making in Groups, to analyze the behavior of individuals and groups in organizations in terms of the key factors that influence organizational behavior and to assess the potential effects of organizational - level factors (such as structure, culture and change) on organizational behavior.

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

WEBLINKS:

COURSE OUTCOMES (COs)	
CO1	**Identify** the frame work of Organizational Behaviour. **(Remember)**
CO2	**Infer** concepts of Interpersonal perception. **(Understand)**
CO3	**Compare** the Merits and Demerits of Group decision making. **(Understand)**
CO4	**Describe** the approach of leadership and Summarize the Sources of power. **(Remember)**
CO5	**Relate** change, conflict and culture of management. **(Understand)**

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H - High; M - Medium; L – Low															
1	**COs/ POs**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
2	CO1					H	H	H			H				
	CO2					H	H	H							
	CO3					H	H	H			H				
	CO4					H	H	H							
	CO5					H	H	H							
3	**Category**	**Humanities and Sciences (HS)**													
4	**Approval**	**48th Academic Council Meeting**													

U18PCAS601	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	**Compare** various functional approximation methods for structural problems. (**Understand**)
CO 2	**Calculate** the nodal field variables for one dimensional structure. (**Apply**)
CO 3	**Determine** the stiffness matrix and stress developed in two dimensional structures. (**Apply**)
CO 4	**Calculate** the nodal displacements and stress for axi-symmetric structures. (**Apply**)
CO 5	**Analyze t**he static and dynamic behavior of structures. (**Analyze**)

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H – High, M – Medium, L – Low

1	**COs/ POs**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
2	CO1	H									M				H
	CO2	H											M		H
	CO3	H											M		H
	CO4	H									M				H
	CO5	H				L									H
3	**Category**	**Program Core (PC)**													
4	**Approval**	**48th Academic Council Meeting**													

	HEAT TRANSFER	L	T	P	C
U18PCAS602	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Fundamentals of Aero – Thermodynamics, Fundamentals of 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. Lienhard J. H., “A Heat Transfer Text Book”, Phlogiston Press, U.S.A., 2008.
2. Ozisik M.N., “Heat Transfer A Basic Approach”, The McGraw-Hill Company, reprint 1995.
3. 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	Solve one dimensional heat conduction problems. **(Apply)**
CO 2	Determine heat transfer in unsteady conduction problems. **(Apply)**
CO 3	Calculate convective heat transfer coefficients for internal and external flows. **(Apply)**
CO 4	Discuss radiative heat transfer and different types of heat exchangers. **(Apply)**
CO 5	Solve heat transfer problems related to aerospace applications. **(Apply)**

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H – High, M – Medium, L – Low

1	**COs/ POs**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
2	CO1	L	H	M	L	H	L				H			M	
	CO2	L	H	M	L	H								M	
	CO3	L	H	M	L	H								M	
	CO4	L	H	M	L	H					H			M	
	CO5	L	H	M	L	H	L							M	
3	**Category**	**Program Core (PC)**													
4	**Approval**	**48th Academic Council Meeting**													

U18PCAS6L1	COMPUTER AIDED ANALYSIS LABORATORY	L	T	P	C
	Total Contact Hours – 30	0	0	2	1
	Prerequisite – Engineering Graphics & Design, Elements of Aerospace Structures, Aerodynamics; Co-requisite – Heat Transfer				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To acquaint the student with various computer software for engineering analysis					

LIST OF EXPERIMENTS

1. Steady state heat conduction analysis of a plate
2. Transient thermal analysis of a rod
3. 1D Structural analysis of 2D truss,
4. 2D Structural analysis a plate with a hole,
5. 3D Structural analysis of a beam with hole
6. Flow analysis over a flat plate
7. Flow analysis over a cylinder
8. Fluid flow over typical airfoil
9. Flow over a wing
10. Flow over a flexible wing and its deformation - one way FSI

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	**Carry out** modelling, meshing and pre-processing as per the problem statement**. (Manipulation)**
CO 2	**Acquire** data using the simulation tools from software**. (Manipulation)**
CO 3	**Perform** basic post-processing techniques and represent the results in form of graph and table **(Precision)**

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H - High; M - Medium; L – Low

1	COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
2	CO1	H		L		H				H	H		H	H	H
	CO2	H		L		H				H	H		H	H	H
	CO3	H		L		H				H	H		H	H	H
3	Category	Program Core (PC)													
4	Approval	48th Academic Council Meeting													

U18PCAS6L2	PROPULSION LABORATORY	L	T	P	C
	Total Contact Hours – 30	0	0	2	1
	Prerequisite – Aerodynamics, Air-breathing 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. Determination of velocity profile of free jet.
4. Supersonic Jet Pattern Analysis using Schlieren Technique.
5. Study of free convective heat transfer over a flat plate.
6. Study of forced convective heat transfer over a flat plate.
7. Operation of a subsonic Ramjet engine.
8. Determine the calorific value of Fuel using Bomb Calorimeter.

REFERENCES:

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

WEBLINKS:

COURSE OUTCOMES	
CO 1	**Demonstrate** the various procedures and techniques for the experiments. (**Manipulation**)
CO 2	**Observe** the data using the different measuring devices and techniques. (**Imitation**)
CO 3	**Follow** the mathematical concepts/equations to obtain quantitative results. (**Imitation**)

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H - High; M - Medium; L – Low

1	COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
2	CO1	H								H	H		M		M
	CO2	H								H	H		M		M
	CO3	H								H	H		M		M
3	Category	Program Core (PC)													
4	Approval	48th Academic Council Meeting													

	AIRCRAFT DESIGN PROJECT	L	T	P	C
	Total Contact Hours – 60	**0**	**0**	**4**	**2**
U18EEAS6L1	Prerequisite –Engineering Graphics & Design; Aircraft Performance, Aircraft Stability and Control				
	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 Selection of main parameters for the design
5 Preliminary and Secondary weight estimations.
6 Power plant selection and airfoil selection
7 Estimation of Drag Polar
8 Performance calculations and stability estimates
9 V – n diagram
10 Critical loading performance and final V – n graph calculation
11 Structural Design Study
12 Load estimation of wings and fuselage
13 Design of components of wings and fuselage
14 Balancing and maneuvering loads
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.
4. Analysis and Design of Flight Vehicle Structures, E F Bruhn

WEBLINKS:

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

COURSE OUTCOMES	
CO 1	**Follow** the design parameters of different airplane configurations **(Imitation)**
CO 2	**Carryout** weight estimation and performance parameter calculations **(Manipulation)**
CO 3	**Design** structural components of the aircraft **(Neutralization)**

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H - High; M - Medium; L – Low

1	COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
2	CO1	H	H	H		L				H	H		H		H
	CO2	H	H	H		L				H	H		H		H
	CO3	H	H	H		L				H	H		H		H
3	**Category**	**Program Core (PC)**													
4	**Approval**	**48th Academic Council Meeting**													

SEMESTER VII

	GUIDANCE AND CONTROL	L	T	P	C
U18PCAS701	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Basic Electricals and Electronics Engineering, Aircraft Stability and Control				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To provide the students the basic knowledge of guidance and control					

UNIT I INTRODUCTION 4

Introduction to Guidance and control - Definition, Historical background.

UNIT II AUGMENTATION SYSTEMS 7

Need for automatic flight control systems, Stability augmentation systems, control augmentation systems, Gain scheduling concepts.

