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, Ministry of Human Resource Development, Govt. of India, dated 4th July 2002)
BHARATH INSTITUTE OF SCIENCE AND TECHNOLOGY
SCHOOL OF AERONAUTICAL ENGINEERING

NAAC
NATIONAL ASSESSMENT AND ACCREDITATION COUNCIL

B. Tech. – AEROSPACE ENGINEERING

(FULL TIME)

CURRICULUM & SYLLABUS

REGULATION – 2020

(As per AICTE Norms)

Based on Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

Applicable to the batches admitted from July 2020 onwards

Department of Aeronautical Engineering

School of Aeronautical Engineering

BHARATH INSTITUTE OF SCIENCE AND TECHNOLOGY

173, Agharam Road, Selaiyur, Chennai -600 073, Tamil Nadu.

SCHOOL OF AERONAUTICAL ENGINEERING

Department of Aeronautical Engineering

VISION

Department of Aeronautical Engineering will endeavor 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.

MISSION

- To be the state of art Teaching and Learning center 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.

Program Specific Outcomes (PSOs)

PSO1: Design and analyze aerospace components/systems for aerospace industries.

PSO2: Acquire the concepts of spacecraft attitude dynamics for the prediction of spacecraft motion.

REGULATION 2020

B. Tech. - Aerospace Engineering

SYLLABUS

Based on Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

U20PYBJ04 Engineering Physics for Aero Engineers

Part A – Introduction of the Course

This course "Engineering Physics for Aero Engineers", designed exclusively for First Year B. Tech. Aeronautical Engineering and Aerospace engineering students. The students will understand the importance of Quantum Mechanics and Electromagnetic theory for their Aero engineering in this course. They will also learn about Kinetic theory of gases and Rigid body dynamics that will provide fundamental concept for Aero engineering.

Course Code	Course Category	Course Title	L 3	T 1	P 2	C 5
U20PYBJ04	B	Engineering Physics for Aero Engineers	Pre-requisite: +2			
Name of the Course Coordinator		Dr. J. Selvaganapathy	Contact Hrs: 90			
Course offering Dept./School		Department of Physics/ Basic Sciences	Total Marks: 100			

Course Objective and Summary

This course will make students

1. To have adequate understanding of Newtonian mechanics.
2. To appreciate the need and importance of Quantum mechanics
3. To understand the concepts of electromagnetic theory
4. To comprehend the knowledge of wave and optics.
5. To learn the kinetic theory of ideal and real gases.

Course Outcomes (COs)

CO1	Identify the fundamentals of Classical Mechanics **(Understand).**
CO2	Discover the significance of Quantum Mechanics **(Apply).**
CO3	Identify the effect of charge dynamics and electromagnetic theory **(Understand)**
CO4	Apply geometrical optics to study optical effects and photonics **(Apply).**
CO5	Express the importance of Kinetic Theory of Gases and its usage **(Understand).**
CO6	Experiment with elementary experiments, collect the data and perform basic mathematical calculations for real time applications

Mapping/Alignment of COs with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H									H		H	L	
CO2	H									H		H	L	
CO3	H									H		H	L	
CO4	H									H		H	L	
CO5	H									H		H	L	
CO6	H			H	H	H	H	H	H	H		H	L	

(Tick mark or level of correlation: 3-High, 2-Medium,1-Low)

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment to Cos
1	**Unit 1: Rigid body equilibrium in 1D, 2D and 3D** Review of Vector Algebra; Newtonian mechanics: Momentum, Force, Newton's laws; 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 – Euler's laws of motion and Independence of Euler's law from Newton's laws - Describing rigid body motion - Precession of a body and a spinning top - Introduction to three-dimensional rigid body motion - Distinction from two-dimensional motion in terms of angular velocity vector, its rate of change - Two dimensional motion in terms of moment of inertia tensor - Three dimensional motion of a rigid body in coplanar manner - Rod executing conical motion with centre of mass fixed - Rod executing conical motion in two dimension and three dimension - Failure of two-dimensional formulation.	18	CO1
	Experiments: 1) Determine acceleration due to gravity using Bifilar Pendulum 2) Determine moment of inertia and angular acceleration -Gyroscope 3) Mechanical conversion of Energy–Maxwell's wheel with measure dynamics	6	CO6

2	**Unit 2: Quantum Mechanics** Young's double slit experiment, Origin of Quantum Mechanics, Failures of classical mechanics; diffraction of matter particles, Compton effect: theory and experimental verification, de Broglie waves and Davisson - Germer Experiment, Wave particle duality, Concept of black body radiation, Plank's black body radiation, Matter waves and concept of wave function. Concept of harmonic oscillator- Quantum harmonic oscillator- Hydrogen atom problem; Heisenberg uncertainty principle, Schrodinger's equation in 1D.	14	CO2
	Experiment: 1) Determine Planck's Constant	2	CO6
3	**Unit 3: Electromagnetic Theory** Del, divergence, curl and gradient operations in vector calculus – Gauss divergence and Stokes theorem- Electric field and electrostatic potential for a charge distribution – Gauss law and its applications- Laplace's equations for electrostatic potential- Poisson equations for electrostatic potential- Boundary conditions of electric field and electrostatic potential - Faradays law – Amperes law - Magnetic Vector Potential - Maxwell's equations Derivation – Electromagnetic wave equation	14	CO3
	Experiments **1)** Calibrate Ammeter using Potentiometer **2)** Calibrate Voltmeter using Potentiometer	4	CO6
4	**Unit 4: Waves and Optics** Geometrical Optics and Lenses; Plane progressive waves – wave equation. Diffraction theory- Fraunhofer diffraction at single slit- Fraunhofer diffraction at double slit; Diffraction grating- Interference phenomenon; Newton's rings, Michelson interferometer. Polarization and Birefringence - Circular polarization-Elliptical polarization; Lasers: population of energy levels, Einstein's A and B coefficients derivation, resonant cavity, optical amplification.	12	CO4
	Experiments 1) Determine of thickness of thin wire using Air wedge method 2) Determine wavelength of a laser source – diffraction grating 3) Determine wavelength of monochromatic light using Newton's ring 4) Determination of Particle size using Laser	8	CO6

5	**Unit 5: Kinetic theory of gases** Ideal gases; System of monoatomic, diatomic and polyatomic molecules, Equation state of ideal gases, Equilibrium properties; Molecular flux, Collision with the wall, Principles of equipartition energy, Specific heat; Intermolecular forces, van der Waals equation of state, Molecular speed, Maxwell–Boltzmann distribution, mean free path, collision cross section; Transport phenomenon: viscosity, conduction, diffusion, Non-equilibrium thermodynamics, thermos-diffusion and thermo-electric effects. Introduction to Real gases, Joule–Thomson effect.	12	CO5

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Mahendra K Verma, Introduction to Mechanics, University Press (India)., 2016.
2. Daniel Kleppner, Robert Kolenkow, "An Introduction to Mechanics", Cambridge University Press, 2014.
3. David J. Griffiths, "Introduction to Electrodynamics", Pearson Publishers, fourth edition, 2013.
4. Francis W. Sears, Gerhard L. Salinger, "Thermodynamics, Kinetic Theory, and Statistical Thermodynamics", Addison Wesley, 1975.
5. M. N. Avadhanulu and P. G. Kshirsagar, "A Text book of Engineering Physics", S. Chand & company Ltd., 2017 New Delhi.

Reference Books:

1. Eisberg and Resnick, Quantum Physics: of Atoms, Molecules, Solids, Nuclei and Particles, John Wiley & Sons, 2nd Edition, 1985.
2. P.W. Mathews and K. Venkatesan, "A textbook of Quantum Mechanics", Tata McGraw Hill, 1976.
3. Michael Seeds and Dana Backman, "Universe: Solar Systems, Stars, and Galaxies", Brooks/Cole, Cengage Learning, 2012.
4. N. Subrahmanyam, Brij Lal and M, N. Avadhanulu, "A text book of Optics" S. Chand and Compoany Ltd., New Delhi. 2006.

Other Resources (Online Resources or others)

1. NPTEL Course: Rigidbody Dynamics by Prof. Anurag Tripathi (Department of Physics, IIT Hyderabad) https://archive.nptel.ac.in/courses/115/106/115106123/
2. NPTEL Course: Quantum Mechanics by Prof. Ajoy Ghatak (Department of Physics, IIT Delhi) https://archive.nptel.ac.in/courses/115/102/115102023/
3. NPTEL Course: Electromagnetic Theory by Prof. D.K. Ghosh (Department of Physics, IIT

Bombay) https://archive.nptel.ac.in/courses/115/101/115101005/

4. NPTEL Course: Applied Optics by Prof. Akhilesh Kumar Mishra (Department of Physics, IIT Roorkee) https://archive.nptel.ac.in/courses/115/107/115107131/
5. NPTEL Course: Thermal Physics by Prof. Debamalaya Banerjee (Dept of Physics, IIT Khragpur) https://archive.nptel.ac.in/courses/115/105/115105129/

U20MABT01 Calculus and Linear Algebra

Part A – Introduction of the Course

Calculus and linear algebra are fundamentals to virtually all of higher mathematics and its applications in the natural, social, and management sciences. These topics, therefore, form the core of the basic requirements in mathematics both for mathematics majors and for students of science and engineering.

Course Code	Course Category	Course Title	L 3	T 1	P 0	C 4
U20MABT01	B	Calculus and Linear Algebra	Pre-requisite: +2			
Name of the Course Coordinator		Dr. M. Boopathi	Contact Hrs: 60			
Course offering Dept./School		Mathematics & Basic Sciences	Total Marks: 100			

Course Objective and Summary

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 mathematic and applications that they would find useful in their disciplines.

Course Outcomes (COs)

CO1	**Apply** the Knowledge of Matrices , Eigen Values and Eigen Vectors Reduce to Quadratics form in problems involving science and Engineering (**Apply**)
CO2	**Gain** familiarity in the knowledge of maxima and minima , Jacobian and Taylor series and apply them to the problems involving Science and Engineering (**Apply**)
CO3	**Gain** Knowledge in solution of Differential Equations and its applications in Engineering problems (**Apply**)
CO4	**Gain** the knowledge of Radius, Center, Envelope and Circle of curvature and apply them in the problems involving in Science and Engineering (**Apply**)
CO5	**Gain** the knowledge of convergence and divergence of series using different test and apply sequences and series in the problem involving in science and Engineering (**Apply**)

Mapping/Alignment of COs with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H										L		
CO2	H	H			L							M		
CO3	H	H			M							M		
CO4	H	H	M		L							L		
CO5	H	H	L									M		

(Tick mark or level of correlation: 3-High, 2-Medium,1-Low)

Part B – Content of the Course

UNIT I MATRICES

Characteristics equations – Eigen value of a real matrix - Eigenvectors of a real matrix– Properties of Eigen values – Cayley-Hamilton Theorem – Finding an inverse using Cayley Hamilton theorem – Finding higher powers of A using Cayley-Hamilton theorem- orthogonal reduction of a symmetric matrix to diagonal form – Reduction of Quadratic form to canonical – Quadratic form by orthogonal transformation – orthogonal matrices application of matrices in Engineering. (**Contact Hours – 12**)

UNIT II FUNCTIONS OF SEVERAL VARIABLES

Functions of two variables – Partial derivatives – Total differential – Taylor's expansion with two variables up to second order terms - Taylor's expansion with two variables up to third order terms – Maxima and Minima – Constrained maxima and minima by Lagrangian multiplies method – Jacobians – Properties of Jacobians and problems – Applications of Taylor's series, maxima and minima and Jacobians in Engineering. (**Contact Hours – 12**)

UNIT III ORDINARY DIFFERENTIAL EQUATIONS

Linear equations of second order with constant coefficients when PI = 0 or exponential - Linear equations of second order with constant coefficients when PI = sinax or cosax - Linear equations of second order with constant coefficients when PI = polynomial - Linear equations of second order with constant coefficients when PI = exponential with sinax or cosax - Linear equations of second order with constant coefficients when PI = exponential with polynomial - Linear equations of second order with constant coefficients when PI = polynomial with sinhax or coshax – Linear equations of second order variable coefficients – Homogenous of Euler type – Homogenous of Legendre's type – Equations reducible to homogenous form – Variation of parameters – Simultaneous first order with constant coefficient – Applications of Differential Equations in Engineering. (**Contact Hours – 12**)

UNIT IV DIFFERENTIAL CALCULUS

Radius of curvature – Cartesian Coordinates – Polar Coordinates – Circle of Curvature – Applications of Radius of Curvature in Engineering – Centre of Curvature Evolute of a parabola – Evolute of a Ellipse – Envelopes of standard curves – Applications of curvature in Engineering – Beta Gamma functions and their properties. (**Contact Hours – 12**)

UNIT V SEQUENCES AND SERIES

Sequences – definition and examples Series type of convergence – series of positive terms – test of convergence – Comparison test – Integral test – D'Alemberts Ratio test – Raabe's root test – Convergent of Exponential series – Cauchy's root test – Log test – Alternative series – Leibnitz test – series of positive and negative terms – Absolute convergence – Conditional convergence – Applications of convergence of series in Engineering. (**Contact Hours – 12**)

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. B.S Grewal Higher Engineering Mathematics, Khanna Publisher, 36th Edition.2010.
2. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.

Reference Books:

1. G. B. Thomas, and R.L.Finney Calculus and Analytic Geometry, 9th Edition, Pearson,Reprint2012.
2. Ramana. B.V. Higher Engineering Mathematics, Tata McGraw – Hill, New Delhi,11th Reprint, 2010.
3. Erwin Kreyszig, Advanced Engineering Mathematics, 9th edition, John Wiley & Sons, 2006.
4. Veerarajan T, Engineering Mathematics for first years, Tata McGraw Hill, New Delhi.2008.

Other Resources (Online Resources or others)

1. Nil

U20LEHJ01 Technical English

Part A – Introduction of the Course

The course is framed with basic grammatical structure focusing on the enhancement of LSRW skills in learning a language and the writing competency of an individual; to act diplomatically and professionally at workplace. Also, it enriches their communication skills with necessary skill-set by overcoming the anxiety of learning a language technically backing up their career in future.

Course Code	Course Category	Course Title	L 2	T 0	P 2	C 3
U20LEHJ01	H	Technical English	Pre-requisite: +2			
Name of the Course Coordinator		Ms. Raagavi A S	Contact Hrs: 60			
Course offering Dept./School		Department of English/ School of Humanities and Social Sciences	Total Marks: 100			

Course Objective and Summary

The main objective of the course is to enhance the learner's communication skills by giving adequate exposure in LSRW – Listening, Speaking, Reading, Writing skills and the related sub skills to help the learners recognize and operate in various styles and registers in English. The course trains the students in technical writing in English in writing descriptions of gadgets, and preparing texts.

Course Outcomes (COs)

CO1	Identify types, modes, channels and barriers of communication. Distinguish different speech sounds, pronounce correctly.
CO2	Identify, rectify the errors in the use of grammar and vocabulary. Improve Listening and writing skills.
CO3	Develop a topic idea into a cohesive paragraph with examples. Improve the fluency of speaking skills.
CO4	Develop ideas into logical and coherent essays. Understand better the workplace culture.
CO5	Identify the steps involved in writing an academic project report. List and practice skills need for making a presentation.
CO6	Build listening, speaking, reading, and writing abilities in English, to interact with English speaking.