UNIT III LONGITUDINAL AUTOPILOT 12

Displacement Autopilot-Pitch Orientation Control system, Acceleration Control System, Glide Slope Coupler and Automatic Flare Control and Flight path stabilization, Longitudinal control law design using back stepping algorithm.

UNIT IV LATERAL AUTOPILOT 10

Damping of the Dutch Roll, Methods of Obtaining Coordination, Yaw Orientation Control system, turn compensation, Automatic lateral Beam Guidance. Introduction to Fly-by-wire flight control systems, Lateral control law design using back stepping algorithm.

UNIT V MISSILE AND LAUNCH VEHICLE GUIDANCE 12

Operating principles and design of guidance laws, homing guidance laws- short range, Medium range and BVR missiles, Launch Vehicle- Introduction, Mission requirements, Implicit guidance schemes, Explicit guidance, Q guidance schemes.

TEXTBOOKS:

1. Blake Lock, J.H "Automatic control of Aircraft and missiles" John Wiley Sons, New York, 1990.

REFERENCES:

1. Stevens B.L & Lewis F.L, "Aircraft control & simulation"', John Wiley Sons, New York, 1992.
2. Collinson R.P.G, "Introduction to Avionics", Chapman and Hall, India, 1996.
3. Garnel.P. &East.D.J, "Guided Weapon control systems", Pergamon Press, Oxford, 1977.
4. Nelson R.C "Flight stability & Automatic Control", McGraw Hill, 1989.
5. Bernad Etikin, "Dynamic of flight stability and control", John Wiley, 1972.
6. Jan Roskam, "Airplane Performance, Stability and Control", DAR Corporation, 1997.

WEBLINKS:

COURSE OUTCOMES	
CO 1	**Explain** the equations governing the aircraft dynamics and the process of liberalizing them. **(Understand)**
CO 2	**Discuss** the guidance schemes and requirements for aircrafts and missiles. **(Understand)**
CO 3	**Apply** the principle of stability and control augmentation systems. **(Apply)**
CO 4	**Analyze** the oscillatory modes and methods of suppressing them. **(Analyze)**
CO 5	**Design** the controller for lateral, longitudinal and directional control of aircrafts. **(Create)**

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H - High; M - Medium; L – Low

1	**COs/ POs**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
2	CO1	H												H	H
	CO2	H									M			H	H
	CO3	H											M	H	H
	CO4	H				M								H	H
	CO5	H	L	L		M	L				M		M	H	H
3	**Category**	**Program Core (PC)**													
4	**Approval**	**48th Academic Council Meeting**													

	SATELLITE TECHNOLOGY	L	T	P	C
U18PCAS702	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Basic Electricals & Electronics Engineering, Applied Dynamics and Vibration				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To provide the students an understanding of different kinds of satellites, their design, dynamics and their components					

UNIT I INTRODUCTION TO SATELLITE SYSTEMS 9

Common satellite applications and missions – Typical spacecraft orbits – Definitions of spin the three axis stabilization -Space environment – Launch vehicles – Satellite system and their functions (structure, thermal, mechanisms, power, propulsion, guidance and control, bus electronics).

UNIT II SATELLITE DYNAMICS 9

Fundamental of satellite dynamics – Time and coordinate systems – Orbit determination and prediction – Orbital maneuvers – GPS systems and application for satellite/orbit determination – Ground station network requirements.

UNIT III SATELLITE STRUCTURES & THERMAL CONTROL 9

Satellite mechanical and structural configuration: Satellite configuration choices, launch loads, separation induced loads, deployment requirements – Design and analysis of satellite structures – Structural materials and fabrication – The need of thermal control: externally induced thermal environment – Internally induced thermal environment - Heat transfer mechanism: internal to the spacecraft and external heat load variations – Thermal control systems: active and passive methods.

UNIT IV SPACECRAFT CONTROL 9

Control requirements: attitude control and station keeping functions, type of control maneuvers – Stabilization schemes: spin stabilization, gravity gradient methods, 3 axis stabilization – Commonly used control systems: mass expulsion systems, momentum exchange systems, gyro and magnetic torque - Sensors star and sun sensors, earth sensor, magnetometers and inertial sensors

UNIT V POWER SYSTEM AND BUS ELECTRONICS 9

Solar panels: Silicon and Ga-As cells, power generation capacity, efficiency – Space battery systems – battery types, characteristics and efficiency parameters – Power electronics. Telemetry and telecommand systems: Tm & TC functions, generally employed communication bands (UHF/VHF, S, L, Ku, Kaetc), their characteristics and applications- Coding Systems – Onboard computer- Ground checkout Systems.

TEXTBOOKS:

1. Spacecraft Thermal Control, Hand Book, Aerospace Press, 2002.
2. Introduction Space Flight, Francis J. Hale Prentice Hall, 1994.

REFERENCES:

1. Analysis and Design of Flight Vehicle Structures, Tri-State off set company, USA, 1980.
2. Space Systems Engineering Rilay, FF, McGraw Hill, 1982.
3. Principles of Astronautics Vertregt. M., Elsevier Publishing Company, 1985
4 Space Communications Systems, Richard.F, FilipowskyEugen I Muehllorf Prentice Hall, 1995
5. Space Vehicle Design, Michael D. Griffin and James R. French, AIAAEducation Series, 1991.

WEBLINKS:
https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-851-satellite-engineering-fall-2003/

COURSE OUTCOMES	
CO 1	**Discuss** the basics of satellites and its system's functions. **(Understand)**
CO 2	**Describe** the fundamentals of orbital mechanics and the coordinate systems. **(Understand)**
CO 3	**Analyze** the satellite structures and thermal protection systems. **(Analyze)**
CO 4	**Express** the attitude controls and its stabilization schemes. **(Understand)**
CO 5	**Summarize** various types of power systems and bus electronics. **(Understand)**

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H - High; M - Medium; L – Low

1	COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
2	CO1	H												H	
	CO2	H									H			H	
	CO3	H												H	
	CO4	H									H			H	
	CO5	H												H	
3	**Category**	**Program Core (PC)**													
4	**Approval**	**48th Academic Council Meeting**													

U18PCAS7L1	SATELLITE DESIGN LABORATORY	L	T	P	C
	Total Contact Hours – 30	**0**	**0**	**2**	**1**
	Prerequisite – Basic Electricals and Electronics Engineering				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To help the student to understand the process of satellite design.					

LIST OF EXPERIMENTS

1 Introduction – Payload Specifications and Requirements
2 Study of Various Types of Sensors and Accessories in Nano Satellites
3 Cost Estimation and Feasibility Studies
4 Design and Fabrication of a Structural Framework for a Nano Satellites
5 Demonstration of Onboard GPS for recovery
6 Design of Communication System for Data Transfer
7 Design of Thermal Protection System
8 Design of Electro Magnetic Shield
9 Exercise on Selection of Appropriate Power Source and Distribution System
10 Assembling and Packing of Nano Satellite

REFERENCES:

1. Analysis and Design of Flight Vehicle Structures, Tri-State off set company, USA, 1980.
2. Space Systems Engineering Riley, FF, McGraw Hill, 1982.