Mapping/Alignment of COs with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	L	H	-	M	-	-
CO2	-	-	-	-	-	-	-	-	L	H	-	M	-	-
CO3	-	-	-	-	-	-	-	-	L	H	-	M	-	-
CO4	-	-	-	-	-	-	-	-	L	H	-	M	-	-
CO5	-	-	-	-	-	-	-	-	L	H	-	M	-	-
CO6	-	-	-	-	-	-	-	-	L	H	-	M	-	-

(Tick mark or level of correlation: 3-High, 2-Medium,1-Low)

Part B – Content of the Course

UNIT I

Definition, process of communication - Filling in-class worksheets - Verbal and non - verbal communication - Individual and group activities - Role play - LAB: Individual speech sounds Courseware speech sounds (Listening and reproducing) - LAB: often mispronounced sounds Audio visual material (Listening to minimal pairs and reproducing) OtherTypes of Communication: general technical, formal, informal, external, internal - Write upon a selected type of communication - Listening, Speaking, Reading, Writing – Group activity (Newspaper) Discussion and Feedback Lab Material on mis-pronounced words - Individual oral activity and rectification of the probable mistakes. LAB: sentence types -Practice on sentence stress and intonation - Communication barriers-Individual activity-sharing of personal experiences - Organizational Communication - Channels of communication Group Activity (worksheet) with visuals or written material - LAB: short biographical account on famous personalities-Video Oral paraphrasing of the content shown - LAB: Listening to short conversations - Answering the questions on the above content. (**Contact Hours – 12**)

UNIT 2

Words with Foreign roots, Word formation - inflectional, derivational prefixes, suffixes - Quiz - Identifying the borrowed roots and their meanings -Worksheet exercise - Synonyms and Antonyms and Standard Abbreviations - Context Based Activity / Learner compiling standard abbreviations from core subject - LAB: Listening to long conversations - identify communication contexts, use of making a word list in relation to the context, daily life Identify various communication contexts and answering questions - Collocation - Homonyms and Homophones - Fun activities - worksheets - Cross Words - Articles - Tenses - Exercise through worksheets - individual activity peer correction - open discussion - LAB: Watching documentaries & short films related to science and technology-Picking out the terminology related to science and technology - LAB: Introduction to English -British and American - Videos-Discussion on difference between British and American words - Noun - Pronoun Agreement and Subject - Verb Agreement - Identifying and learning through error analysis - worksheets - Misplaced modifiers - Prepositions - prepositional verbs and phrasal verbs - Learn through practice - placing same modifier in different places in a sentence - LAB: Watching video based on daily life - Observing and recording the features of spoken English - LAB: Watching interviews of famous personalities - Quiz on the video shown. (**Contact Hours – 12**)

UNIT 3

Sentence structure, Phrases and Clauses - Exercise: worksheet, Identifying phrases, clauses, compound, complex sentences - Developing ideas into paragraphs - cohesion markers - Identify topic sentence in a paragraph; writing a paragraph based on a topic - LAB: Listening to short stories - Science fiction-

Identify main idea of the given story and narrate a story on the given topic - Written - LAB: Speaking - practice activity - brain storming - mind mapping-Just a Minute - Inputs on writing precisely, redundancies, wordiness - repetition - clichés-Error analysis and editing- Defining, describing technical terms-Writing definitions product and Process Description- LAB: Describing as ceneor event - videos - String narration - describing an event or a scene - LAB: Channels of communication-videos Observing and identifying the channels of communication-Role play - Inputs on classifying / categorizing and sequencing ideas with relevant diagrams - Writing a passage on the given hints, tree diagram, classification table and flow chart - Importance of punctuation - Miscommunication - Errors in punctuation - Fun activities - worksheets for appropriate punctuation - written –videos

(**Contact Hours – 12**)

UNIT 4

Reading Comprehension, Guidelines - questions (referential, critical, interpretative) - Practice Exercise - Précis writing - Guidelines - Practice Exercise - LAB: Videos on workplace scenario - Open Discussion on Workplace Etiquette - speaking language known to everyone, space, polite words, actions, objective - LAB: Videos on workplace communication - Role play based on the given workplace context Summarizing-Group activity (oral/written) on the given passages - Essay Writing, general introduction - Brainstorming on relevant technical and nontechnical topics - LAB: Technical communication - Interpreting Data-Group activity- interpretation of data - oral presentation - LAB: External Communication-Advertising ADZAP(promoting a product)-Oral Essay Writing Guidelines: introduction, elaboration and conclusion with examples -individual activity (Written) on the given topic - Organizational Report Writing-Progress report- Guidelines- Writing a progress report- LAB: Sample case studies for work ethics - videos - Debate on the videos shown - LAB: Learning interview techniques through models - Mock interview. (**Contact Hour – 12**)

UNIT 5

Topics for project writing-Discussion-Collection of Data - avoiding plagiarism - authenticity and credibility of data - Collection of data for verification - LAB: Importance of availing credible resources with examples - Collecting and compiling resource materials - LAB: Guidelines for preparing a PPT; presentation techniques -Preparing PPT on the topic of learners' choice - Guidelines for writing: outline objectives - background - methodology - discussion -Drafting an outline - Discussion using sample project - Writing the first draft on the selected topic - Giving inputs on documentation based on IEEE - Preparing references - Checklist for project format (PPT) - Self-verification and submission of final draft - LAB: Formal Presentation. (**Contact Hour –12**)

List of LAB ACTIVITIES to be recorded (observation):

1. Speech Sounds
2. Role play
3. Writing/ oral – Famous personalities
4. British/ American English
5. Just A Minute
6. Precise Writing
7. Group Discussion/Debate
8. Mock Interview
9. ADZAP
10. Formal Presentation

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

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

Reference Books:

1. Anbazhagan K, Cauveri B, Devika M.P., English for Engineers. Cengage, 2016.
2. Swan, Michael. Practical English Usage. OUP,1995
3. Kumar Sanjay and Pushpa Lata. Communication Skills. OUP,2011
4. CIEFL, Hyderabad. Exercises in Spoken English. Parts 1-111.OUP 5) Kumar, Suresh. E. Engineering English. Orient Blackswan: Hyderabad,2015.
5. Means, L. Thomas and Elaine Langlois, English & Communication for Colleges. Cengage Learning, USA: 2007.
6. Raman, Meenakshi and Sharma, Sangeetha- Technical Communication Principles and Practice. Oxford University Press: NewDelhi,2014.

Other Resources (Online Resources or others)

1. Nil

U20PDHJ01 Employability Skills and Practices

Part A – Introduction of the Course

This course introduces students to understand the features of UAV, elements, navigation and guidance of UAV and to design and simulate UAV.

Course Code	Course Category	Course Title	L 2	T 0	P 2	C 3
U20PDHJ01	H	Employability Skills and Practices	Pre-requisite: +2			
Name of the Course-Coordinator		Dr. T. Muthulakshmi	Contact Hrs: 60			
Course offering Dept./School		Department of Career Development	Total Marks:100			

Course Objective and Summary

This course will make students

1. To help students explore their values and career choices through individual skill assessments.
2. To make realistic employment choices and to identify the steps necessary to achieve a goal.
3. To develop and practice self-management skills for the work site.

Course Outcomes (COs)

CO1	**Apply** the concept of Divisibility rule in unit digit problems (**Apply**)
CO2	**Grasp** the approaches and strategies to find solutions (**Apply**)
CO3	**Organize** and articulate ideas clearly (**Understand**)
CO4	**Understand** the Interview skills and behaviors required for job. (**Understand**)
CO5	**Understand**, comprehend and provide logical conclusions (**Understand**)
CO6	**Gain** appropriate skills to succeed in preliminary (**Manipulate**)

Mapping/Alignment of COs with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	-	-	M	-	-	-	-	-	-	L		
CO2	H	H	-	-	M	-	-	-	-	-	-	M		
CO3	H	H	M	-	M	-	-	-	-	-	M	M		
CO4	H	H	-	-	-	-	-	-	-	H	H	H		
CO5	H	H	M	-	-	-	-	-	-	H	H	H		
CO6	H	H	-	-	-	-	-	-	-	H	H	H		

(Tick mark or level of correlation: 3-High, 2-Medium,1-Low)

Part B – Content of the Course

UNIT 1 DIVISIBILITY RULE

Arithmetic Divisibility Rules - Arithmetic HCF-LCM factors -Sentence Correction-Practice Arithmetic Unit Digit, - Squares Problem Solving- Para Jumbles- Practice Algebra Introduction- Algebra Linear Equation- Reading Comprehension- Practice. (Contact Hours – 6)

UNIT 2 PROFIT AND LOSS

Algebra Quadratic Equation Problem Solving - Video Profiling - Commercial Mathematics – Profit and Loss Problem Solving – Critical Reasoning – Type I, II and III Practice - Commercial Mathematics – Discount and Rebate- Problem Solving- Critical Reasoning- Type IV,V and VI.(Contact Hours - 6)

UNIT 3 PERMUTATION AND COMBINATION

Modern Mathematics- Permutation Modern Mathematics – Combination Group Discussion-Introduction Group Discussion- Mock I- Modern Mathematics- Probability Problem Solving - Group Discussion- Mock II Group Discussion-Mock II- Geometry I- Problem Solving - Group Discussion-Mock III Group Discussion- Mock III. (Contact Hours 6)

UNIT 4 GEOMETRY AND DATA INTERPRETATION

Geometry II - Problem Solving - Group Discussion- Mock IV- Mensuration Problem Solving- Resume Writing- Tips and Strategies Resume Writing- Evaluation – Data Interpretation I-Interview Skills-Introduction. (Contact Hours – 6)

UNIT 5 INTERVIEW SKILL

Data Interpretation – II - Problem Solving - Interview Skills- - Mock I- Interview Skills Mock I – Data Sufficiency – I-Problem Solving - Interview Skills- - Mock II- Interview Skills Mock II -Data Sufficiency – II Problem Solving Revision. (Contact Hours – 6)

LIST OF ACTIVITIES (PRACTICALS) (Contact hours 30)

1. Sentence Correction.
2. Para Jumbles
3. Reading Comprehension
4. Critical Reasoning- Type IV, V and VI practice
5. Group Discussion-Mock I
6. Group Discussion-Mock II
7. Group Discussion-Mock III
8. Resume writing- Tips andStrategies
9. Interview Skills-Mock I
10. Interview Skills-Mock II
11. Data Sufficiency-I
12. Data Sufficiency-II

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Dinesh Khattar, The Pearson Guide to Quantitative Aptitude for Competitive examinations,
2. Norman Lewis, Word Power Made Easy, W.R.Goyal Publications,2011 3) Wiley's GMAT Reading Comprehension Grail ,Wiley,2016
3. Archana Ram, Place mentor, Oxford UniversityPress,2018.
4. P.A.Anand, Quantitative aptitude for Competitive Examinations, Wiley Publication 2016

Reference Books:

1. Hari Mohan Prasad, Verbal ability for Competitive Examinations, Tata McGraw Hill Publications.
2. Edgar Thrope , Test of Reasoning for Competitive Examinations, Tata McGraw Hill 4th Edition, 2012
3. Norman Lewis,Word Power Made Easy, W.R.Goyal Publications,2011
4. JoernMessnar, Manhattan Review, GRE Analytical Guide, Manhattan, Review lnc 2011
5. GRE Analytical writing, Solutions to the Real Essay Topics (Test Prep.Series), Vibrant Publishers,2011
6. Manhattan Prep GRE; Reading Comprehensive and Essays, 5th edition 7) Archana Ram, Place mentor, Oxford University Press,2018.

Other Resources (Online Resources or others)

1. Nil

U20CYHT01 Social and Environmental Engineering

Part A – Introduction of the Course

The course on social and Environmental Engineering describes the environment and ecosystem, biodiversity and their significance. The course also elaborated, their various aspects of environmental pollution, social issues and their effect on environment and the possible solution using the technology.

Course Code	Course Category	Course Title	L 3	T 0	P 0	C 3
U20CYHT01	H	Social and Environmental Engineering	Pre-requisite: +2			
Name of the Course-Coordinator		Dr. T. Lakshmikandhan	Contact Hrs: 45			
Course offering Dept./School		Department of Chemistry	Total Marks: 100			

Course Objective and Summary

The main objective of the course is to understand the basic structure and functions of environment and gain knowledge about various forms of ecosystems. And to gain depth knowledge on Biodiversity, its conservation and to develop critical thinking for shaping strategies for environmental protection and social equity. To understand the various forms of environmental pollution, its causes and their consequences and also to know the concepts of environmental issues, realize the rapid growth of human population and their consequences.

Course Outcomes (COs)

CO1	To Study the nature and facts about environment (**Remember**)
CO2	To find and implementing scientific, economic and political solutions to environmental problems (**Apply**)
CO3	To study the interrelationship between living organism and environment (**Understand**)
CO4	To appreciate the importance of environment by assessing its impact on the human world; envision the surrounding environment, its functions and its value (**Understand**)
CO5	To study the dynamic processes and understand the features of the earth's interior and surface (**Apply**)

Mapping/Alignment of COs with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	-	-	-	-	-	-	-	-	-	-	-	-	-	-

(Tick mark or level of correlation: 3-High, 2-Medium,1-Low)

Part B – Content of the Course

UNIT I ENVIRONMENT AND ECOSYSTEMS

Definition, Scope and Importance of Environment - need for public awareness - 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 (a) Forest ecosystem, (b) Grassland ecosystem, (c) Desert ecosystem, (d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries). Introduction of biodiversity definition; - Genetic, Species and Ecosystems diversity. Bio-geographical classification of India- Value of biodiversity; Consumptive use, Productive use, Social, Ethical, Aesthetic and Option values. (Contact Hours – 9)

UNIT II BIODIVERSITY

Biodiversity at global, national and local levels- India as a mega - diversity nation- Hot-spots of biodiversity- Threats to biodiversity; Habitat loss, poaching of wildlife, man-wildlife conflicts endangered and endemics species of India- Conservation of biodiversity; In-situ and Ex-situ Conservation of biodiversity. Field study of common plants, insects, birds; Field study of simple ecosystems- pond, river, hill slopes, etc. (Contact Hours – 9)

UNIT III ENVIRONMENTAL POLLUTION

Definition- causes, effects and control measures of; (a) Air pollution, (b) water pollution, (c) soil pollution, (d) marine pollution, (e) Noise pollution, (f) Thermal pollution, and (g) Nuclear Hazards- Solid waste management; Causes, effects and control measures of municipal solid wastes-Role of an individual in prevention of pollution- Pollution Case studies- Disaster Management; floods, earthquake, Cyclone and Landslides. Field Study of local polluted site- Urban / Rural/Industrial /Agricultural. (Contact Hours – 9)

UNIT IV. SOCIAL ISSUES AND THE ENVIRNOMENT

From unsustainable to sustainable development- urban problems related to energy- Water conservation - Rain water harvesting , Watershed management- Resettlement and rehabilitation of people; Its problem and concerns, case studies-role of non-governmental organizationEnvironmental Ethics: Issues and possible Solutions- Climate change, Global warming, Acid rain, Ozone layer depletion, Nuclear accidents and holocaust, case studies-wasteland reclamation- consumerism and waste products- Environmental Protection act, Air (Prevention and Control of Pollution) act- Water (Prevention and Control of Pollution) act - Wildlife protection act- Forest Conservation act-Enforcement machinery involved in environmental legislation- central and state pollution control boards- Public awareness. (Contact Hours – 9)

UNIT V. HUMAN POPULATION AND THE ENVIRONMENT

Population growth, variation among nations- Population explosion- Family Welfare programs- Environment & human health- Human Rights-Value Education – HIV/AIDS- Women & Child Welfare- Role of Information Technology in Environment and Human health - Case Studies (Contact Hours – 9)

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2006.