WEBLINKS:

COURSE OUTCOMES	
CO 1	Perform investigation on accessories in nano satellites
CO 2	Design of satellite subsystems
CO 3	Demonstrate the systems in nano satellite

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H – High, M – Medium, L – Low

1	**COs/ POs**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
2	CO1	H				H				H				H	
	CO2	H				H				H				H	
	CO3	H				H				H				H	
3	**Category**	**Program Core (PC)**													
4	**Approval**	**48th Academic Council Meeting**													

	PROJECT PHASE I	L	T	P	C
	Total Contact Hours – 90	**0**	**0**	**6**	**3**
U18PRAS7P1	Prerequisite – Engineering Graphics & Design, Aerodynamics, Aircraft Structural Mechanics, Air-breathing Propulsion, Aerospace Materials, Compressible flow, Heat Transfer, Finite Element Analysis				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To acquaint the student with theoretical and experimental studies related to aerospace Engineering.
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	**Observe** the current market scenario to develop new or modify the existing product. **(Imitation)**
CO 2	**Build** a preliminary design of the prototype. **(Manipulation)**
CO 3	**Point out** the methodology for implementation of design. **(Manipulation)**

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H - High; M - Medium; L – Low

1	COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
2	CO1	H	H	H	H	H	H		H	H	H	H	H	H	H
	CO2	H	H	H	H	H	H		H	H	H	H	H	H	H
	CO3	H	H	H	H	H	H		H	H	H	H	H	H	H
3	**Category**	**Program Core (PC)**													
4	**Approval**	**48th Academic Council Meeting**													

SEMESTER VIII

	PROJECT PHASE II	L	T	P	C
U18PRAS8P2	Total Contact Hours – 270	0	0	18	9
	Prerequisite – Engineering Graphics & Design, Aerodynamics, Aircraft Structural Mechanics, Air-breathing Propulsion, Aerospace Materials, Compressible flow, Heat Transfer, Finite Element Analysis				
	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	**Tell** the value of achieving perfection in projects implementation & completion. **(Imitation)**
CO 2	**Build** the skills, competencies and point of view of designed concepts. **(Naturalization)**
CO 3	**Replicate** professional skills in Presentation, Technical report writing, critical thinking and decision making. **(Manipulation)**

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H - High; M - Medium; L – Low

1	COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO2
2	CO1	H	H	H	H	H	H		H	H	H	H	H	H	H
	CO2	H	H	H	H	H	H		H	H	H	H	H	H	H
	CO3	H	H	H	H	H	H		H	H	H	H	H	H	H
3	Category	Program Core (PC)													
4	Approval	48th Academic Council Meeting													

U18EEAS8C1	COMPREHENSION	L	T	P	C
	Total Contact Hours – 30	0	0	2	1
	Prerequisite – All the courses up to eighth semester				
	Course Designed by – Department of Aeronautical Engineering				

OBJECTIVES

1. To provide a complete review of Aerospace Engineering topics covered up to eighth semesters, so that a comprehensive understanding is achieved.

2. It will also help students to face job interviews, competitive examination and also to enhance the employment potential.

3. To provide overview of all topics covered and to assess the overall knowledge level up to eighth semester.

COURSE OUTCOMES	
CO 1	**Recollect** the core engineering concepts. **(Remember)**
CO 2	**Acquire** Presentation Skills to face job interviews. **(Apply)**
CO 3	**Write** competitive examinations for successful career. **(Apply)**

Mapping of Course Outcomes with Programme Outcomes (POs) CO/SO Mapping: H - High; M - Medium; L – Low

1	COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
2	CO1	H								H					
	CO2	H								H	M				
	CO3	H								H					
3	Category	Program Core (PC)													
4	Approval	48th Academic Council Meeting													

PROGRAM ELECTIVE I (PE I)

U18PEAS011	**SPACE MISSION DESIGN AND ANALYSIS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Introduction to Aerospace Engineering				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To make the students learn basics of Space Mission design process					

UNIT I SPACE MISSION DESIGN PROCESS 9

Classification of space missions – Low earth, Medium altitude, Geo-stationary, deep space, space mission life cycle, Mission objectives, identification of mission needs, requirements and constraints, mission characterization, mission evaluation, orbit and constellation design - Space Environment – peculiarities, survivability, selection of spacecraft material - Selection of launch system

UNIT II SPACECRAFT SYSTEM ENGINEERING 9

Spacecraft design and sizing, spacecraft payload design, spacecraft subsystems, functional requirement - Propulsion, attitude determination and control, power systems, thermal control, navigation and guidance, telemetry, tracking and command systems, ground system design

UNIT III GENERAL N-BODY PROBLEM 9

Relative Motion in the N-body Problem, Two body problem, orbit determination techniques, Kepler's equation, Lamberts problem - Restricted Three Body Problem – Lagrange points - Jacobi Integral, orbital perturbation

UNIT IV SATELLITE INJECTION AND REENTRY FLIGHT DYNAMICS 9

Launching of a satellite - General aspects of satellite Injections, launch vehicle ascent trajectories, injection parameters and orbital elements, launch vehicle performance, orbit deviations due to injection errors - Reentry flight dynamics – fundamentals of entry flight mechanics, fundamentals of entry heating, entry vehicle design, landing and recovery techniques

UNIT V INTERPLANETARY TRAJECTORIES 9

Patched Conic Approximation - Patched Conic Procedure - Sphere of Influence - Locating the Planets - Design of the Transfer Ellipse - Design of the Departure Trajectory - Design of the Arrival Trajectory - Gravity-Assist maneuver - Establishing Planetary Orbit – Motion of the Earth-Moon System - Time of Flight and Injection Velocity - Lunar Patched Conic

TEXTBOOKS:

1. Cornelisse, J.W, Schoyer H F R, and Wakker K F, "Rocket Propulsion and Space Dynamic", Pitman Publishing Co., 1979

REFERENCES:

1. Peter Fortescue, John Stark, Graham Swinerd, "Spacecraft systems engineering" Wiley 2004
2. Vincent N Pisacane, "Fundamentals of space system design" Oxford University Press, 2005
3. W J Larson and J R Wertz, "Space Mission Analysis and Design", Kluwer Academic Publishers, 1999.
4. Michael Griffin, "Space Vehicle Design", AIAA education series, 2004
5. Ashish Tewari, "Atmospheric and Space Flight Dynamics", Birkhauser, Boston, 2007

WEBLINKS:

COURSE OUTCOMES	
CO 1	**Estimate** the conceptual design parameters for space mission **(Evaluate)**
CO 2	**Calculate** detail design parameter for space vehicle design **(Analyze)**
CO 3	**Explain** N body problems and orbit parameters **(Analyze)**
CO 4	**Examine** the orbit parameter for satellite injection and predict the trajectory for re-entry vehicles **(Analyze)**
CO 5	**Plan** different orbit maneuvers for interplanetary mission **(Evaluate)**

U18PEAS012	SYSTEMS ENGINEERING	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Introduction to Aerospace Engineering				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To introduce the concepts related to system engineering and its significance with respect to aerospace systems.					

UNIT I INTRODUCTION 9

Overview, Systems definition and concepts, Conceptual system design, Systems thinking and Systems Engineering.

UNIT II DESIGN AND DEVELOPMENT 9

Detail Design Requirements, The Evolution of Detail Design, Design Data, Information, and Integration, Various phases in product life cycle, Systems verification & Integration

UNIT III DESIGN FOR OPERATIONAL FEASIBILITY 9

Design for Reliability, Maintainability, Usability, Sustainability and Affordability - Definition and Explanation, Measures, System Life Cycle cost, Analysis Methods, Practical considerations.

UNIT IV SYSTEMS ENGINEERING MANAGEMENT 9

Systems Engineering Planning and Organization, Systems Engineering Management Plan (SEMP), Program Leadership and Direction, Risk Management, Evaluation and Feedback.

UNIT V CASE STUDIES 9

Systems Integration -Aircraft Systems, Missile Systems, Satellite Systems-Launch Vehicle Systems and Radar, Design Drivers in the Project, Product, Operating Environment-Interfaces with the Subsystems

TEXTBOOKS:

1. Systems Engineering and Analysis by Benjamin S. Blanchard / WolterJ.Fabrycky, Prentice Hall, International Version 2010

REFERENCES:

1. Alexander Kossiakoff, William N. Sweet, Systems Engineering : Theory & Practice, John Wiley &Sons, 2002
2. James N. Martin, Systems Engineering Guidebook: A Process for Developing Systems and Products, CRC Press, 1997
3. Gandoff, M. (1990). Systems Analysis and Design
4. Andrew P Sage and James E Armstrong, Systems Engineering, Wiley Inter science publications, (2004)

WEBLINKS:

COURSE OUTCOMES	
CO 1	Explain the conceptual system design (Understand)
CO 2	Describe the stage s of product development (Understand)
CO 3	Observe the parameters influencing the design (Remember)
CO 4	Enumerate the factors related to systems engineering management(Remember)
CO 5	Appraise various systems and their processes, faults, rectifications etc through case studies.(Analyze)

	LAUNCH VEHICLE AERODYNAMICS	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
U18PEAS013	Prerequisite – Aerodynamics; Co-requisite- Compressible Flow, Rocket Propulsion				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To acquaint the students with the fundamentals of the aerodynamics of launch vehicles					

UNIT I BASICS OF HIGH SPEED AERODYNAMICS 9

Compressible flows -Isentropic relations-mathematical relations of flow properties across shock and expansion waves-fundamentals of Hypersonic Aerodynamics

UNIT II BOUNDARY LAYER THEORY 9

Basics of boundary layer theory-compressible boundary layer-shock shear layer interaction - Aerodynamic heating-heat transfer effects

UNIT III LAUNCH VEHICLE CONFIGURATIONS AND DRAG ESTIMATION 9

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

UNIT IV AERODYNAMICS OF SLENDER AND BLUNTBODIES 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 V AERODYNAMIC ASPECTS OF LAUNCHING PHASE 9

Booster separation-crosswind effects-specific consideration sin missile launching-missile integration and separation-methods of evaluation and determination -Stability and Control Characteristics of Launch Vehicle Configuration-Wind tunnel tests –Comparison with CFD Analysis.

TEXTBOOKS:

1. Anderson, J.D., “Fundamentals of Aerodynamics”, McGraw-Hill BookCo. NewYork, 2010. (Units 1 & 2)
2. Chin SS, Missile Configuration Design, McGrawHill, New York, 1961. (Unit 3)
3. Anderson, J.D., “Hypersonic and High Temperature Gas Dynamics”, AIAA Education Series.(Units 4 & 5)

REFERENCES:

1. Nielson, Jack N, Stever, Gutford, “Missile Aerodynamics”, McGraw Hill, New York, 1960.
2. Anderson Jr.,D.,–“Modern compressible flows”, McGraw-Hill BookCo.,NewYork1999.
3. Charles D.Brown, “Spacecraft Mission Design”, AIAA Education Series, Published by AIAA, 1998
4. Elements of Space Technology for Aerospace Engineers”, Meyer Rudolph X, Academic Press,1999

WEBLINKS:

COURSE OUTCOMES	
CO 1	Explain the effect of shock wave formation in supersonic and hypersonic speed **(Analyze)**
CO 2	Determine the shock boundary layer and interaction and viscosity effects on high speed condition **(Analyze)**
CO 3	Choose proper design parameter and calculate the aerodynamic characteristics of Launch vehicle **(Evaluate)**
CO 4	Examine the interference effects on different configuration and analyze the aero elastic phenomena **(Analyze)**
CO 5	Evaluate the stability characteristics of launch vehicle at different environmental condition **(Evaluate)**

U18PEAS014	BOUNDARY LAYER THEORY	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Aerodynamics; Co-requisite- Compressible Flow				
	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	
CO1	**Examine** the boundary layer character tics based on viscous effect **(Apply)**
CO 2	**Analyze** the boundary layer effect on different geometry **(Analyze)**
CO 3	**Calculate** the laminar boundary layer thickness by using various methods **(Analyze)**
CO 4	**Estimate** the thickness of turbulent boundary layer on flat plate, pipes and wall **(Analyze)**
CO 5	**Examine** the compressibility effect on boundary layer **(Apply)**

PROGRAM ELECTIVE II (PE II)

U18PEAS021	**THEORY OF ELASTICITY**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Aerospace Structural Mechanics				
	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.

WEBLINKS:

COURSE OUTCOMES	
CO 1	**Determine** the states of stress and strain at a point in the body. (**Apply**)
CO 2	**Compute** field variables under plane stress/stress conditions. (**Apply**)
CO 3	**Compute** field variables for cylindrical co-ordinate problems. (**Apply**)
CO 4	**Produce** analytical solutions for non-circular torsional problems. (**Apply**)
CO 5	**Explain** the fundamentals of stress analysis of plates and shells. **(Apply)**

U18PEAS022	**MANNED SPACE MISSIONS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Introduction to Aerospace Engineering				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To acquaint the students with the basic requirements and mission planning for manned space missions.					

UNIT I INTRODUCTION 9

The physics of space - Current missions: space station, Moon mission, and Mars missions - Engineering challenges on Manned vs. unmanned missions - Scientific and technological gains from space programs - Salient features of Apollo and Space station missions – space shuttle mission

UNIT II EFFECT OF SPACE ENVIRONMENT 9

Atmosphere: Structure and Composition - - Atmosphere: Air Pressure, Temperature, and Density - Atmosphere: Meteoroid, Orbital Debris & Radiation Protection - Human Factors of Crewed Spaceflight,Safety of Crewed Spaceflight - Magnetosphere - Radiation Environment: Galactic Cosmic Radiation (GCR), Solar Particle Events (SPE) - Radiation and the Human Body – Impact of microgravity and g forces on humans – space adaptation syndrome.

UNIT III LIFE SUPPORT SYSTEMS 9

Life Support Systems and Space Survival Overview - - Environment Controlled Life Support Systems - Human / Machine Interaction - - Human Factors in Control Design – Crew Accommodations

UNIT IV MISSION PLANNING 9

Ground Communication and Support - Space Resources and Mission Planning - Space Mission Design: Rockets and Launch Vehicles - Orbital Selection and Astrodynamics, Entry, Descent, Landing, and Ascent, Designing and Sizing Space elements, Transfer, Entry, Landing, and Ascent Vehicles, Designing, Sizing, and Integrating a Surface Base, Planetary Surface Vehicles

UNIT V SPACECRAFT SUBSYSTEMS 9

Spacecraft Subsystems: Space Operations - Space Architecture, Attitude Determination and Control - Designing Power Systems - Extravehicular Activity Systems - Space Robotics – Mission Operations for Crewed Spaceflight - Command, Control, and Communications Architecture

TEXTBOOKS:

1. Larson, W. J. and Pranke, L. K., Human Spaceflight: Mission Analysis and Design, McGrawHill Higher Education, Washington, DC , 1999

REFERENCES:

1. Connors, M.M., Harrison, A.A., and Akins, F.R. 2005. Living Aloft: Human Requirements for Extended Spaceflight, University Press of the Pacific,Honolulu, Hawaii: ISBN: 1-4102-1983-6
2. Eckart, P. 1996. Spaceflight Life Support and Biospherics.
3. McNamara, Bernard. 2000. Into the Final Frontier: The Human Exploration of Space. (Brooks Cole Publishing.)