Reference Books:

1. Gilbert M. Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education 2004.
2. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT LTD, New Delhi, 2007.
3. ErachBharucha, 'Text book Environmental studies', Universities Press, Hyderabad, 2015
4. G.Tyler Miller and Scott E.Spoolman, ' Environmental Science' , Cengage Learning India Pvt. Ltd, New Delhi, 2014
5. Rajagopalan. R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, 2005.
6. Dr.P.Kamaraj, Dr.M.Arthanareeswari, Environmental Science-Challenges and Changes" Sudhandhira Publications (2007),
7. A.K. De, Environmental Chemistry, 6th Edition, New Age, International, New Delhi, 2006.
8. B.K. Sharma and H. Kaur, Environmental Chemistry, Goel Publishing House, Meerut, 1996.

Other Resources (Online Resources or others)

1. https://nptel.ac.in/courses/103/107/103107084/

https://onlinecourses.nptel.ac.in/noc19_ge22/preview

U20MEET01 Engineering Mechanics

Part A – Introduction of the Course

Course Code	Course Category	Course Title	L 3	T 0	P 0	C 3
U20MEET01	E	Engineering Mechanics	Pre-requisite: + 2			
Name of the Course Coordinator		Dr, D. Ravi	Contact Hrs: 45			
Course offering Dept./School		Mechanical Engineering	Total Marks: 100			

Course Outcomes (COs)

CO1	Apply knowledge of mathematics, science for engineering applications and Identify, formulate, solve engineering problems
CO2	Determine the resultant force and moment for a given system of forces
CO3	Analyze planar and spatial systems to determine the forces in members of trusses, frames and problems related to friction
CO4	Determine the equilibrium of a particle in space using principle of laws of mechanics.
CO5	Compute the equilibrium of rigid bodies in two dimensions and in three dimensions
CO6	Calculate the motion characteristics of a body subjected to a given force system

Mapping/Alignment of COs with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M	M						H			M		
CO2	H	H	L						H			M		
CO3	H	H	M	H	M				H			M		
CO4	H	H	L						H			M		
CO5	H	H	M	H					H			M		
CO6	H	H	M	H					H			M		

(Tick mark or level of correlation: 3-High, 2-Medium,1-Low)

Part B – Content of the Course

UNIT 1 Properties of Surfaces and Volumes

Centre of gravity: Introduction to Centroid and center of gravity. Centroids of lines, areas and volumes. Determination of centroids by Integration principles. Theorem of Pappus-Guldinus. Moment of Inertia: second moment or Moment of Inertia of area and theorems. Determination of moment of inertia of area. Radius of gyration Polar moment of Inertia. Mass moment of Inertia. **(Contact Hours – 09)**

UNIT 2 Analysis of Trusses and Friction

Trusses: Trusses and types of trusses. Analysis of trusses by method of joints. Analysis of trusses by method of sections. Friction: Friction and types of friction. Laws of frictions. Belt friction. Wedge friction and rolling friction. Thrust bearing. Friction in journal bearing. **(Contact Hours – 09)**

UNIT 3 Statics of particles

Equilibrium of Particles: Fundamental concepts and principles of engineering mechanics. Vector representation of forces. Types of force systems like coplanar system, concurrent system etc. Resolution of forces and resultant forces. Free body diagram and forces in space. Equilibrium of Rigid Bodies: Principles of transmissibility – Moment of force -Moment of force and Varigon's theorem. Equilibrium of rigid bodies and equivalent system of forces. Types of supports and reactions. Statically determinant and indeterminate structures. **(Contact Hours – 09)**

UNIT 4 Dynamics of Particles

Rectilinear motion- uniform velocity and uniformly accelerated motion. Rectangular components of velocity and acceleration. Curvilinear motions and components. Newtons second law and D'Alemberts principle. Principle of work and energy. Principle of impulse and momentum. Impact of elastic bodies. Direct central impact. Oblique central impact. **(Contact Hours – 09)**

UNIT 5 Dynamics of rigid Bodies

Introduction to kinematics of rigid bodies. Translation and rotation of rigid bodies. Fixed axis rotation. General plane motion. Absolute and relative velocity velocity in plane motion, Instantaneous center of rotation in plane motion. Principle of work and energy for a rigid body. Application of work and energy for rigid body. Principle of impulse and momentum for the plane motion of a rigid body.

(Contact Hours – 09)

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Ferdinard P. Beer, E. Russell Johnston Jr, David Mazurek, Philip J Cornwell, Vector Mechanics for Engineers: Statics and Dynamics, McGraw Hill, New Delhi, 2013
2. Palanichamy, M.S., and Nagan.S., Engineering Mechanics (Statics and Dynamics), Tata McGraw Hill, New Delhi, 2011.
3. Bansal R. K. & Bansal, S. A Text Book of Engineering Mechanics, Lakshimi Publications, 2011.

Reference Books:

1. Timoshenko and Young, Engineering Mechanics, Tata Mc-Graw Hill, New Delhi 1988
2. Mclean and Nelson, Theory and Problems of Engineering Mechanics (Statics and Dynamics), Schaum Series, 1980.
3. Shames, I.H., and Krishna Mohana Rao G., Engineering Mechanics (Statics and Dynamics) Dorling Kindersley (India) Pvt ltd, 2006.

Other Resources (Online Resources or others)

1. Nil

U20MEEJ01 Engineering Graphics and Design

Part A – Introduction of the Course

Course Code	Course Category	Course Title	L 1	T 0	P 6	C 4
U20MEEJ01	E	Engineering Graphics and Design	Pre-requisite: + 2			
Name of the Course Coordinator		Dr. K. Selva Kumar	Contact Hrs: 105			
Course offering Dept./School		Mechanical Engineering	Total Marks: 100			

Course Outcomes (COs)

CO1	Identify engineering graphics. Draw objects like lines, planes and solids in perspective
CO2	& orthographic projections
CO3	Draw projection of solid like prism, cylinder, pyramid and cone inclined in general positions, obtain auxiliary views
CO4	Draw projection of combination of solids made out of primitives, draw the section of solids, create building plans
CO5	Crete 3D part models. Develop its surfaces with solid modelling software for assembly of parts
CO6	Evaluate the assembly of parts including interference of parts. Create 2D drawings of assembly of parts

Mapping/Alignment of COs with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	M									L		
CO2			L											
CO3	H		L											
CO4	M		H		H					H	H			
CO5	M	H	H		H									
CO6	M		H		H					H				

(Tick mark or level of correlation: 3-High, 2-Medium,1-Low)

Part B – Content of the Course

UNIT 1

Principles, Standards, Conventions – Angle of projections, Symbols, Dimensions – 2D, Geometrical Constructions – Conic Curves, ellipse by eccentricity method – Cycloids, Epicycloids, Hypocycloid – Involutes of a square, Circle – Spirals – Introduction to perspective projection with terminologies and concepts – Orthographic Multi view and isometric projection – Perspective projection of a point, line, planes, solids – Orthographic Multi view of point, line, planes, Solids – Isometric projection of a point, planes, solids – Isometric to orthographic Multi view sketching – Orthographic to isometric sketch – Orthographic Multi view projection of lines inclined planes, auxiliary projections. (**Contact Hours 15**)

UNIT 2

Introducing AutoCAD Software, layers, dimensions, tolerance, annotations – Create, modify, customize, print using AutoCAD – Demo : Menu, Tool bars, Drawing Area, Dialog box, Windows, Shortcut menus - Command Line, Status Bar, Different zoom methods, Create, Select, Erase objects, Draw straight lines, rectangle, polar, absolute, relative – Orthographic constraints, Ortho ON, snap to objects manually, automatically drawing lines, arcs, circles, polygons – create, edit, use layers, extend lines – Dimensioning objects, annotations – Demo : drawing page, print, units/ scale/ limits settings, standards for dimensioning ISO, ANSI Std. dimensioning, tolerancing, Projection of solid prisms and cylinders inclined to both the planes – change of position method, reference line method / auxiliary projections, - Viewing isometric and perspective views, shaded, wire-frame models – Oblique prismatic solids and its projections – Projections of solid pyramids and cones inclined to both the planes – change of position method and reference line method / auxiliary projections, -- Auxiliary projections – Viewing isometric and perspective views, shaded wire frame models – Oblique pyramidal solids and projections. (**Contact Hours 15**)

UNIT 3

Combination of solids, Constructive Solid Geometry (CSG), Boolean operations, Creating combination of solids, isometric, perspective views, shaded, wire-frame – Constructive solid geometry, - Section of right regular solid with axis perpendicular to one principal planes and cutting plane inclined to any one principal plane, true shape of section – Sectional plan, elevation, and sectional side view of Building/dwelling, include windows, doors, fixtures etc., (**Contact Hours 15**)

UNIT 4

3D modeling, parametric, parts of CSG, surface, wire frame, shaded-Rendered models, background, shadows, multi view, isometric, perspective views – Viewing models in multi-view, isometric and perspective views – Modeling industrial part drawings – Design new components as a team. 3D part to 2D Drawings geometric dimensioning and tolerancing annotations – generating 2D from 3D models, printing drawings, generating sectional views – Geometric dimensioning and tolerancing, Annotations – generating sectional views – Printing drawings to printer or as .pdf – Development of surfaces: Un-

cut & cut right regular solids – Simple position with cutting planes perpendicular to any one principal plane. (**Contact Hours 15**)

UNIT 5

Part/ component model creation for assembly – Study of various widely used assembly of parts like flanged coupling, Universal joint etc. – Creation of parametric parts for assembly – Assembly drawings: exploded view with assembly annotations part details – Printing assembly drawings to printer and as pdf (**Contact Hours 15**)

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Bhatt N.D., Panchal V.M. & Ingle P.R., Engineering Drawing, Charotar Publishing House, 2014.
2. Bethunc, J., Engineering Graphics with Auto CAD 2017, Pearson Education, 2016.
3. Natarajan, K.V., A Text Book of Engineering Drawing, 21st edition, Dhanalakshmi Pub., 2012.
4. Shah, M.B. &Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education Pvt. Ltd., 2005
5. Jeyapoovan, T., Kannaiah, V., Engineering Graphics, Scitech Publications, 2010
6. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publications, 2010.

Reference Books:

1. Luzzader, Warrant J., Duff John M., Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Prentice Hall of India Pvt. Ltd., 2005.
2. Mohammad Dastbaz, Chris Gorse, Alise Moncater (eds), Building Information Modelling, Building performance, Design and smart Construction, Springer 2017.
3. User Manual of Respective CAD Software
4. User Manual of AutoCAD.

Other Resources (Online Resources or others)

1. Nil

U20MBHT01 Management Principles for Engineers

Part A – Introduction of the Course

This course will provide on the overview on the principles of the management for an organization. The functions of management are able to understood for the functioning of the organization. The various functions of management are able to formulate the ideologies for the smooth functioning of the activities.

Course Code	Course Category	Course Title	L 3	T 0	P 0	C 3
U20MBHT01	H	Management Principles for Engineers	Pre-requisite: +2			
Name of the Course Coordinator		Dr. J. Pavithra	Contact Hrs:45			
Course offering Dept/School:		Management Studies/School of Humanities and Social Science	Total Marks:100			

Course Objective and Summary

This course will make students

1. To enable the students to study the evolution of Management,
2. To study the functions and principles of management.
3. To learn the application of the principles in an organization.
4. To study the system and process of effective controlling in the organization.

Course Outcomes (COs)

CO1	**Observe** and evaluate the various influencing factors on the current practices of the organization and management (**Remember**)
CO2	**Use** the techniques and tools of planning and make prudent decisions (**Apply**)
CO3	**Identify** how organizations adapt to uncertain environment, identify techniques managers use to influence and control the internal environment (**Apply**)
CO4	**Apply** and execute management goals (**Apply**)
CO5	**Manage** people and deal with cultural and ethical issues (**Manipulation**)
CO6	**Utilize** the basic fundamentals of managing organizations and utilize optimum resources (**Manipulation**)

Mapping/Alignment of COs with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	L	-	H	H	M	-	M		
CO2	-	-	-	-	-	H	-	H	H	M	-	H		
CO3	-	-	-	-	-	M	-	H	H	H	-	M		
CO4	-	-	-	-	-	M	-	H	M	H	-	H		
CO5	-	-	-	-	-	H	-	H	H	H	-	H		
CO6	-	-	-	-	-	M	-	M	M	H	-	M		

(Tick mark or level of correlation: 3-High, 2-Medium,1-Low)

Part B – Content of the Course

UNIT 1

Organization – the individual and the organization – management – primary functions – functions of management – role of management organizations – advantages of managing people well – types of organization – role of managers – management thought – management roles – environmental factors – external factors. (**Contact Hours – 9**)

UNIT 2

Information technology and the new workplace – precaution measures – information deciaion making – style of decision making – the decision-making process – barriers to individual decision making – planning and mission – the planning process – the planning cycle tools, processes – putting together – planning and mission. (**Contact Hours – 9**)

UNIT 3

Organizational control – control on the business culture – business setting – importance of employee motivation – leadership – effective leader – organizing – purpose of organization – organizational design – common framework – common organizational structure – factors influencing organizational design – contingencies (**Contact Hours – 9**)

UNIT 4

Strategic management – role of strategies in management – evaluating business environment – common framework for situational analysis – goals and processes – strategic competitiveness – different strategies – stages and types of strategies – strategy formulation – bridging the gaps – strategy implementation. (**Contact Hours – 9**)

UNIT 5

People management – importance of people – attracting workforce – recruiting process – employee diversity – conflict management, organizational culture – influence on organizational culture – initiating and fostering cultural change, ethics, cultural issues attracting workforce. (**Contact Hours – 9**)

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Nil

Reference Books:

1. Haralod Koontz, Essentials of management- An international & leadership perspective – 10th edition, Tata Mc Graw Hill
2. Charles W Hill, principles of management, Principles of Management, Mc Graw Hill 2017
3. Stephen Robbins, Mary Coulter, Fundamentals of Management, Pearson Education, 9th Edition 2016.

Other Resources (Online Resources or others)

1. Nil

U20CYBJ01 Engineering Chemistry

Part A – Introduction of the Course

Engineering chemistry course focuses on introduction to the atoms, molecules and their characterization using spectroscopic techniques, as well as thermodynamic functions and principles involved in corrosion and its control, followed by organic reaction mechanisms, its isomerism, optical activity and synthesis of common drug molecules are discussed.

Course Code	Course Category	Course Title	L 3	T 1	P 2	C 5
U20CYBJ01	B	Engineering Chemistry	Pre-requisite: +2			
Name of the Course Co-ordinator		Dr. D. Sivasankaran	Contact Hrs: 90			
Course Offering Dept/School		Department of Chemistry	Total Marks:100			

Course Objective and Summary

This course will make students

1. To understand the concepts of chemistry to lay the groundwork for subsequent studies in the fields such as mechanical, civil, electrical and electronics engineering etc.
2. To develop the interest among the students regarding chemistry and their applications in engineering.
3. To learn the use of fundamental principles and tools used to predictions of molecules.
4. To introduce the principles of optical and electron microscopy, X-ray diffraction and various spectroscopic techniques.