WEBLINKS:

COURSE OUTCOMES	
CO 1	Identify the basics of manned space missions (Remember)
CO 2	Describe the effect of space environment on spacecraft and living things(Understand)
CO 3	Generalize the various life support systems necessary for manned space missions (Understand)
CO 4	Sketch various plans for space missions (Apply)
CO 5	Explain the different subsystems of a spacecraft (Understand)

U18PEAS023	ELECTRIC PROPULSION	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Rocket Propulsion				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To introduce basic physics of electric propulsion systems.					

UNIT I INTRODUCTION TO THE BASIC PHYSICS OF ELECTRIC PROPULSION SYSTEMS 8

Historical outline - Definition of Electric Propulsion - High impulse Space Missions - Exhaust velocity and specific impulse - Power supply penalty – Electric charges and Electrostatic fields - Currents and Magnetic interactions - Time dependent fields and Electromagnetic wave propagation - Application to ionized gas flows

UNIT II PHYSICS OF IONIZED GASES 12

Atomic structure of gases - Ionization processes - Particle collisions in an ionized gas - Electrical conductivity of an ionized gas - Kinetic Theory

UNIT III ELECTRO-THERMAL PROPULSION 9

One dimensional model - Enthalpy of high temperature gases - Frozen flow efficiency - Resistojets - Electrical discharges - Arcjets - Operation and Analysis - Materials - Advantages and Disadvantages

UNIT IV ELECTROMAGNETIC PROPULSION 9

The Lorentz force - Magnetogasdynamics channel flow - Ideal steady flow acceleration - Thermal and viscous losses - Geometry considerations - Self induced fields - Sources of the conducting gas - The magneto plasmadynamic arc - Magneto- plasmadynamic (MPD) thrusters - Pulsed plasma acceleration - Pulsed plasma thrusters (PPT) - Quasi steady acceleration - Pulsed inductive acceleration - Traveling wave acceleration

UNIT V ELECTROSTATIC PROPULSION 7

One dimensional space-charge flows - Basic relationships - The acceleration- deceleration concept - Ion engines - Design and Performance - Hall effect – Hall thrusters - Field emission electric propulsion (FEEP) - Colloid thrusters

TEXTBOOKS:

1. Robert G. Jahn, “Physics of Electric Propulsion”, McGraw-Hill Series, New York, 1968.

REFERENCES:

1. George W. Sutton, “Engineering Magneto hydrodynamics”, Dover Publications Inc., New York, 2005 2. George P. Sutton & Oscar Biblarz, “Rocket Propulsion Elements, John Wiley & Sons Inc., New York, 8th Edition, 2010.

WEBLINKS:

https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-522-space-propulsion-spring-2015/

COURSE OUTCOMES	
CO 1	**Identify** the different types of electric propulsion techniques (**Understand**)
CO 2	**Discuss** the concept of electrical conductivity of an ionized gas (**Understand**)
CO 3	**Describe** the operation of electro thermal thrusters (**Understand**)
CO 4	**Identify** the rocket thrusters based on electromagnetic propulsion **(Understand)**
CO 5	**Explain** the design and performance of electrostatic thrusters **(Understand)**

	SPACECRAFT POWER SYSTEMS	L	T	P	C
U18PEAS024	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Basic Electrical and Electronics Engineering				
	Course Designed by – Department of Aeronautical Engineering, Introduction to Aerospace Engineering				
OBJECTIVE: The students will understand the advanced concepts of Spacecraft power systems, its elements, energy storage technology, power convertors and power distribution.					

UNIT I SPACECRAFT ENVIRONMENT & DESIGN CONSIDERATION 9

Orbit definition /Mission Requirements of LEO, GEO, GTO & HEO, Lunar orbits, IPO with respect to Power Generation – Power System Elements - Solar aspect angle Variations

UNIT II POWER GENERATION 9

Study of Solar spectrum - Solar cells - Solar Panel design - Solar Panel Realization – Solar Panel testing - Effects of Solar cells and panels (IR, UV, Particles)

UNIT III ENERGY STORAGE TECHNOLOGY 9

Types of batteries – Primary & Secondary batteries - Nickel Cadmium - Nickel-Hydrogen – Nickel metal hydride - Lithium-ion –Lithium Polymer - Silver Zinc– Electrical circuit model – Performance characteristics of batteries - Application of batteries in launch vehicles and satellites – Fuel Cell – Polymer Electrolyte membrane Fuel Cell – Regenerative Fuel Cell

UNIT IV POWER CONVERTERS 9

DC – DC converters – Basic Convertors - Buck, Boost, Buck- boost converter –Derived converters: Fly back converter – Transformer coupled forward converter – Push-Pull converter - CUKs convertor– Resonant converter – Voltage and current regulators

UNIT V POWER CONTROL, CONDITIONING AND DISTRIBUTION 9

Solar Array Regulators – Battery changing schemes – Protection Schemes - Distribution – Harness - Thermal Design - EMI/EMC/ESD/Grounding schemes for various types of circuits and systems

TEXTBOOKS:

1. Patel, Mukund R, 'Spacecraft Power Systems' CRC Press Boca Raton, 2005

REFERENCES:

1. Hyder, A k et.al, 'Space Power Technologies' Imperial College Press London,2000
2. Fortescue, Peter et.al, 'Spacecraft Systems Engineering' John Wiley England,2003.
3. P R K Chetty, 'Spacecraft Power Systems', 1978.

WEBLINKS:

COURSE OUTCOMES	
CO 1	Recall the concepts of orbits in space(Remember)
CO 2	Discuss the techniques involved in solar panels (understand)
CO 3	Classify the types of power storage systems in space applications(Understand)
CO 4	List the efficient power convertors for space applications (Remember)
CO 5	Describe the schemes involved in power conversion and distribution(Understand)

PROGRAM ELECTIVE (PE) III

U18PEAS031	**HYPERSONIC AERODYNAMICS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Aerodynamics, Compressible flow				
	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	**Recall** the concepts of compressible flows and differentiate between supersonic and hypersonic flows. **(Remember)**
CO 2	**Discuss** simple solution methods of hypersonic inviscid flows. **(Understand)**
CO 3	**Discuss** the basics of viscous hypersonic flows. **(Understand)**
CO 4	**Describe** the shock shear layer interaction in hypersonic flows. **(Understand)**
CO 5	**Discuss** basics of high temperature flows. **(Understand)**

	VIBRATIONS AND ELEMENTS OF AERO ELASTICITY	L	T	P	C
U18PEAS032	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Applied Dynamics and Vibration				
	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	**Review** free, damped and forced vibrations of the single degree of freedom systems and **discuss** the vibration measuring instruments **(Understand)**.
CO 2	**Develop** equation of motion for multi degree of freedom systems and **explain** the concept of Eigen value problems along with principal modes of vibrations **(Apply).**
CO 3	**Connect** vibrations of discrete systems to the vibrations of continuous systems **(Analyze).**
CO 4	**Discuss** approximate methods for analyzing vibration problems **(Understand).**
CO 5	**Explain** the basic concepts of aero elasticity and **discuss** wing divergence & flutter **(Apply).**

	SPACE VEHICLE DESIGN	L	T	P	C
U18PEAS033	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Introduction to Aerospace Engineering, Aerospace Structural Mechanics				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To introduce to the student about the design of a space vehicle					

UNIT I FUNDAMENTAL ASPECTS OF SPACE SYSTEMS ENGINEERING 9

Space Systems Engineering – Definition, Requirements of Systems Engineering, Design Team, Tradeoffs, Top level requirements, Functional requirements, Functional Block diagram, Tradeoff analysis, Communication Systems and Power systems, Technology Tradeoffs

UNIT II SPACE MISSIONS 9

Space Missions - Low Earth Orbit, Flight Tests, Earth Observation, Space observation, Medium Altitude Earth Orbit, Geosynchronous Earth Orbit, Communications Satellites, Weather satellites, Lunar and Deep space missions – Inner and outer planetary missions, Observation of small bodies – comets and asteroids, Orbit Design Considerations, Advanced Mission concepts-Large Space structures, Space stations, space colonies, Use of lunar and asteroid materials, Nuclear waste disposal

UNIT III ENVIRONMENTAL CONSTRAINTS 9

Natural and Manmade environments, Earth environment – corrosion due to humidity, Clean room, problems in transporting, Launch environment, Shuttle Vibration, Atmospheric environment – wind shear constraint, density shear, Effect of Polar mesospheric clouds during re – entry, Space and Upper Atmosphere environment – Effect of vacuum on materials, Space plasma and spacecraft charging, Magnetic field, Weightlessness and microgravity, Radiation – Van Allen Radiation belt, Micrometeoroids, Orbital debris, Thermal environment

UNIT IV LAUNCH VEHICLE SELECTION AND ATMOSPHERIC ENTRY 9

Solid vs Liquid propellant, Hybrid propulsion, Space shuttle payload accommodations, expendable launch vehicles, Atmospheric entry – Requirements, fundamentals of entry flight mechanics, ballistic entry, gliding entry, skip entry, Cross-Range entry, Entry heating, free molecular heating, Thermal protection, Entry vehicle design

UNIT V STRUCTURAL DESIGN CONSIDERATIONS 9

Vehicle center of mass, Vehicle moment of inertia, structural loads, load alleviation, modal analysis, fracture mechanics, stress levels and safety factors, large structures, structural materials, films and fabrics

TEXTBOOKS:

1. Michael D. Griffin and James R. French, “Space Vehicle design” AIAA Education Series, Second Edition, 2004

REFERENCES:

1. Nickolay Zosimovych, “Commercial Launch Vehicle Design”, LAP LAMBERT Academic Publishing , 2016

WEBLINKS:

COURSE OUTCOMES	
CO 1	**Describe** the fundamentals of space systems. (**Understand**)
CO 2	**Demonstrate** various space mission program. (**Understand**)
CO 3	**Examine** the challenges in space environment. (**Apply**)
CO 4	**Classify** the method of selection to launch vehicle and methods for re-entry.(**Understand**)
CO 5	**Determine** the structural parameters in space system design. (**Apply**)

U18PEAS034	SOLAR THERMAL ENERGY	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Heat Transfer				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To learn the basics of solar thermal energy					

UNIT I INTRODUCTION 9

Introductory aspects of non-renewable and renewable energy sources – fundamentals of thermal radiation – resource assessment – solar radiation concepts – solar-earth geometry – models to predict global and daily and hourly irradiation.

UNIT II SOLAR COLLECTION THEORY AND TECHNOLOGIES 8

Heat transfer in solar collectors – basic modeling aspects – steady and dynamic analysis – performance parameters.

UNIT III SOLAR CONCENTRATION SYSTEMS AND RECEIVERS 10

Overview and introduction to concentration optics – concentration ratio and thermodynamic maximum – linear concentration: trough and linear Fresnel – point concentration: dish and tower (central receiver system).

UNIT IV SOLAR POWER GENERATION SYSTEMS 9

Overview and types of systems – components and sub systems – aspects of design and performance prediction.

UNIT V THERMAL STORAGE AND SOLAR COOLING 9

Need for thermal storage – methods – simple models for thermal storage - solar liquid absorption and solar solid sorption technologies

TEXTBOOKS:

1. Boyle, G., Renewable Energy: Power for a Sustainable Future, 3rd ed., Oxford Univ. Press (2012).

REFERENCES:

1. Duffie, J. A. and Beckman, W. A., Solar Engineering of Thermal Processes, John Wiley (1991).
2. Sukhatme, S. P. and Nayak, J. K., Solar Energy: Principles of Thermal Collection and Storage, 3rd ed., McGraw-Hill (2009).

WEBLINKS:

COURSE OUTCOMES	
CO 1	Describe the different techniques to extract energy form the sun. (Understand)
CO 2	Discuss the modeling and analysis of solar collectors. (Understand)
CO 3	Explain the principle, working methodology for solar concentrators and receivers. (Understand)
CO 4	Classify solar power generation systems based on efficiencies. (Understand)
CO 5	Identify the models for thermal storage and cooling systems. (Understand)

PROGRAM ELECTIVE (PE) IV

U18PEAS041	**INTRODUCTION TO COMBUSTION**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Air-breathing Propulsion, Heat Transfer				
	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	**Explain** thermo chemical reaction associated with combustion process and the various parameters affecting burning velocity. **(Understand)**
CO 2	**Select** apt fuel for optimum combustion in piston engines. **(Analyze)**
CO 3	**Compare** the ramjet and gas turbine combustion chamber design. **(Understand)**
CO 4	**Analyze** the challenges associated with supersonic combustion. **(Analyze)**
CO 5	**Discuss** combustion process in solid, liquid propellant rockets and hybrid rockets. **(Understand)**

U18PEAS042	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. Timoshenko, S.P. and Gere, J.M., Theory of Elastic Stability, McGraw Hill Book Co.1986.
2. Harry Kraus, 'Thin Elastic Shells', John Wiley and Sons, 1987.
3. Llyod Hamilton, Donald, "Beams, Plates and Shells", McGraw Hill, 1976.
4. Ansel Ugural, Stresses in Plates & Shells, McGraw Hill, 1981
5. Reddy.J.N., "Theory & Analysis of Elastic Plates", CRC, I Edition, 1999

WEBLINKS:

COURSE OUTCOMES	
CO 1	**Explain** the classical plate theory subjected to Axi-symmetric loading. **(Understand)**
CO 2	**Use** Navier's method and Levy's method to obtain solution for rectangular plates under different boundary conditions. **(Apply)**
CO 3	**Illustrate** the stability and free vibration analysis of rectangular plates. **(Understand)**
CO 4	**Apply** various approximate methods on rectangular plates for stability analysis. **(Apply)**
CO 5	**Describe** the concepts of shell type structures and bending theories for circular cylindrical shells. **(Understand)**