Course Outcomes (COs)

CO1	Analyze atomic, molecular orbitals of organic, inorganic molecules to identify structure, bonding, molecular energy levels
CO2	Utilize the principles of Spectroscopic technique in analysing and explaining the structure and properties of molecules
CO3	Rationalize bulk properties using thermodynamic consideration and periodic properties of elements
CO4	Utilize the concept of thermodynamics in understanding and executing thermodynamically driven chemical reactions
CO5	Perceive the importance of stereochemistry in synthesizing organic molecules applied in pharmaceutical industries
CO6	Utilize the concepts in chemistry for technological and applying quantitative analyses and estimations for physical and chemical characteristics

Mapping/Alignment of COs with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	-	H	-	-	-	-	-	-	L	-			
CO2	H	-	-	H	H	-	-	-	-	-	-			
CO3	-	H	-	-	-	-	-	-	-	L	-			
CO4	H	H	-	H	-	-	-	-	-	-	-			
CO5	-	H	H	-	-	-	-	-	-	-	-			
CO6	-	-	L	-	-	-	-	-	-	L	-			

(Tick mark or level of correlation: 3-High, 2-Medium,1-Low)

Part B – Content of the Course

UNIT 1 Atomic and Molecular Structure

Schrodinger equation– Introduction – Derivation – Particle in a box solution – Applications for conjugated molecules – Forms of the hydrogen atom wave functions – Plots of these functions to explore their spatial variations. Molecular orbitals of diatomic molecules- Homonuclear – Heteronuclear diatomic molecules- Equations for atomic orbital – Equation for molecular orbitals – Energy level diagrams of diatomic. Introduction – Explanation –π-molecular orbitals of butadiene – π-molecular orbitals benzene – Aromaticity – Introduction – Explanation – Crystal field theory – Introduction – Explanation – Energy level diagrams for transition metal ions –Magnetic properties of transition compounds. (**Contact Hours – 14**)

UNIT 2 Fundamentals and Applications of Spectroscopy

Spectroscopy – General introduction and Explanation; Types of Spectroscopy – Basic concepts and Principles of Electronic spectroscopy, Rotational spectroscopy and Vibrational spectroscopy – Applications of rotational and vibrational spectroscopy of diatomic molecules – Selection rules – Nuclear magnetic resonance spectroscopy – Introduction, principle, Instrumentation and applications. (Contact Hours – 14)

UNIT 3 Surface characterization and Ionization Energy

XPS (X-ray Photoelectron Spectroscopy) – Introduction – Explanation – Diffraction and Scattering of solids – Explanation – Ionic, dipolar interaction – vander Waals interaction – Equation of state of real gases – critical phenomena – Effective nuclear charge, penetration of orbitals – Variations of s, p, d and f orbital energies of atoms in the periodic table – Electronic configurations, atomic and ionic sizes – Ionization energies, electron affinity and electronegativity – Polarizability, oxidation states – Coordination numbers and geometries.(**Contact Hours – 14**)

UNIT 4 Thermodynamics and Corrosion

Hard soft acids and bases – Thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies. Free energy and emf. Cell potentials, the Nernst equation and applications.

Acid base, oxidation reduction and solubility equilibria. Water chemistry – Corrosion and its control. (**Contact Hours – 14**)

UNIT 5 Synthesis of Organic compounds, Reactions and Mechanisms

Introduction to type of reactions involving substitution -Addition-Elimination, oxidation and reduction reactions- Cyclization and ring opening reactions. Optical activity, Absolute Configurations-Conformational analysis-Isomerism in transition metal complex. Representation of 3 dimensional structures – Structural isomers and stereoisomers – Configurations and symmetry and chirality – Enantiomers, diastereomers. Introduction-Synthesis of commonly used drug molecules-Examples. (**Contact Hours – 14**)

Chemistry Laboratory (Contact Hours – 20)

List of Experiments

1. Determine the hardness (Ca2+) of water using EDTA – Complexometric method (CO2).
2. Estimate the amount of chloride content in a water sample (CO2).
3. Determine the strength of an acid using pH meter (CO4).
4. Determine the strength of an acid by conductometry (CO4).
5. Determine the strength of a mixture of acetic and hydrochloric acid by conductometry (CO4).
6. Determine the ferrous ion using potassium dichromate by potentiometric titration (CO2).
7. Determine the molecular weight of a polymer by viscosity average method (CO4).
8. Determine adsorption of oxalic/acetic acid from aqueous solution by activated carbon (CO4).
9. Determine the rate constant of acid hydrolysis of an ester (CO4).
10. Determine the amount of sodium carbonate, sodium hydroxide in a mixture by titration (CO4).

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Concise Inorganic Chemistry: 5thEdition by J.D. Lee, Wiley, 2008
2. Inorganic Chemistry: Principles of Structure and Reactivity, 4th Edition, By James E. Huheey, Medhi 1983.
3. Morrison R.T and Boyd R.N., Organic Chemistry, 6th Edition, New York, 1976.
4. Bahl B.S and Arun Bahl, Advance Organic Chemistry, 12th Edition, Sultan Chand & Co, New Delhi, 1997.
5. Vogel A.I. A Text book of Practical Organic Chemistry, Longman, London, 1957.
6. Finar I. L., Organic Chemistry, Vol 2, 5th Edition, Pearson education, London, 1975.
7. C.N. Banwell and E.M. McCash, Fundamental of Molecular Spectroscopy, 5th Edition. Tata McGraw Hill Publishers, 2013.

8. Chemistry Laboratory – I & II.

Reference Books:

1. William Kemp, Organic Chemistry, 3rd Edition. MacMillan, 2009.
2. Peter Atkins, Julio de Paula, and James keeler Atkins Physical Chemistry, 11th Edition, 2017.
3. Introduction to Chemical Engineering Thermodynamics, J.M. Smith, H.C. Ness, M. Abbott, B Bhatt, 2009

Other Resources (Online Resources or others)

1. https://nptel.ac.in/courses/122/101/122101001/
2. https://nptel.ac.in/courses/122/101/122101001/

U20MABT02 Advanced Calculus and Complex Analysis

Part A – Introduction of the Course

This course aims to introduce the notion of differentiation and integration in general and sets, functions, limits and continuity of functions in particular. Techniques of derivatives and integration and solving various examples to grasp the idea of each technique are the main objective.

Course Code	Course Category	Course Title	L 3	T 1	P 0	C 4
U20MABT02	B	Advanced Calculus and Complex Analysis	Prerequisite: +2			
Name of the Course Co-Ordinator:		Dr. R. Anbu	Contact Hours: 60			
Course offering Dept/School:		Mathematics & Basic Sciences	Total Marks: 100			

Course Objective and Summary

This course will make students

1. The aim of the Advanced Calculus and Complex Analysis is to equip the students of Engineering and Technology with techniques in Integral calculus, vector calculus, complex variables.
2. Laplace transform with advanced level of mathematics and applications that would be essential to formulate problems in engineering environment.

Course Outcomes (COs)

CO1	**Gain** familiarity in evaluation of multiple integrals using Change of variables (**Apply**)
CO2	**Gain** knowledge in applying the techniques of vector calculus in problems involving science and Engineering in solving ODE (**Apply**)
CO3	Many Engineering problems can be transformed in to problems involving ODE, PDE and Integrals. Laplace transform method and Complex methods can be used for solving them (**Apply**)
CO4	**Gain** knowledge in fundamentals of complex analytic functions and its properties (**Understand**)
CO5	**Gain** knowledge in evaluating improper integrals using Residue Theorem involving problems in science and Engineering (**Apply**)

Mapping/Alignment of COs with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H										L		
CO2	H	H										M		
CO3	H	H										M		
CO4	H	H	M									L		
CO5	H	H	L									M		

(Tick mark or level of correlation: 3-High, 2-Medium,1-Low)

Part B – Content of the Course

UNIT I MULTIPLE INTEGRALS

Evaluation of Double integration Cartesian and plane polar coordinates- Evaluation of double integral by changing of order of integration- Area of double integral (Cartesian) - Area of Double integral (polar) - Triple integration in Cartesian coordinates- Conversation from Cartesian to polar in double integrals - Area of triple integral- Applications of Integral in Engineering. (**Contact Hours-12**)

UNIT II VECTOR CALCULUS

Review of Vectors in 2,3 dimensions- Gradient- divergence - Curl – Solenoidal- Irrotational fields- vector identities (without Proof) -Directional derivatives- Line Integrals- Surface Integrals .Volume Integrals Green's Theorem (without proof) - Gauss divergence theorem (without proof) -Verification Applications to cube- Applications to parallelepiped- Stoke's Theorem (without proof)-Verification - Applications to cubes- Applications to parallelepiped - Application of Line and Volume Integrals in Engineering. **(Contact Hours- 12)**

UNIT III LAPLACE TRANSFORM

Laplace Transforms of standard functions- Transforms properties- Transforms of derivatives and integrals- Initial value theorems (without proof) and Final value theorems (without proof) - verification for some problems- Inverse Laplace transforms using partial fractions – Inverse Laplace transforms using shifting theorem - LT convolution theorem- ILT convolution theorem - LT of periodic functions - Applications of LT for solving Linear ordinary differential equations up to second order with constant coefficient – Solution of integral equation and integral equation involving convolution type- Applications of Laplace transform in Engineering. **(Contact Hours 12)**

UNIT IV ANALYTIC FUNCTIONS

Definition of Analytic function- Cauchy Riemann equations- Properties of analytic function - Determination of analytic function using Milne Thomson's Method - Conformal mappings: magnification, rotations, inversion, reflection- Bilinear transformation- Cauchy's Integral theorem (without proof) - Cauchy's integral theorem applications- Application of Bilinear transformation and Cauchy Integral in Engineering. **(Contact Hours- 12)**

UNIT V COMPLEX INTEGRATION

Cauchy's Integral formulae- Taylor's expansions- Laurent's expansions - Types of poles and Residues - Cauchy's residue theorem (without proof) - Contour Integration: Unit Circle- semicircular contour Application of Contour integration in Engineering. **(Contact Hours 12)**

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9thEdition, John Wiley &Sons, 2006.
2. B. S. Grewal. Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.

Reference Books:

1. Veerarajan.T, Engineering Mathematics for fist years, Tata McGraw - Hill, New Delhi, 2008
2. G.B.Thomas and R.L.Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002
3. Ramana. B.V, Higher Engineering Mathematics, Tata McGraw - Hill, New Delhi, 11th Reprint, 2010
4. N.P.Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, reprint, 2008.

Other Resources (Online Resources or others)

1. Basic Integration (https://www.symbolab.com/)
2. Multiple Integrals (https://www.youtube.com/watch?v=Uexc4hsaFdM&list=PLhSp9OSVmeyLwtQbXv7VRXgoueSFaJGB4)
3. Complex Variables (https://www.youtube.com/watch?v=fmOlwPtaDek&list=PLhSp9OSVmeyITvYvCWwrYBiPkzsCNSOWu)

U20EEEJ01 Basic Electrical and Electronics Engineering

Part A – Introduction of the Course

This course aims to introduce the notion of differentiation and integration in general and sets, functions, limits and continuity of functions in particular. Techniques of derivatives and integration and solving various examples to grasp the idea of each technique are the main objective.

Course Code	Course Category	Course Title	L	T	P	C
U20EEEJ01	Engineering Sciences	Basic Electrical and Electronics Engineering	3	0	2	4
			Pre-requisite: +2			
Name of the Course Coordinator:		Ms. R. Sathyapriya	Contact Hours: 75			
Course offering Dept./ School:		EEE/School of Electrical Engineering	Total Marks: 100			

Course Objective and Summary

The main objective of the course is to impart the fundamental knowledge on electrical and electronic circuits along with its applications. This course helps the students to work in all disciplines of science and technology with all the basic knowledge of electric and magnetic circuits, which are used in the emerging new technologies.

Course Outcomes (COs)

CO1	**Analyse** basic theory utilized in electrical circuits (**Analyze**)
CO2	**Outline** the working principle of direct current and alternative current machine such as transformers, motors and generators. (**Understand**)
CO3	**Experiment** with basic electronics devices. Compare and contrast their uses and constructional features (**Understand**)
CO4	**Identify** the different types of transducers used in measurement of various physical parameters (**Understand**)
CO5	**Apply** binary logic and Boolean expressions for digital circuit design, list the elements in a communication system. (**Apply**)
CO6	**Implementation** of basic electrical circuits, theorem and draw the characteristics of semiconductor devices and transducers (**Manipulation**)

Mapping/Alignment of COs with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M	L											
CO2	H	M	L											
CO3	H	M	L											
CO4	H													
CO5	H	M	M								L			
CO6	H	H	H	L	L					H	L			

(Tick mark or level of correlation: 3-High, 2-Medium,1-Low)

Part B – Content of the Course

UNIT I ELECTRICAL CIRCUITS

Introduction to DC and AC Circuits-Active and Passive elements-Ohms law, Power, Energy-RLC circuits, Ideal and non-Ideal voltage and current sources-Kirchhoff's Current and Voltage Law-Mesh and Nodal Analysis-Superposition Theorem, Thevenin's Theorem-Norton's theorem-Maximum Power Transfer Theorem-Star-Delta Transformation-RL, RC and RLC Transient analysis-Relation between line and phase quantities of three phase balanced circuits and unbalanced circuits.

(Contact Hours – 9)

UNIT II DC MACHINES AND AC MACHINES

Generation of AC Sinusoidal voltage-calculation of Average ,RMS value, Form and Peak factor Analysis of single phase AC circuits, Real, Reactive, Apparent power, Power factor-Magnetic Materials-B-H Characteristics, Simple magnetic circuits, single Phase transformers: Construction, types, ideal, practical transformer-EMF equation-Regulation-Efficiency-construction and working of DC Machines-Types of DC machine connections-OC and load characteristic of Generators-Mechanical characteristics of DC Motor, Armature reaction, Losses, power stages of DC generators, 2 point and 3 point starters-construction and working of AC machines, losses - Single Phase and Three phase machine-working of Induction and synchronous motors. Fractional kW motors. PMSM-BLDC-Stepper Motors. **(Contact Hours – 9)**

UNIT III ELECTRONIC DEVICES

Safety measure in electrical system-Types of wiring, wiring accessories-House wiring for stair case, fluorescent lamp, LED Lamps& corridor wiring-Basic principles of earthing, types of earthing, Grounding in DC circuits-Basic Principles and Classification of instruments-MC and MI Instruments Overview of Semiconductors-PN Junction diode-Zener diode-Diode circuits: Rectifier, Half and Full wave –Bridge rectifier-Filter circuits-Clippers and Clampers-BJT Construction and operation, BJT

Characteristics(CB,CE,CC) and uses-JFET: Construction, operation, characteristics(CS) and uses-MOSFET: Construction ,operation, Characteristics(CS) and uses. **(Contact Hours – 9)**

UNIT IV TRANDUCERS

Transducer function and requirements- Classification: Active and Passive-Displacement: Capacitive, Inductive, Variable inductance-Linear-Variable Differential Transforms (LVDT) Electromechanical: Pressure, Flow, Accelerator, Potentiometer etc-Strain Gauge-Chemical: Ph probes, Electro galvanic sensoretc –Electro acoustics: Mic, Speaker, Piezoelectric, Sonar, Ultrasonic, tactile, Geophones, Hydrophone Electrooptical LED, LASER, Photodiode, Photoresistor, Phototransistor-Photoconductive Cell, Photovoltaic cell, Solar cell-infrared emitters-LCD- Optocouplers thermoelectric: Resistance Temperature-Detectors-Thermocouple-Thermistor Electrostatic: Electrometer Electromagnetic: Antenna, Hall effect, Magnetic cartridge etc-Radio acoustics: Geiger Muller Tubes, Radio Receiver-Radio Transmitter. **(Contact Hours – 9)**

UNIT V DIGITAL SYSTEMS

Number systems-Binary codes-Binary Arithmetic-Boolean algebra, laws and theorems-simplification of Boolean expressions-SOP and POS expressions-standard forms of Boolean expression-simplify using Boolean expressions-Minterm and Maximum-K-Map simple reduction techniques-Two, Three and Four Variables K-map-principle of communication-block diagram of communication system. Amplitude, Frequency and phase modulations-demodulation.