U18PEAS043	**SPACECRAFT ATTITUDE DYNAMICS AND CONTROL**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Introduction to Aerospace Engineering; Co-requisite – Guidance and Control, Satellite Technology				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To familiarize the student with the basics of spacecraft attitude dynamics and control					

UNIT I ATTITUDE SENSORS 8

Relative Attitude sensors – Gyroscopes, Motion reference Units, Absolute Attitude sensors – Horizon sensor, Orbital Gyrocompass, Earth sensors, sun sensors (Digital and analog), star sensor- Magnetometer

UNIT II CONTROL ACTUATORS 9

Fundamental principles of operation of Thrusters- Momentum Wheel-Control Moment Gyros Reaction wheel- Magnetic Torques- Reaction Jets- Ion Propulsion- Electric propulsion- solar sails

UNIT III ATTITUDE DYNAMICS, ATTITUDE AND ORBITAL DISTURBANCES 9

Rigid Body Dynamics - Flexible body Dynamics - Slosh Dynamics- disturbing forces due to Drag, Solar radiation Pressure and forces - Disturbances due to Celestial bodies

UNIT IV ATTITUDE STABILIZATION SCHEMES & ORBIT MANEUVERS 10

Spin, Dual spin - Gravity gradient - Zero momentum system - Momentum Biased system - Reaction control system - Single and Multiple Impulse orbit Adjustment - Hohmann Transfer Station Keeping and fuel Budgeting

UNIT V MISSILE AND LAUNCH VEHICLE GUIDANCE 9

Operating principles and design of guidance laws - homing guidance laws- short range - Medium range and BVR missiles - Launch Vehicle- Introduction - Mission requirements- Implicit guidance schemes - Explicit guidance - Q guidance schemes

TEXTBOOKS:

1. Marcel J. Sidi, “Spacecraft Dynamics and control, A Practical Engineering Approach”, Cambridge University Press.2000

REFERENCES:

1. James R Wertz, Spacecraft Attitude Determination and control, Reidel Publications.2001.
2. Vladimir A Chobotov,”Spacecraft Attitude Dynamics and Control (Orbit)”, Krieger Publishing Company Publishers, 1991.
3. Blake Lock, J.H ‘Automatic control of Aircraft and missiles ‘, John Wiley Sons, New York, 1990.
4. Meyer Rudolph X, Elements of Space Technology for Aerospace Engineers”, Academic Press, 1999
5. Kaplan M, “Modern Spacecraft Dynamics and control”, Wiley Press, 1979.

WEBLINKS:

https://onlinecourses.nptel.ac.in/noc19_ae04

COURSE OUTCOMES	
CO 1	Describe the sensors used in spacecraft to determine the attitude (Understand)
CO 2	Classify the different types of control actuators (Understand)
CO 3	Discuss the reasons behind orbital / attitude disturbances (Understand)
CO 4	Establish relevant equations for stabilization systems (Apply)
CO 5	Compare missile guidance and control methods (Understand)

U18PEAS044	HIGH TEMPERATURE GAS DYNAMICS	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Aerodynamics, Compressible Flow				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To enable the student to understand about the basics of high temperature gas flows					

UNIT I INTRODUCTION 8

Nature of high temperature flows – Chemical effects in air – Real perfect gases – Gibb's free energy and entropy by chemical and non-equilibrium – Chemically reacting mixtures and boundary layers.

UNIT II STATISTICAL THERMODYNAMICS 8

Introduction to statistical thermodynamics – Relevance to hypersonic flow - Microscopic description of gases – Boltzmann distribution – Cartesian function

UNIT III KINETIC THEORY AND HYPERSONIC FLOWS 9

Chemical equilibrium calculation of equilibrium composition of high temperature air – equilibrium properties of high temperature air – collision frequency and mean free path – velocity and speed distribution functions.

UNIT IV INVISCID HIGH TEMPERATURE FLOWS 10

Equilibrium and non – equilibrium flows – governing equations for inviscid high temperature equilibrium flows – equilibrium normal and oblique shock wave flows – frozen and equilibrium flows – equilibrium conical and blunt body flows – governing equations for non-equilibrium inviscid flows.

UNIT V TRANSPORT PROPERTIES IN HIGH TEMPERATURE GAS 10

Transport coefficients – mechanisms of diffusion – total thermal conductivity – transport characteristics for high temperature air – radiative transparent gases – radiative transfer equation for transport, absorbing and emitting and absorbing gases

TEXTBOOKS:

1. "Ethirajan Rathakrishnan", "High Enthalpy Gas Dynamics", John Wiley and Sons, 2017

REFERENCES:

1. John D. Anderson, Jr., Hypersonic and High Temperature Gas Dynamics, McGraw-Hill Series, New York, 1996.
2. John D. Anderson, Jr., Modern Compressible Flow with Historical perspective McGraw Hill Series, New York, 1996.
3. William H. Heiser and David T. Pratt, Hypersonic Air breathing propulsion, AIAA Education Series.
4. John T. Bertin, Hypersonic Aerothermodynamics publishers - AIAA Inc., Washington, D.C., 1994.
5. .K.Bose, High Temperature Gas Dynamics

WEBLINKS:

https://engineering.purdue.edu/ProEd/courses/molecular-gas-dynamics

COURSE OUTCOMES	
CO 1	**Review** the types of compressible flow. (**Understand**)
CO 2	**Explain** the relevance of statistical thermodynamics to high temperature flows(**Understand**)
CO 3	**Determine** the collision frequencies of molecules at high temperature. (**Apply**)
CO 4	**Describe** the governing equations of the inviscid and viscid high temperature flows. (**Understand**)
CO 5	**Discuss** the diffusion and radiative properties in high temperature flows. (**Understand**)

PROGRAM ELECTIVE (PE) V

U18PEAS051	**SPACE FLIGHT MECHANICS**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Introduction to Aerospace Engineering				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To introduce to the student about the basic concepts in space mechanics and about the laws that govern motion in space					

UNIT I BASIC CONCEPTS AND THE GENERAL N- BODY PROBLEM 10

The solar system – reference frames and coordinate systems – terminology related to the celestial sphere and its associated concepts – Kepler's laws of planetary motion and proof of the laws – Newton's universal law of gravitation - the many body problem- Lagrange-Jacobi identity – the circular restricted three body problem – libration points – the general N-body problem two body problems – relations between position and time.

UNIT II SATELLITE INJECTION AND SATELLITE PERTURBATIONS 9

General aspects of satellite injection – satellite orbit transfer – various cases – orbit deviations due to injection errors – special and general perturbations – Cowell's method and Encke's method – method of variations of orbital elements – general perturbations approach.

UNIT III INTERPLANETARY TRAJECTORIES 9

Two-dimensional interplanetary trajectories – fast interplanetary trajectories – three dimensional interplanetary trajectories – launch of interplanetary spacecraft – trajectory estimation about the target planet – concept of sphere of influence – Lambert's theorem

UNIT IV BALLISTIC MISSILE TRAJECTORIES 9

Introduction to ballistic missile trajectories – boost phase – the ballistic phase – trajectory geometry – optimal flights – time of flight – re-entry phase – the position of impact point – influence coefficients.

UNIT V MATERIALS FOR SPACECRAFT 8

Space environment – peculiarities of space environment – effect of space environment on materials of spacecraft structure – materials required for the construction of space craft – TPS for re-entry space vehicles.