(Contact Hours – 9)

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. R. Muthusubramanian, S.Salivahanan, "Basic Electrical and Electronics Engineering", Tata McGraw-Hill,2012.
2. P.S.Bimbhra, Electrical Machinarey, 7th ed., Khanna Publishers, 2011.

Reference Books:

1. Dash.s.s, Subramani C, Vijayakumar.K, Basic Electrical Engineering,1sted.,Vijay Nicole.
2. S.Salivahanan, N.Sureshkumar"Electronics devices and circuits", Tata McGraw-Hill, 2012.
3. Moris M. Mano, Digital Design, 3rd Pearson, 2011.

11. Other Resources (Online Resources or others)

1. Electrical Engineering ,Prof. T.K. Bhattacharya,Prof. G.D. Roy,Prof. N.K. De,IIT Kharagpur. https://nptel.ac.in/courses/108/105/108105053/
2. Electrical Engineering ,Prof. L. Umanand, IISc Bangalore. https://nptel.ac.in/courses/108/108/108108076/

U20MEEJ02 Basic Civil and Mechanical Engineering

Part A – Introduction of the Course

Course Code	Course Category	Course Title	L	T	P	C
			3	0	2	4
U20MEEJ02	E	Basic Civil and Mechanical Engineering	Pre-requisite +2			
Name of the Course Coordinator		Dr. C.Anbalagan / Mr. V.P. Durairaj	Contact Hrs: 75 Hours			
Course Offering Dept/School		Dept. of Civil and Mechanical Engineering	Total Marks: 100			

Course Objective and Summary

This course will make students familiarize the materials and measurements used in Civil Engineering. To provide the exposure on the fundamental elements of civil engineering structures. To enable the students to distinguish the components and working principle of power plant units, IC engines, and R and AC system.

Course Outcomes (COs)

CO1	**Characterize** building materials and its applications (**Understand**)
CO2	**Understand** the building components and its applications (**Understand**)
CO3	a) **Identify** different transportation systems, water and waste water treatment and its applications b) **Identify** the working of IC engines and understand the need of various auxiliary systems (**Understand**)
CO4	**List** the basic components and analyze the working of major power plants (**Understand**)
CO5	**Identify** manufacturing process of welding (**Apply**)
CO6	**Apply** the basic knowledge of Civil and Mechanical Engineering (**Manipulation**)

Mapping/Alignment of COs with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H		L	H	H		M	M	M	M		M		
CO2	H	M	M	M	H		M	M	M	M		M		
CO3	H	M	M	M	H		M	M	M	M		M		
CO4	H	L	L	L	L		M	M	M	M		M		
CO5	H	L	M	L	M		M	M	M	M		M		
CO6	H	L	L	L	L		M	M	M	M		M		

(Tick mark or level of correlation: 3-High, 2-Medium,1-Low)

Part B – Content of the Course

UNIT I Introduction

Introduction to Civil Engineering, Building Materials, History-Disciplines in Civil Engineering. Early construction and development over time. Ancient Monuments; Peruvuddiyar or Brihadesswarar Temple, Kallanai Dam, TajMahal, Golconda Fort, Angkor Wat, Pyramid Building materials: stone, Classification of Rocks, Quarrying, Dressing, Properties and uses of stones-Mortar. Plain and Reinforced cement concrete-grade and properties and uses-special concretes-Fiber reinforced concrete and Ferro cement, Pre-Stressed concrete-Construction Chemicals-Recycling: construction, demolition wastes-Buildings: classification and selections of site for a building-components of building, Soil, General type of soil and classification-bearing capacity, Factors affecting bearing capacity, -Foundation: Functions, General types of Foundation, Shallow foundations, Deep foundations, Machine foundations. **(Contact hours-9)**

UNIT II Civil Engineering Constructions

Cement Concrete Flooring-Mosaic- Flooring-Marble Flooring-Terrazzo Flooring- Granite flooring-Mosaic tile flooring- Roofs: Types of roofs, Madras terrace roof, trussed roof- Roof covering: Classifications and types- weathering course: classifications and types- stress and stain: types- stress & strain course for mild steel- three moduli of elasticity. Poison's ratio- Ductility, stiffness, simple problems- Transportations: Introduction, Classifications- Highways: Design element, cross section-Classification of roads: administrative and structural- Railways: Zone and Headquarters, permanent way and its requirement- Bridges: Component of Bridges, Classification, types and Structure- Dams: Purpose, Classification, Selection of site, Gravity, advantages and Limitation-Water Supply system. Per capita demand, Factors affecting, Sources of water supply- Water Treatment: Standards of drinking water, layout of treatment plant, slow sand filter, rabid sand filter. **(Contact hours-9)**

UNIT III Water Management

Disinfection of water and its methods, Water distribution system and methods -Sewage collection,

treatment, disposal-methods of collection, Sewage system- Septic tank: principles, working and construction details- Solid waste management: Sources and types of solid waste, collection, Transfer and disposal- Surveying- Leveling: objectives- Classification of surveying, instrument used.

IC Engine:

IC Engine: Classification, Comparisons Engine operation: 2 Stroke & 4 stroke –Comparison of SI & CI engines. Numerical Problems-Engine starting system: battery ignition system. Numerical Problems-Engine starting system: battery ignition system. Magneto ignition system- Fuel supply systems of CI Engine. Fuel injector, working of common Rail Diesel injection Lubrication systems: fuel injector, working of common Rail Diesel injection Lubrication systems. Functions, working of mist and forced lubrication system. Cooling systems: Air and water cooled Engines.

(Contact hours-9).

UNIT IV Power Plants

Coal based thermal power plant: Layout, Components description, working , advantage, disadvantage-Hydro Electric power plant: layout, components, description, working, Nuclear power plant- Nuclear fission and fusion reactions, nuclear reactor, components and description Layout, working merits and demerits of boiling water reactor - Layout, working, merits and demerits of pressurized water reactor. Gas turbine power plants: components and description, working and types gas turbines, methods to improve performance. Layout and working of open cycle and closed cycle plants-Plans with inter cooling, reheating and recognition. Solar Thermal power plant: Layout of flat plate collector-based plant, central receiver type plant, advantages and disadvantages. Ocean Thermal energy conversion system: Layout of open cycle, layout of closed cycle, Advantages and disadvantage. **(Contact hours-9)**

UNIT V Manufacturing Process

Casting introduction and history expendable mold casting process-production steps in a typical sand casting process, Terms including patterns and core-other expandable mold casting: shell molding, vacuum molding- Expanded polystyrene process. Investment casting-metal forming, Forging, Rolling, extrusion, drawing-sheet metal working applications, Cutting operation: shearing, blanking – Materials removal processes: Conventional Lathe with its main components, three and four jaw chuck, Tool and work holding devices-Lathe operations: facing, turning, drilling, Boring and threat cutting_ Overview of radial drilling machine with its main components- Overview if upright drilling machine with its main components. Metal joining process: welding, types, welding equipment, tools and accessories, Types of welding joints: butt, corner, lab, tee edge joint, fillet, groove, plug, spot, seam weld **(Contact hours-9).**

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Nil

Reference Books:

1. Rangwala S.C. Engineering Material, charotar publishing house, Anand, 2012.
2. Patil, Building and Engineering contract, 1974
3. Raju, K.V.B, Ravichandran P.T. Basic of civil Engineering, Ayyappa publication, Chennai, 2012
4. M.S.Shetty, Concrete Technology, S.Chand publications, 2006
5. John B. Heywood, Internal Combustion Engine Fundamentals, Tata McGraw Hill Education, 2017
6. Drbal, Larry F. Boston, Patricia G. Westra, Kayla L. Black, Veatch, Power Plant Engineering, Kluwer, 1995.
7. Serope Kalpakjian, Steven Schmid, Manufacturing process for engineering materials, Pearson, 2016.

Other Resources (Online Resources or others)

2. Nil

U20CSEJ01 Programming for Problem Solving

Part A – Introduction of the Course

Course Code	Course Category	Course Title	L	T	P	C
U20CSEJ01	E	Programming and Problem Solving	3	0	2	4
			Pre-requisite: +2			
Name of the Course Co-Ordinator:		Dr. M. K. Vidhyalakshmi	Contact Hrs: 75			
Course offering Dept/School:		CSE/School of Computing	Total Marks: 100			

Course Objective and Summary

This course will make students

1. Contemplate and construct algorithm, flowchart and pseudocode to do programs.
2. Employ operators and expressions to solve engineering problems.
3. Handle data in single and multi-dimensional arrays.
4. Develop routines that are user defined and can be used in various applications.
5. Build storage constructs using structure and unions.
6. Build and deploy files to store and retrieve information.
7. Construct the programming steps and procedures to solve various Engineering applications.

Course Outcomes (COs)

CO1	**Identify** methods to solve a problem through computer programming. List the basic data types and variables in C (**Remember**)
CO2	**Apply** the logic operators and expressions. Use loop constructs and recursion. Use array to store and retrieve data. (**Apply**)
CO3	**Analyze** programs that need storage and form single and multidimensional arrays. Use pre-processor constructor in C (**Analyze**)
CO4	**Create** user defined functions for mathematical and other logical operations. Use pointer to address memory and data. (**Analyze**)
CO5	**Create** Structures and unions to represent data constructs. Use files to store and retrieve data (**Analyze**)
CO6	**Apply** programming concepts to solve problem. Learn about how C programming can be effectively used for solutions (**Manipulate**)

Mapping/Alignment of COs with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	H	H	H	H			M	M	L		H	L	
CO2	L	H	H	H	H			M	M	L		H	L	
CO3	L	H	H	H	H			M	M	L		H	L	
CO4	L	H	H	H	H			M	M	L		H	M	
CO5	L	H	H	H	H			M	M	L		H	M	
CO6	L	H	H	H	H			M	M	L		H	M	

(Tick mark or level of correlation: 3-High, 2-Medium,1-Low)

Part B – Content of the Course

UNIT I INTRODUCTION

Evolution of programming & languages – problem solving through programming – Creating algorithms – Drawing flowcharts- Writing pseudocode- Evolution of C language, its usage history– Input and output functions: printf and scanf – Variables and identifiers – Expressions- single line and multiline comments – Constants, Keywords – Values, Names, Scope, Binding, Storage classes– Numeric data types: integer- Numeric Data types: floating point – Non-Numeric data types: char and string - Increment and decrement operator – comma, Arrow and assignment operator – Bitwise and Size of operator. **(Contact Hours – 9)**

UNIT II OPERATORS & LOOPING STATEMENTS

Relational and logical operators-condition operators- operator precedence – expressions with pre/post increment operator – expressions with conditional and assignment operators- if statement in expression –l- value and r-value in expression– control statements – if else, else if and nested if – switch case – iterations, conditional and unconditional branches – for loop, while loop, do while loop, goto, break, continue – array basics and types – array initialization and declaration -initialization of one dimensional array – accessing and indexing one dimensional array – Array operations – One dimensional array operations. **(Contact Hours – 9)**

UNIT III ARRAY & FUNCTIONS

Initializing and accessing 2D array-initializing multidimensional array-array programs-2D array contiguous memory- array advantages and limitations-array construction for real time applications - common programming errors- string basics - string declaration and initialization- string functions-gets(), puts()- getchar() - putchar()- printf()- string functions – atoi, strlen, strcat, strcmp, - string functions :sprint, sscanf, strrev, strcpy, strtok,- arithmetic characters on strings – functions declaration and definition – types: call by value, call by reference - function with and without arguments and no return values – passing arrays to functions with return types- recursion and recursion functions. **(Contact Hours – 9)**

UNIT IV FUNCTIONS & POINTERS

Passing array element to function – formal and actual parameters – advantages of using functions – processor directives and #define directives – nested preprocessor macro – advantages of using functions – pointers and address operator – size of pointer variable and pointer operator – pointer declaration and dereferencing pointer – void pointer and size of void pointers – arithmetic operations – incrementing pointers– constant pointers – pointers to array elements and strings – function pointers – array of function pointers – accessing array of function pointers – null pointers.

(Contact Hours – 9)

UNIT V STRUCTURE & UNION

Initializing Structure, Declaring structure variable – structure using typedef, Accessing members– Nested structure – Accessing elements in a structured array – Array of structure – Accessing elements in structure array – Passing Array of structure to function – Array of pointers to structures – Bit manipulation to structure and pointer to structure – Union Basic and declaration – Accessing union members- Pointers to Union – Dynamic memory allocation, mallaoc, realloc, free – Allocation Dynamic array – Multidimensional array using dynamic memory allocation – file:opening, defining, closing, File modes, File types – writing contents into a file – Reading file contents – Appending an existing file – File permissions and rights – changing permissions and rights. **(Contact Hours – 9)**

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1 Nil

Reference Books:

1 Nil

Other Resources (Online Resources or others)

1 Nil

U20BTBT01 Biology for Engineers

Part A – Introduction of the Course

Course Code	Course Category	Course Title	L	T	P	C
U20BTBT01	B	Biology for Engineers	2	0	0	2
			Pre-requisite: +2			
Name of the Course Coordinator		Ms. M. Priya	Contact Hrs: 30			
Course offering Dept/School:		Biotechnology/School of Bio Engineering	Total Marks: 100			

Course Objective and Summary

This course will provide a basic understanding of biological mechanisms of living organisms from the perspective of engineers. In addition, the course is expected to encourage engineering students to think about solving biological problems with engineering tools.

Course Outcomes (COs)

CO1	**Define** the fundamental structural units of all living things. (**Remember**)
CO2	**Explain** the functions of biological molecules. **(Understand)**
CO3	**Describe** the kinetic mechanism of catalysed reactions. **(Understand)**
CO4	**Illustrate** the methods involved in cellular transport and energy production. **(Understand)**
CO5	**Discuss** the role of signaling in cellular biology. **(Understand)**

Mapping/Alignment of Cos with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	H	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	M	-	-	-	-	-	-	-	-	-	-	L	-	-
CO4	M	-	L	-	-	-	L	-	-	L	-	L	-	-
CO5	M	-	-	-	-	-	-	-	-	-	-	L	-	-

(Tick mark or level of correlation: 3-High, 2-Medium,1-Low)

Part B – Content of the Course

UNIT I FROM ATOMS TO ORGANISMS

The Cell: the basic unit of life- Molecular components of cell - Expression of genetic information - Protein structure and function - Cell metabolism - Cells maintains their internal environments – Cells respond to their external environments - Cells grow and reproduce – Cells differentiate.

(Contact Hours – 6)

UNIT II THE MOLECULAR DESIGN OF LIFE

Biochemistry and the Genomic revolution – DNA illustrates the relation between form and function - Biochemical unity underlies biological diversity – Chemical bonds in biochemistry - Biochemistry and human biology - Protein synthesis requires the translation of nucleotide sequence into amino acid sequences – Aminoacyl- Transfer RNA synthetases read the genetic code - A ribosome is a ribonucleoprotein particle (70 S) made of small (30S) and a large (50S) subunit - Protein factors play a key role in protein synthesis - Eukaryotic protein synthesis differs from prokaryotic protein synthesis primarily in translation initiation . **(Contact Hours – 6)**

UNIT III CATALYTIC STRATEGIES

Proteases facilitating a difficult reaction – Making a fast reaction faster: Carbonic anhydrases - Restriction enzymes: Performing highly specific DNA - Cleavage reaction - Nucleoside –

Monophosphate kinases – Catalysing phosphoryl group exchange between nucleotides without promoting hydrolysis Metabolism – anabolism and catabolism - Photosynthesis and carbon fixation - Biological energy production. (**Contact Hours – 6)**

UNIT IV MECHANOCHEMISTRY

How protein motors convert chemical energy into mechanical work – Brief description of ATP synthase structure - The F1 motor: A power stroke – A pure power stroke - Coupling and coordination of motor – Measures of efficiency - F1 motor of ATP synthase - The bacterial flagellar motor – Motor driven by H and Na ion flux - Proton motive force - Sodium motive force- Ion flux - Molecular motor directionality- Chimeric kinesin motors - Backwards myosins - Chimeric myosin motors – Bidirectional dyneins. **(Contact Hours – 6)**

UNIT V SENSORY AND IMMUNO SYSTEMS

General principles of cell signaling – Signaling via G protein linked cell surface receptors - Signaling via enzyme linked cell surface receptors - Target cell adaptation -The logic of intracellular signaling: Lessons from computer-based “Neural Networks” - The cellular basis of immunity -The functional properties of antibodies - The fine structure of antibodies - The generation of antibody diversity- T cell receptors and subclasses - MHC molecules and antigen presentation to T cells - Cytotoxic T cells - Helper T cells and T cell activation – Selection of the T cell repertoire.**(Contact Hours – 6)**

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. The cell, Geoffrey M.Cooper & Robert E. Housman, Sinauer Associates Inc, 2015
2. Biochemistry, 5th Edition, Jeremy M Berg, John L Tymoczko, and Lubert Stryer, W.H.Freeman and Company, 2002.

Reference Books:

1. Lehninger Principles of Biochemistry 6th Edition by David L. Nelson, Michael M. Cox
2. Molecular Biology of the cell.4th Edition, Alberts B, Johnson A, Lewis J, et al. New York: Garland Science; 2002.
3. Cell Biology and Histology, Leslie P. Gartner and James L, Hiatt, Wolters Kluwer, 2014

Other Resources (Online Resources or others)

1. https://nptel.ac.in/courses/121/106/121106008/

U20MABT03 Transforms and Boundary Values Problems

Part A – Introduction of the Course

Transforms and boundary value problems are fundamentals to virtually all of higher mathematics and its applications in the natural, social, and management sciences. These topics, therefore, form the core of the basic requirements in mathematics both for mathematics majors and for students of science and engineering.

Course Code	Course Category	Course Title	L 3	T 1	P 0	C 4
U20MABT03	B	Transforms and Boundary Values Problems	Pre-requisite: U20MABT02- Advanced Calculus and Complex Analysis			
Name of the CourseCoordinator		Dr. S. Anusuya	Contact Hrs: 60			
Course offering Dept./School		Mathematics & Basic Sciences	Total Marks: 100			

Course Objective and Summary

This course will make students

1. To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems?
2. To acquaint the student with Fourier transform techniques used in wide variety of situations.
3. To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z transform techniques for discrete time Systems.

Course Outcomes (COs)

CO1	**Expand** given function using the knowledge of Fourier Series and frequently needed practical harmonic analysis that an Engineer may have to make from discrete data. (**Apply**)
CO2	**Solve** PDE and Higher order with constant co-efficient and physically interpret the results. (**Apply**)
CO3	**Apply** PDE in Boundary Value Problems and Analyze the solution involving PDE. (**Apply**)
CO4	**Solve** many problems in Engineering by applying Fourier Transforms with the possible special cases with attention to their applications. (**Apply**)
CO5	**Apply** the basics of Z- Transforms in its applicability to discretely varying functions gained the skill of formulate certain problems in terms of difference equation and solve them using the Z- Transforms techniques. (**Apply**)

Mapping/Alignment of Cos with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	-	-	-	-	-	-	-	-	-	L		
CO2	H	H	-	-	L	-	-	-	-	-	-	M		
CO3	H	H	-	-	M	-	-	-	-	-	-	M		
CO4	H	H	M	-	L	-	-	-	-	-	-	L		
CO5	H	H	L	-	-	-	-	-	-	-	-	M		

(Tick mark or level of correlation: 3-High, 2-Medium,1-Low)

Part B – Content of the Course

UNIT I FOURIER SERIES (9+3)

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

UNIT II PARTIAL DIFFERENTIALEQUATIONS (9+3)

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 (9+3)

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 FOURIER TRANSFORMS (9+3)

Fourier integral theorem (without proof) – Fourier transform pairs – Fourier sine and cosine transform – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

UNIT V Z– TRANSFORMS AND DIFFERENCE EQUATIONS (9+3)

Z – Transform – Elementary properties – Inverse Z – Transform – Convolution theorem –Formation of difference equations– Solution of difference equations using Z–Transform.

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Kandasamy, P., etal., Engineering Mathematics, Vol. II & Vol. III, S. Chand & Co., New Delhi, 2000
2. Grewal B.S, "Higher Engg Maths", Khanna Publications, 2012.
3. Kreyszig. E, "Advanced Engineering Mathematics", John Wiley & Sons. Singapore, 2012.

Reference Books:

1. Sivaramakrishna Das P. and Vijayakumari.C, A text book of Engineering Mathematics III,2010
2. Narayanan. S., Manickavachagom Pillay. T . and Ramanaiah, G., Advanced Mathematics for Engineering students, Volume II & III (2nd edition), S,V iswanathan Printers and Publishers, 1992
3. Venkataraman, M, K., Engineering Mathematics - Vol.III - A & B, National Publishing Co., Chennai, 1998.
4. Veerarajan, T., Engineering mathematics", Tata McGraw-Hill (Education) India Pvt. Ltd, 2006

Other Resources (Online Resources or others)

1. Partial differential equations (https://www.math.uni-leipzig.de/~miersemann/pdebook.pdf)
2. Fourier Series (https://www.studocu.com/row/document/makerere-university/electrical-engineering/fourier-series-engineering-mathematics/6364142)
3. Boundary value problems (https://sites.ualberta.ca/~niksirat/ODE/chapter-7ode.pdf)
4. Fourier Transforms (https://www.thefouriertransform.com/)
5. Z – Transforms (https://learn.lboro.ac.uk/archive/olmp/olmp_resources/pages/workbooks_1_50_jan2008/Workbook21/21_2_bscs_z_trnsfm_thry.pdf)

U20ASCT01 Introduction to Space Science & Applications

Part A – Introduction of the Course

To make students to acquire knowledge about the atmospheric conditions, spacecraft, history of space technology, fundamental principles of space vehicles and systems.

Course Code	Course Category	Course Title	L 2	T 0	P 0	C 2
U20ASCT01	C	Introduction to Space Science & Applications	Pre-requisite: +2			
Name of the Course Coordinator		Mr. M. Edwin	Contact Hrs: 30			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students

1. Ability to use and incorporate fundamental Principles to study the broad field of Aerospace Systems.
2. Learn the Atmospheric parameter changes with altitude
3. Ability to identify the types & classifications of components and control systems
4. To understand the evolution, and structure of Space
5. To introduce the basic concepts of Jet and Rocket Propulsion

Course Outcomes (COs)

CO1	**Explain** the nature of different airspace vehicle (**Understand**)
CO2	**Describe** the Principle of Aerodynamics to flight (**Understand**)
CO3	**Describe** the contribution of space vehicle components, materials and structures with their functions (**Understand**)
CO4	**Describe** the gravitational law, Kepler's law and Newton's law to the space vehicle (**Understand**)
CO5	**Summarize** the Operating principle and performance of propulsion system, Rockets, Satellites at global level (**Understand**)

Mapping/Alignment of Cos with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H											H	L	L
CO2	H											H	L	L
CO3	H									H		H	L	L
CO4	H									H		H	L	L
CO5	H											H	L	L

(Tick mark or level of correlation: H-High, M-Medium, L-Low)

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment to Cos
1	**Module 1: Atmosphere and Aerospace History** Standard Atmosphere-Various altitudes-International Standard Atmosphere- History of Flight-Space environment-Anatomy of Airplane & Rocket Vehicles- Space craft-Overview- Space Flight Analogs and human factors	6	CO1
2	**Module 2: Physics of Flight** Aircraft Nomenclatures-. Incompressible Flow- -Coanda Effect - Evolution of Lift, Drag – Airfoils- Compressible flows- Mach number, UAV's MAV's –classification-Application.	6	CO2
3	**Module 3: Flight Mechanics** Drag- Components & contribution-Calculation of Lift and Drag-Thrust-Power Available and Required-Critical Mach no-Steady Level Flight- Phases of Flight- Introduction to structural assembly of wing and fuselage.	6	CO3
4	**Module 4: Space Science** Solar System- planets- types- formation of solar system, Planetary motion-Keplar's law-Stars- Stellar Characteristics-Stellar evolution and Structure-Universe-Fate and Expansion of Universe- Extraterritorial Missions- Introduction to Reentry.	6	CO4
5	**Module 5: Propulsion & Space Agencies** Air & Non Air breathing Engines- Classification- Principles-Applications- Launch Vehicle Dynamics- basic Orbital Mechanics-Satellites-Architecture & Applications-LEO- GEO- Evolution of Sounding Rockets- Contribution of ISRO, NASA,ISA-Astronauts-Chandryan -I & II- Mangalyan-Mission to Mars.	6	CO5

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Anderson, J.D., Introduction to Flight, McGraw-Hill; 8th edition, 2015
2. A. Brandt, Introduction to aeronautics: A design perspective, 2nd edition, AIAA Education Series, 2004.

Reference Books:

1. Kermode, A.C. Flight without Formulae, Pearson Education; Eleven edition, 2011
2. L J Clancy: Aerodynamics
3. E L Houghton and PW Carpenter, "Aerodynamics for Engineering students", Sixth edition,

Edward Arnold publications, 2012

4. Howard D. Curtis, “Orbital Mechanics for Engineering Students”, Elsevier Butterworth Heinemann, Third Edition, 2010
5. Sutton, G.P. “Rocket Propulsion Elements”, John Wiley, 2012.

Other Resources (Online Resources or others)

1. https://nptel.ac.in/courses/101/101/101101079/

U20ASCT02 Fundamentals of Thermal Engineering

Part A – Introduction of the Course

To make students to understand the Laws of Thermodynamics and Conditions for Energy Transformation.

Course Code	Course Category	Course Title	L 2	T 1	P 0	C 3
U20ASCT02	C	Fundamentals of Thermal Engineering	U20CYBJ01-Engineering Chemistry U20MEEJ02 – Basic Civil and Mechanical Engineering			
Name of the Course-Coordinator		Mr. G. Abinicks Raja	Contact Hrs: 45			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students

1. To impart the knowledge of work, heat, and laws of thermodynamics.
2. To impart the knowledge of the concept of entropy
3. To impart the knowledge of the working of gas turbine cycles, heat transfer and air compressors

Course Outcomes (COs)

CO1	**Explain** the fundamental thermodynamic laws and concepts, work, various types of works and heat and its applications (**Apply**)
CO2	**Apply** Second law of thermodynamics to relevant systems **(Apply)**
CO3	**Describe** the process in various air standard cycles (**Understand**)
CO4	**Explain** the operating principles and properties of Brayton cycle (**Understand**)
CO5	**Describe** the fundamentals of heat transfer (**Apply**)
CO6	**Explain** the operations of Air Compressor (**Understand**)

Mapping/Alignment of Cos with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H											H	M	
CO2	H									H		H	M	
CO3	H											H	M	
CO4	H									H		H	M	
CO5	H											H	M	
CO6	H											H	M	

(Tick mark or level of correlation: 3-High, 2-Medium, 1-Low)

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment to Cos
1	**Topic 1: First law of Thermodynamics** System-boundary-surroundings-state-intensive & extensive properties-energy interactions-work and heat transfer-equilibrium-zeroth law-first law-internal energy-applications	8	CO1
2	**Topic 2: Second law of Thermodynamics** Second law-Kelvin and Planck statement-Clausius Statement-reversibility-Irreversibility -principles of entropy-availability-entropy change in non-flow process-Carnot cycle	8	CO2
3	**Topic 3: Air standard Cycles** Otto Cycle-Diesel Cycle-Dual cycle-Joule Brayton Cycle-Sterling Cycle-Efficiencies- Mean Effective Pressures.	8	CO3
4	**Topic 4: Aircraft Propulsion Cycles** Brayton cycle-Intercooling- Reheat and Regeneration – Ideal Jet Propulsion cycles	8	CO4
5	**Topic 5: Heat Transfer** Elements of Heat Transfer- Basics of Conduction-convection-Radiation Heat Transfer in Extended Surfaces	7	CO5
6	**Topic 6: Air Compressors** Working Principles- Work of compressor- with and without clearance-Iso-thermal and Isentropic efficiency-Reciprocating Air compressors-with and without Intercooler	6	CO6

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA -2, CLA -3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Nag. P. K, Engineering Thermodynamics, Tata McGraw Hill Pub. 5th Edition, 2013.
2. Yunus, A. Cenegal and Michael A. Boies, Thermodynamics: An engineering approach, Tata MacGraw Hill publishing company, Seventh Edition 2011

Reference Books:

1. Holman J. P, Thermodynamics, McGraw Hill, Fifth edition, 2007
2. Rathakrishnan.E, Fundamentals of Engineering Thermodynamics, Prentice- Hall, India, 2005.
3. Arora C. P, Thermodynamics, McGraw Hill, 2003.

Other Resources (Online Resources or others)

1. http://nptel.ac.in/courses/112105123/

U20ASCT03 Applied Dynamics and Vibrations

Part A – Introduction of the Course

This course introduces students to the concepts of dynamic responses of mechanical structures and introduces them to the methods of solving them.

Course Code	Course Category	Course Title	L 2	T 1	P 0	C 3
U20ASCT03	C	Applied Dynamics and Vibrations	Pre-requisite: U20MEET01- Engineering Mechanics			
Name of the Course-Coordinator		Mr. R. Bhoominathan	Contact Hrs: 45			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students

1. To understand the fundamental components of mechanisms
2. To analyze the force-motion relationship in standard mechanisms that are subjected to external forces
3. To analyze the undesirable effects of unbalances resulting from prescribed motions in mechanism
4. To understand free and forced vibrations of single and multi-degrees vibrating systems

Course Outcomes (COs)

CO1	**Explain** various inversions of mechanisms and **estimate** the velocity and accelerations. (**Apply**)
CO2	**Explain** the force-motion relationship of mechanisms and the effects of unbalances subjected to external forces (**Apply**)
CO3	**Solve** problem on free vibrations of single degree of freedom systems (**Apply**)
CO4	**Solve** problem on forced vibrations of single degree of freedom systems (**Apply**)
CO5	**Estimate** the natural frequency of multi degrees of freedom systems (**Apply**)

Mapping/Alignment of Cos with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M										L	H	
CO2	H	M										L	H	
CO3	H	M										L	H	
CO4	H	M								H		L	H	
CO5	H	M								H		L	H	

(Tick mark or level of correlation: 3-High, 2-Medium, 1-Low)

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment to COs
1	**Topic 1 - Mechanisms** Machine 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.	9	CO1
2	**Topic 2 - Force Analysis and Balancing** Static and Dynamic Force analysis – Inertial Force and Inertial torque – D Alembert's principle-– Static and dynamic balancing —Balancing of reciprocating and rotating masses- primary balancing and secondary balancing	9	CO2
3	**Topic 3 - Free Vibration** Basic features of vibratory systems – Degrees of freedom- Single degree of freedom – Free Vibration-Equations of motion- Natural frequency – Types of damping – Damped vibration – Torsional vibrational of shaft – critical speeds of shafts	9	CO3
4	**Topic 4 - Forced Vibration** Response of single degree of freedom systems-Harmonic excitations– Disturbance caused by unbalance – support motion – transmissibility – vibration isolation	9	CO4
5	**Topic 5- Vibrations of Multi Degree of Freedom Systems** Two degrees of freedom systems, static and dynamic couplings, Principal co-ordinates, Eigen values, Principal modes, orthogonal condition, Vibration absorbers – vibrations of continuous systems, Approximate methods-Rayleigh's method, Dunkerleys method, Holzer method.	9	CO5

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA -3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Rattan, S.S, "Theory of Machines", McGraw-Hill Education Pvt. Ltd., 2014.
2. Grover. G.K., "Mechanical Vibrations", 7th Edition, Nem-Chand Brothers, India, 2003.
3. S. S. Rao, "Mechanical Vibrations", Sixth Edition, Pearson, 2018.