TEXTBOOKS:

1. Cornelisse, J.W., "Rocket Propulsion and Space Dynamics", J.W. Freeman &Co., Ltd, London, 1982

REFERENCES:

1. Sutton, G.P., "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 7th Edition, 2001.
2. Parker, E.R., "Materials for Missiles and Spacecraft", McGraw Hill Book Co. Inc., 1982.

WEBLINKS:

https://online.stanford.edu/courses/aa279a-space-mechanics

COURSE OUTCOMES	
CO 1	Describe n-body problem with terminologies. (Understand)
CO 2	Discuss the methods for satellite injection, parking and transfer orbits. (Understand)
CO 3	Examine the interplanetary trajectories for manned and unmanned missions to other planets (Apply)
CO 4	Explain the need and importance of trajectory for ballistic missiles (Analyze)
CO 5	Interpret the effect of space environment on materials (Understand)

U18PEAS052	EXPERIMENTAL STRESS ANALYSIS	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 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.
2. James W. Dally, William F. Riley" Experimental Stress Analysis", McGraw Hill Education; 1991

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	**Describe** the working principle of different extensometers and their uses. **(Understand)**
CO 2	**Compute** the strain in loaded structures based on measurement of change in resistance using strain gauges. (**Apply**)
CO 3	**Discuss** the techniques used for determination of stress in photo elastic materials. **(Understand)**
CO 4	**Explain** the concepts of more technique and brittle coating techniques. **(Understand)**
CO 5	**Describe** the different type of NDT methods. **(Understand)**

U18PEAS053	AUTOMATIC CONTROL	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Basic Electrical and Electronics and Engineering; Co-requisite – Guidance and Control				
	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	**Analyze** mathematical model for mechanical and Electrical systems. **(Analyze)**
CO 2	**Analyze** time response of the system with various test inputs and steady state errors. (**Analyze**)
CO 3	**Analyze** the frequency response of the system and correlate frequency - time domain specifications. (**Analyze**)
CO 4	**Predict** the stability of the system using Root Locus and Routh Hurwitz stability criterion. (**Evaluate**)
CO 5	**Discuss** the basic components of Digital Control System. **(Understand)**

U18PEAS054	COMPUTATIONAL FLUID DYNAMICS	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – 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:

https://onlinecourses.nptel.ac.in/noc16_ch02

COURSE OUTCOMES	
CO 1	**Describe** governing equations of fluid dynamics. (**Understand**)
CO 2	**Apply** appropriate Finite Difference Method and Finite Volume Method for solving diffusion problems. (**Apply**)
CO 3	**Analyze** various explicit and implicit schemes in Finite Volume Method for solving one dimensional convection diffusion problems. (**Analyze**)
CO 4	**Identify** suitable turbulence model for fluid flow problems. (**Understand**)
CO 5	**Analyze** Computational Fluid Dynamics problems by using packages and programming software. (**Analyze**)

PROGRAM ELECTIVE (PE) VI

U18PEAS061	**CRYOGENIC ROCKET PROPULSION**	**L**	**T**	**P**	**C**
	Total Contact Hours – 45	**3**	**0**	**0**	**3**
	Prerequisite – Rocket Propulsion, Heat Transfer				
	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	**Discuss** the basic components of cryogenic systems. **(Understand)**
CO 2	**Explain** the types of cryogenic propellant used and their storage and handling. **(Understand)**
CO 3	**Discuss** cryo equipment and accessories of cryogenic engine system. **(Understand)**
CO 4	**Discuss** various subsystem involved in the operation of cryogenic engine and their design aspects. **(Understand)**
CO 5	**Discuss** the challenges in cryogenic rocket technology. **(Understand)**

U18PEAS062	HIGH TEMPERATURE MATERIALS	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Aerospace Materials				
	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	**Discuss** the effect of creep on the functional life of components. **(Understand)**
CO 2	**Explain** the creep resistance of ductile and brittle materials. **(Understand)**
CO 3	**Describe** the effect of different alloys and oxides materials behavior from low temperature to high temperature**. (Understand)**
CO 4	**Discuss** the fracture mechanism maps for different alloys and oxides**. (Understand)**
CO 5	**Describe** the process of oxidation and different oxidations prevention techniques. **(Understand)**
CO 6	**Discuss** the various types of super alloys and its strengthening mechanisms. **(Understand)**

	STRUCTURAL DYNAMICS	L	T	P	C
	Total Contact Hours – 45	3	0	0	3
U18PEAS063	Prerequisite – Applied Dynamics and Vibration, Elements of Aerospace Structures				
	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

WEBLINKS:

COURSE OUTCOMES	
CO 1	**Review** stiffness and flexibility method of structural analysis (**Understand)**
CO 2	**Describe** the significance of dynamic loading and **solve** forced vibrations of finite degree of freedom systems (**Apply**).
CO 3	**Explain** modal analysis of multiple degree of freedom systems (**Analyze**).
CO 4	**Apply** energy methods to solve beam and plate vibrations problems under dynamics loads (**Apply**).
CO 5	**Evaluate** dynamic response of continuous systems using approximate methods (**Analyze**)

	HIGH TEMPERATURE PROBLEMS IN AEROSPACE STRUCTURES	L	T	P	C
U18PEAS064	Total Contact Hours – 45	3	0	0	3
	Prerequisite – Aerospace Structural Mechanics, Heat Transfer				
	Course Designed by – Department of Aeronautical Engineering				
OBJECTIVE: To study the effect of Temperature effects in aerospace applications.					

UNIT I TEMPERATURE EQUATIONS & AERODYNAMIC HEATING 9

For condition, radiation and convection – Fourier's equation – Boundary and initial conditions – One-dimensional problem formulations – Methods and Solutions. Heat balance equation for idealised structures – Adiabatic temperature – Variations – Evaluation of transient temperature.

UNIT II THERMAL STRESS ANALYSIS 9

Thermal stresses and strains – Equations of equilibrium – Boundary conditions – Thermoelasticity – Two dimensional problems and solutions – Airy stress function and applications.

UNIT III THERMAL STRESS IN BEAMS, TRUSSES AND THIN CYLINDERS 9

Thermal stresses in axially loaded members, beams with varying cross sections. Effect of temperature in thin cylinders.

UNIT IV THERMAL STRESSES IN PLATES 9

Membrane thermal stresses – Circular plates – Rectangular plates – Bending thermal stresses – Thick plates with temperature varying along thickness – Thermal vibration of plates.

UNIT V SPECIAL TOPICS & MATERIALS 9

Thermal bucking, Fatigue and shock applications – High temperature effects on material properties.

TEXTBOOKS:

1. A.B. Bruno and H.W. Jerome, "Theory of Thermal Stresses", John Wiley & Sons Inc., New York, 1980.
2. N.J. Hoff, "High Temperature effects in Aircraft Structures", John Wiley & Sons Inc., London, 1986.

REFERENCES:

1. D.J. Johns, "Thermal Stress Analysis", Pergamon Press, Oxford, 1985.

WEBLINKS:

COURSE OUTCOMES	
CO 1	**Describe** basic parameters of Aerodynamic heating and temperature effects. (Understand)
CO 2	**Demonstrate** the important principles of Stress analysis in thermal problems. (Understand)
CO 3	**Solve** for thermal stress in bars and cylinders. (Apply)
CO 4	**Determine** thermal stresses in rectangular, circular plates. (Apply)
CO 5	**Determine** the high temperature effects on modern materials. (Apply)