Reference Books:

1. Khurmi R.S. "Theory of Machines" S. Chand & Co., Delhi, 2013
2. Thomson W T, 'Theory of Vibration with Application' - CBS Publishers, 1990

Other Resources (Online Resources or others)

1. https://archive.nptel.ac.in/courses/101/105/101105081/

U20ASCT04 Aerospace Materials and Process

Part A – Introduction of the Course

This course introduces the basic concepts of materials science to undergraduate aeronautical and aerospace engineering students.

Course Code	Course Category	Course Title	L	T	P	C
			2	0	0	2
U20ASCT04	C	Aerospace Materials and Process	Pre-requisite: U20CYBJ01-Engineering Chemistry U20MEEJ02 – Basic Civil and Mechanical Engineering			
Name of the Course-Coordinator		Mr. R. Karthikeyan	Contact Hrs: 30			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students

1. To familiarize the concepts of materials and its development.
2. To describe the principles of material requirements for aerospace applications.
3. To explain key factors that determine the performance of aerospace materials.
4. To impart the knowledge on crystal structure and microstructures of metals and alloys
5. To familiarize students with scientific principles behind alloying and their heat/mechanical treatment.

Course Outcomes (COs)

CO1	**Explain** the mechanical properties and microstructure of metals and alloys (**Understand**)
CO2	**Explain** Properties of Light Alloys, Steels & Composites. (**Understand**)
CO3	**Explain** the effect of high temperature materials used in aerospace applications. (**Understand**)
CO4	**Describe** the heat treatment processes and corrosion resistance metals and alloys. (**Understand**)
CO5	**Explain** the significant of modern materials and its applications. (**Understand**)

Mapping/Alignment of COs with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H											H		
CO2	H											H		
CO3	H									M		H		
CO4	H									M		H		
CO5	H											H		

(Tick mark or level of correlation: 3-High, 2-Medium, 1-Low)

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment to COs
1	**Topic 1: Atomic Structure of Materials** General properties of materials - Structure of solid materials – Atomic structure of materials – crystal structure – miller indices – density – packing factor – space lattices – x-ray diffraction – imperfection in crystals – General requirements of materials for aerospace applications	6	CO1
2	**Topic 2: Alloy Materials for Aerospace Structures** Aluminum Alloys – Al Li Alloys – Al Mg Alloys – Al Cu Alloys – Al Zn Alloys, Titanium Alloys – α β Titanium Alloy – Steel Alloy – Low Alloy Steel – High Alloy Steel, Magnesium Alloys.	6	CO2
3	**Topic 3: High Temperature and Advanced Materials** Intermetallic Alloy - Super Alloys – Composites, classification and manufacturing – Refractory Materials -Ceramic Matrix Composites – Shape Memory Alloys – Stealth Materials – Piezoceramic Materials – Coating and Paint Materials.	6	CO3
4	**Topic 4: Phase Diagrams, Heat Treatment and Corrosion** Solid solutions - Hume Rothery's rules - Gibbs-phase rule - unary & binary phase diagrams - lever rule - microstructural changes during cooling; Heat treatment and its types - Protection Hardening – Case Hardening – Annealing – Normalizing – Tempering of carbon steel, Corrosion and its types - Effect of corrosion on mechanical properties –Corrosion resistant materials used in aerospace vehicles.	9	CO4
5	**Topic 5: Modern Materials** Significance of Nanocomposites in aerospace applications, Introduction to graphene, spider silk, silica aerogel and metamaterials and their applications.	3	CO5

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA -2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Callister, William D., and David G. Rethwisch. Materials science and engineering: an introduction. Vol. 9. New York: Wiley, 2018.
2. Raghavan, Viswanatha. "Materials science and engineering: a first course." Prentice-Hall of India Private Limited, 1979.

Reference Books:

1. George F. Titterton, "Aircraft materials and processes", 5th Edition, Himalyan Books, New Delhi.

Other Resources (Online Resources or others)

1. https://archive.nptel.ac.in/courses/113/106/113106032/

U20ASCT05 Spacecraft Instrumentation

Part A – Introduction of the Course

The main objective of this course is to introduce students to the concepts of various flight systems cockpit displays, autopilot systems, engine instruments and communication devices used in Aircraft, Space Vehicles and Satellite.

Course Code	Course Category	Course Title	L 2	T 0	P 0	C 2
U20ASCT05	C	Spacecraft Instrumentation	Pre-requisite: U20EEEJ01-Basic Electrical and Electronics Engineering			
Name of the Course Coordinator		Ms. Praveena S	Contact Hrs: 30			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students

1. The students will understand the available basic concepts of Flight instruments to the engineers and the necessary knowledge that are needed in understanding their significance and operation.
2. The students will also have an exposure to various topics such as measurement concepts, air data sensors and measurements, Flight Management Systems, and other instruments pertaining to Gyroscopic measurements and Engine data measurements and will be able to deploy these skills effectively in understanding and analyzing the instrumentation methods in avionics engineering.

Course Outcomes (COs)

CO1	**Describe** the basic principles of spacecraft instrumentation, including sensors, actuators, and air data acquisition systems. (**Understand**)
CO2	**Explain** the different types of gyroscopic instruments used in navigation, such as rate gyros, attitude gyros, and its properties. (**Understand**)
CO3	**Describe** the principles of power plant instrumentation, including measurement of parameters such as temperature, pressure, flow, and level. (**Understand**)
CO4	**Explain** design, calibration, and operation of guided missile instruments, including considerations for auto pilot, target tracking, and mission requirements. (Understand)
CO5	**Describe** principles and functions of instruments used in spacecraft for navigation, communication, scientific observation, and other purposes. (**Understand**)

Mapping/Alignment of Cos with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M											M		H
CO2	M									M		M		H
CO3	M											M		H
CO4	M									M		M		H
CO5	M											M		H

(Tick mark or level of correlation: 3-High, 2-Medium,1-Low)

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment to COs
1	**Topic 1: Measurement Science and Air Data Instruments** Instrumentation brief review- Functional elements of an instrument system –Transducers - classification - Static and dynamic characteristics- calibration - classification of aircraft instruments - Air data instruments-airspeed, altitude, Vertical speed indicators. Static Air temperature, Angle of attack measurement, Synchronous data transmission system.	7	CO1
2	**Topic 2: Gyroscopic Instruments** Gyroscope and its properties, gyro system, Gyro horizon, Direction gyro-direction indicator, Rate gyro-rate of turn and slip indicator, turn coordinator, acceleration and turning errors.	6	CO1
3	**Topic 3: Power Plant Instruments** Pressure measurement, temperature measurement, fuel quantity measurement, engine power and control instruments-measurement of RPM, manifold pressure, torque, exhaust gas temperature, EPR, fuel flow, engine vibration, monitoring.	7	CO3
4	**Topic 4: Guided Missile Instruments** Autopilots — Definitions, Types of Autopilots, Example Applications-Open-loop autopilots. Inertial instruments and feedback. Autopilot response, stability, and agility, Target tracker – missile tracker – guidance computer – beam riding – Active radar systems.	6	CO4
5	**Topic 5: Spacecraft Instruments** Introduction - Radiometer, Spectrophotometers, Magnetometer, Particle Detectors, Seismometers	4	CO5

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Pallet, E.H.J., "Aircraft Instruments: Principles and Applications", Pearson, 2009.
2. Doeblin. E. O, "Measurement Systems Application and Design", McGraw-Hill, New York, 1999.
3. Pallet, E.H.J. "Aircraft Instruments & Integrated systems", McGraw-Hill, 1992.

Reference Books:

1. Murthy, D.V.S., 'Transducers and Measurements', McGraw-Hill, 1995.
2. Mohan S. R., "Fundamentals of Guided Missiles", Cataloguing-in-Publication, 2016.

Other Resources (Online Resources or others)

1. Nil

U20ASCT06 Spacecraft Communication

Part A – Introduction of the Course

It gives comprehensive study of electromagnetic theory, wave propagation, radiation pattern and types of antennas used for communication in spacecraft.

Course Code	Course Category	Course Title	L	T	P	C
U20ASCT06	C	Spacecraft Communication	2	0	0	2
Pre-requisite: U20MABT02- Advanced Calculus and Complex Analysis U20EEEJ01- Basic Electrical and Electronics Engineering						
Name of the Course Coordinator		Mr. R Ayyapparishi	Contact Hrs: 30			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students

1. To understand the concepts of electromagnetic theory and wave propagation.
2. To understand antenna operation and types as well as their usage in real time field.
3. To outline the basics of aircraft, space vehicle and satellite communication.

Course Outcomes (COs)

CO1	**Explain** the concepts of electromagnetic waves and its various modes of propagation. (**Understand**)
CO2	**Explain** the antenna fundamentals and radiation properties. (**Understand**)
CO3	**Describe** the working of radar systems and its types. (**Remember**)
CO4	**Explain** the concepts of wireless telemetry system and ground station (**Understand**)
CO5	**Outline** the basics of communication networks, frequency bands and deep space network in satellite communication. (**Understand**)

Mapping/Alignment of COs with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M											M		H
CO2	M											M		H
CO3	M											M		H
CO4	M									M		M		H
CO5	M									M		M		H

(Tick mark or level of correlation: 3-High, 2-Medium, 1-Low)

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment to Cos
1	**Topic 1: Electromagnetic Theory and Wave Propagation** Introduction to Electromagnetic Theory, Electromagnetic spectrum, Radio frequency and Microwave based wireless communication, Maxwell's equation, Electromagnetic wave equation, Plane waves in lossy and lossless mediums. Wave Propagation: Modes of propagation, Structure of atmosphere, Ground wave propagation, Tropospheric propagation, Duct propagation, Tropo-scatter propagation, Flat earth and curved earth concept, Sky wave propagation.	7	CO1
2	**Topic 2: Electromagnetic Radiation and Antennas** Introduction to electromagnetic radiation, Hertzian dipole, antennas as transmitters/ receivers, antenna parameters: impedance, bandwidth, directivity, gain, efficiency, beam-width, polarization and efficiency; common types of antennas: wire, array; Introduction to radiometry and systems.	5	CO2
3	**Topic 3: Aircraft Communication** Nature of radar and applications, radar equation, radar block diagram and operation, prediction of range performance, pulse radar, Doppler radar, airborne radar, space borne radar, VHF and HF communication,	5	CO3
4	**Topic 4: Telemetry and Space Vehicle Communications** Introduction to telemetry, components of a typical wireless telemetry system, radio wave propagation, frequency band, range, airborne telemetry system, ground station telemetry.	5	CO4
5	**Topic 5: Satellite Communications** Historical background, Basic concepts of Satellite Communications, Communication Networks and Services, Comparison of Network Transmission technologies, Satellite uplink and downlink, Deep Space Network, Analog and digital communication schemes for satellite communication, Atmospheric losses, ionospheric effects, rain attenuation, polarization effects in satellite communication, Space relay.	8	CO5

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Dennis Roddy., Satellite Communications, 4th Edition, McGraw-Hill, 2006.

Reference Books:

1. Timothy Pratt,Charles W. Bostian,Jeremy E. Allnutt., Satellite Communications, Wiley, 2002.
2. Ghosh S.N., Electromagnetic Theory and Wave Propagation, Narosa Publisher, 2002.

Other Resources (Online Resources or others)

1. Nil

U20ASCJ01 Fluid Mechanics for Aerospace Engineers

Part A – Introduction of the Course

To make students understand flow characteristics and different types of flow and application of dimensional analysis.

Course Code	Course Category	Course Title	L 2	T 0	P 2	C 3
U20ASCJ01	C	Fluid Mechanics for Aerospace Engineers	Pre-requisite: U20MEET01- Engineering Mechanics			
Name of the Course-Coordinator		Dr. Surekha Rathi Samundi D	Contact Hrs: 60			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students

1. To introduce the basic concepts of fluid Kinematics.
2. To Introduce basic laws governing fluid motion and its application
3. To Provide Knowledge about the concept of basic airflow

Course Outcomes (COs)

CO1	**Explain** the properties of different fluids and Fluid Characteristics (**Understand**)
CO2	**Describe** the Incompressible Inviscid Flows and Elementary Flows (**Understand**)
CO3	**Describe** the non-dimensional parameters used in airflow. (**Understand**)
CO4	**Describe** the nature of Boundary layer separation over a bluff and slender body (**Understand**)
CO5	**Determine** the geometric features of airfoils with the help of conformal transformations. (**Apply**)
CO6	**Acquire** data using the conservation laws to determine the coefficient of discharge of a venturimeter and Orificemeter. **(Manipulation)**
CO7	**Carry out** the pressure distribution of a symmetric airfoil using subsonic wind tunnel**. (Imitation)**
CO8	**Perform** the Bernoulli's test to show the sum of kinetic, potential and pressure energy of fluid is same at any point in the tube. **(Precision)**

Mapping/Alignment of COs with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H								H		H	H	
CO2	H	H										H	H	
CO3	H	H										H	H	
CO4	H	H								H		H	H	
CO5	H	H										H	H	
CO6	H							H	H	H		H	H	
CO7	H							H	H	H		H	H	
CO8	H							H	H	H		H	H	

(Tick mark or level of correlation: 3-High, 2-Medium,1-Low)

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment to COs
1	**Topic 1: Basic Aerodynamic Principles** Definition of a fluid – Fluid properties - Pressure distribution in a static fluid, - Continuum hypothesis Methods describing Fluid motion, Lagrangian and Eulerian Methods –Continuity equation, Equations of motion-Euler's equation of motion and Bernoulli's equation - Energy equation-Momentum equation – and its Applications.	8	CO1
	Practical • Determination of coefficient of discharge of Venturimeter. • Determination of coefficient of discharge of Orifice meter. • Verification of Bernoulli's theorem.	15	CO6, CO7 & CO8
2	**Topic 2: Fundamentals of Inviscid Flows** Streamlines, Path lines and Streak lines, velocity potential function and stream function. Types of motion circulation and Vorticity - D'Alembert's Paradox, Magnus effect - Elementary Flows and their combinations - KuttaJoukowski Theorem, Starting Vortex, Kutta condition.	8	CO2
3	**Topic 3: Dimensional Analysis** Dimensionless groups- Homogeneity Principle- Buckingham Pi Theorem-Non-Dimensional Numbers- similarity- Relationship between Similarity an d Dimensional Analysis	4	CO3
4	**Topic 4: Viscous Flow Theory** Laminar Boundary layer and its thickness, displacement thickness, momentum thickness, Energy thickness, 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	4	CO4
5	**Topic 5: Airfoil Theory** Complex Potential, Methodology of Conformal Transformation, Kutta-Joukowski transformation and its applications, Karman Trefftz Profiles, Thin Airfoil theory and its applications.	6	CO5

	Practical • Calibration of Subsonic wind tunnel. • Estimation of Pressure distribution of symmetric airfoil. • Estimation of Pressure distribution on cylinder.	15	CO6, CO7 & CO8

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

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

Reference Books:

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

Other Resources (Online Resources or others)

1. https://nptel.ac.in/courses/112/105/112105171/
2. https://nptel.ac.in/courses/112/104/112104118/
3. https://nptel.ac.in/courses/105/103/105103192/

U20ASCJ02 Fundamentals of Aerospace Structures

Part A – Introduction of the Course

This course introduces students to the concepts of internal reaction forces, stress, strain and deformation in various structural members subjected to different types of loads.

Course Code	Course Category	Course Title	L 2	T 0	P 2	C 3
U20ASCJ02	C	Fundamentals of Aerospace Structures	Pre-requisite: U20PYBJ04 Engineering Physics for Aero Engineers			
Name of the Course-Coordinator		Dr. C. Suresh Kumar	Contact Hrs: 60			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students

1. To introduce students to the different structural components of aircraft/spacecraft and let them appreciate the significance of learning Strength of Materials.
2. To provide the students, an understanding about the basics of stress, strain, tensile material properties, Hooke's law.
3. To develop the basic understanding of torsion of structural members.
4. To provide the students, an understanding of column buckling and critical load.
5. To develop the basic understanding about the combined loading and stress transformation.
6. To impart knowledge of beams bending and deflection estimation.

Course Outcomes (COs)

CO1	**Explain** the structural components of airplane and spacecraft (**Understand**)
CO2	**Compute** the stress developed in statically determinate and indeterminate structures subjected to axial load. (**Apply**)
CO3	**Determine** power transmission and shear stress in circular shaft, and axial deformation of helical springs. (**Apply**)
CO4	**Compute** the buckling load and crippling stress of columns with different end conditions. (**Apply**)
CO5	**Determine** the principal stress induced in structural components using analytical and graphical methods. (**Apply**)
CO6	**Estimate** the bending stresses, shear stress and deflection in beams. (**Analyze**)
CO7	**Carry out** elementary mechanical coupon testing of materials as per the given procedure. (**Imitation**)
CO8	**Acquire** data using the available measuring devices. (**Manipulation**)
CO9	**Perform** basic mathematical calculation using the appropriate formulae and represent the results in form of graph and table (**Precision**)

Mapping/Alignment of COs with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M								H		H	H	
CO2	H	M										H	H	
CO3	H	M										H	H	
CO4	H	M										H	H	
CO5	H	M										H	H	
CO6	H	M								H		H	H	
CO7	H	M						H	H	H		H	H	
CO8	H	M						H	H	H		H	H	
CO9	H	M						H	H	H		H	H	

(Tick mark or level of correlation: 3-High, 2-Medium, 1-Low)

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment to Cos
1	**Topic 1: Aircraft & Spacecraft Structural Components** Design philosophy for light-weight structures: truss based, monocoque and semi-monocoque; Structural components of aircraft: wing & fuselage; Structural components of spacecraft.	2	CO1
2	**Topic 2: Analysis of Bars due to Uniaxial Loads** Introduction to deformable materials: homogeneity and isotropy; Mechanical properties of engineering materials; Stress-strain curve, Hooke's law, Relation between three elastic moduli; Statically determinate and indeterminate problems in tension and compression; Thermal stress and strain; Composite bars.	5	CO2
	Lab experiment: Uniaxial tensile testing of MS/Al specimens to determine the basic material properties.	6	CO7, CO8, CO9
3	**Topic 3: Torsion** Torsion of solid and hollow circular shafts: Power transmission by circular shafts; Composite shaft: parallel and series connection; Torsion of open and closed-coiled helical springs: stress and deflection.	4	CO3
	Lab experiment: Torsion testing of circular bar; Determination of spring constant of helical spring.	6	CO7, CO8, CO9
4	**Topic 4: Column Buckling** Euler column buckling: governing ODE, Critical loads for different support conditions; Rankine empirical formula; Euler's column curve; Effect of eccentric loading; Effect of initial curvature.	5	CO4
	Lab experiment: Buckling of columns.	3	CO7, CO8, CO9

5	**Topic 5: Bi-Axial Stress** Combined loading: Thin cylindrical and spherical shell under internal pressure; Plane stress, 2D Stress transformation, Mohr's circle - principal stresses and maximum shear stress.	4	CO5
	Lab experiment: Combined bending and torsion experiment	3	CO7, CO8, CO9
6	**Topic 6: Stress in Beam Bending** Shear force and bending moment diagrams for statically determinate beams, Relationship among loads, shear force and bending moments; Euler-Bernoulli's beam theory: bending and shear stresses due to pure and non-uniform bending for Rectangular, Circular, I-section and T-section.	5	CO6
	Lab experiment: Constant strength beam test; Plotting of bending stress distribution	6	CO7, CO8, CO9
7	**Topic 7: Deflection of Beam** Deflection of beam: Double integration method, Macaulay's method, method of superposition and moment area method.	5	CO6
	Lab experiment: Four or three-point beam bending experiment	6	CO7, CO8, CO9

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. James M. Gere, Mechanics of Materials, Ninth Edition, Cengage Learning India Pvt. Ltd.
2. Federal Aviation Administration, Pilot's Handbook of Aeronautical Knowledge.
3. R K Rajput, Strength of Materials, Sixth Edition, S Chand & Co Ltd

Reference Books:

1. Gere & Timoshenko, Mechanics of Materials, McGraw Hill, India.
2. Stephen Timoshenko, Strength of Materials, Vol I & II, CBS Publishers India.
3. E. P. Popov, Mechanics of Materials, Second Edition, Pearson India.
4. R. C. Hibbeler, Mechanics of Materials, Ninth Edition, Pearson India.

Other Resources (Online Resources or others)

1. https://nptel.ac.in/courses/112/107/112107146/
2. https://ocw.mit.edu/courses/mechanical-engineering

U20MABT04 Numerical Methods for Engineers

Part A – Introduction of the Course

This course covers the most important Numerical Methods that an Engineer should know including Root finding, Matrix Algebra, Integration & Interpolation, ODE, PDE. The numerical results give a reasonable understanding of how materials behave. Students will learn not only how to solve but also how they can apply those solutions in everyday life like to construct a beam in a building, to estimate the ocean currents, air flow patterns in the respiratory tract, modelling combustion flow in a coal power plant and transport and disposition of chemicals through ODEs & PDEs.

Course Code	Course Category	Course Title	L 3	T 1	P 0	C 4
U20MABT04	B	Numerical Methods for Engineers	Pre-requisite: U20MABT03-Transforms and Boundary Values Problems			
Name of the Course-Coordinator		Dr. Dr.V.Vetrivel	Contact Hrs: 60			
Course offering Dept./School		Mathematics & Basic Sciences	Total Marks: 100			

Course Objective and Summary

This course will make students

1. Introduce the basic concepts of solving algebraic & transcendental equations.
2. Introduce the numerical techniques of interpolation in various intervals and numerical techniques of differentiation and integration which plays an important role in engineering and technology disciplines.
3. To acquaint the knowledge of various techniques and methods of solving ordinary and partial differential equations.

Course Outcomes (COs)

CO1	**Apply** Newton-Raphson, Regula-Falsi Methods and to solve Linear System of Polynomial and Transcendental Equations using various methods. (**Apply**)
CO2	**Interpolate** the value of a dependent variable in the given data by Newton's Forward and Backward Difference Formulae and also for unequal intervals. (**Apply**)
CO3	**Understand** the concept of Numerical Differentiation and Integration using Trapezoidal and Simpson's Rules. (**Apply**)
CO4	**Solve** Initial Value Problems of ODE by applying Taylor's Series and Runge-Kutta Methods. (**Apply**)
CO5	**Solve** Two Dimensional Laplace, Poisson Equations and apply Finite Difference Method in one-dimensional Heat and Wave Equations of PDE. (**Apply**)

Mapping/Alignment of COs with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H										H		
CO2	H	H										M		
CO3	H	H	M									M		
CO4	H	H	L									M		
CO5	H	H	L									M		

(Tick mark or level of correlation: 3-High, 2-Medium, 1-Low)

Part B – Content of the Course

UNIT I Solution of Polynomial and Transcendental Equations (9+3)

Introduction – 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-Seidel Method.

UNIT II Interpolation (9+3)

Introduction-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 (9+3)

Introduction-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 (9+3)

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 – Applications.

UNIT V Boundary value problems for ordinary and partial differential equations (9+3)

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 – Applications.

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Rao, K.Sankara, "Numerical Methods for Scientists and Engineers", PHI Learning Pvt. Ltd., 2017.
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", 4th edition, 2005.

Reference Books:

1. James F. Epperson, "An Introduction to Numerical Methods and Analysis", 2nd Edn. John Wiley & Sons, Inc, 2013.
2. Dennis G. Zill and Warren S. Wright., "Advanced Engineering Mathematics", 3rd Edn. Jones & Bartlett Publishers, UK. 1992.
3. P. Kandasamy, K. Thilagavathy, K. Gunavathi – "Numerical Methods", S. Chand & Company, 2nd Edition 2010.

Other Resources (Online Resources or others)

1. Nil

U20ASCJ03 Low and High Speed Aerodynamics

Part A – Introduction of the Course

To make students understand flow characteristics and different types of flow.

Course Code	Course Category	Course Title	L 3	T 0	P 2	C 4
U20ASCJ03	C	Low and High-speed Aerodynamics	Pre-requisite: U20ASCJ01-Fluid Mechanics for Aerospace Engineers; U20BTBT01 – Biology for Engineers			
Name of the Course Coordinator		Dr. Surekha Rathi Samundi D	Contact Hrs: 75			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students

1. To equip the students with the basic concepts necessary to understand the flow around low speed aircrafts.
2. To give 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.

Course Outcomes (COs)

CO1	**Apply** the concept of lift generation and the factors for efficient wing design. (**Apply**)
CO2	**Show** that subsonic nozzle is convergent and supersonic nozzle is divergent, with variation in pressure and temperature. (**Apply**)
CO3	**Calculate** the properties of flow through shock and expansion waves. (**Apply**)
CO4	**Discuss** the performance characteristics of a convergent divergent nozzle **(Understand)**
CO5	**Describe** the various aspects of Transonic Flow Over Wing surfaces. (**Understand**)
CO6	**Carry out** flow analysis over various aerodynamic models. (**Imitation**)
CO7	**Demonstrate** the qualitative analysis of the shock pattern by using shadowgraph technique (**Manipulation**)
CO8	**Carry out** the experiments of jet flows. (**Imitation**)

Mapping/Alignment of COs with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L										H	H	
CO2	H	L										H	H	
CO3	H	H								M		H	H	
CO4	H	L								M		H	H	
CO5	H	H										H	H	
CO6	H	H		H				H	H	H		H	H	
CO7	H	H		H				H	H	H		H	H	
CO8	H	H		H				H	H	H		H	H	

(Tick mark or level of correlation: 3-High, 2-Medium, 1-Low)

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment to Cos
1	**Topic 1: Finite Wing Theory** Vortex system – Starting vortex, trailing vortex, bound vortex system and horseshoe vortex. Laws of vortex motion - Helmholtz's theorem, Biot-Savart law, Lifting Line Theory and its limitations, Elliptic lift distribution	9	CO1
2	**Topic 2: Fundamental Aspects of Compressible Flow** 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.	9	CO2
3	**Topic 3: Shocks and Expansion Waves** **Normal Shock waves:** Normal shock relations for a perfect gas, Hugoniot equation, Shock tube, **Oblique shocks and expansion waves:** Oblique shock relations, θ-β-M relation, Shock Polar, supersonic flow over a wedge, supersonic compression, supersonic expansion, Prandtl - Meyer Expansion, Shock expansion theory, Thin airfoil theory.	9	CO3
4	**Topic 4: Potential equation for compressible flow** 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	9	CO4

5	**Topic 5: Transonic Flow Over Wing** Lower and upper critical Mach numbers, Lift and drag divergence, shock induced separation, Characteristics of swept wings, Effects of thickness, camber and aspect ratio of wings, Transonic area rule.	9	CO5
	Practical • Pressure distribution over symmetrical and unsymmetrical airfoil at various angle of attack • Velocity profiles of free and wall jets. • Study on supersonic wind tunnel • Wall pressure measurements of subsonic diffusers • Velocity and pressure measurements of high-speed jets. • Qualitative analysis of circular jet using shadowgraph	30	CO6 , CO7 & CO8

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

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

Reference Books:

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

Other Resources (Online Resources or others)

1. Nil

U20ASCJ04 Advanced Aerospace Structures

Part A – Introduction of the Course

This course introduces students to the concepts of analyzing indeterminate structures and thin-walled structures and introduces them to energy methods.

Course Code	Course Category	Course Title	L 3	T 0	P 2	C 4
U20ASCJ04	C	Advanced Aerospace Structures	Pre-requisite: U20ASCJ02-Fundamentals of Aerospace Structures			
Name of the Course Coordinator		Mr. M. K. Karthik	Contact Hrs: 75			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students

1. To acquaint students with the analysis of statically determinate and indeterminate structures.
2. To determine the displacement of truss member structures.
3. To introduce energy methods to find deflection of structural members
4. To introduce the concept of unsymmetrical bending stress and crippling strength of thin-walled sections
5. To discuss about the shear flow distribution of open and closed sections.

Course Outcomes (COs)

CO1	**Determine** the displacement and forces acting in the members of statically determinate truss. **(Apply)**
CO2	**Calculate** the slope and deflection of statically indeterminate beams. **(Apply)**
CO3	**Calculate** the deflection and strain energy of statically determinate structures using energy method. **(Apply)**
CO4	**Compute** the bending stress distribution of unsymmetrical section beam and crippling strength of thin plates **(Apply)**
CO5	**Estimate** the shear flow distribution and shear center in open and closed thin-walled sections. **(Apply)**
CO6	**Carry out** elementary mechanical coupon testing of materials as per the given procedure**. (Imitation)**
CO7	**Acquire** data using the available measuring devices**. (Manipulation)**
CO8	**Perform** basic mathematical calculation using the appropriate formulae and represent the results in form of graph and table **(Precision)**

Mapping/Alignment of COs with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M			M							H	H	
CO2	H	M			M					H		H	H	
CO3	H	M			M					H		H	H	
CO4	H	M			M							H	H	
CO5	H	M			M							H	H	
CO6	H	M		L				H	H	H		H	H	
CO7	H	M		L				H	H	H		H	H	
CO8	H	M		L				H	H	H		H	H	

(Tick mark or level of correlation: 3-High, 2-Medium,1-Low)

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment to COs
1	**Topic 1: Analysis of Trusses** Statically determinate plane trusses using method of joints, method of sections, space truss, Deflection of truss using unit load method, problems specific to aerospace applications.	9	CO1
2	**Topic 2: Analysis of statically indeterminate beam** Analysis of propped cantilever beam, fixed-fixed beam and continuous beam using compatibility and equilibrium methods: Clapeyron's three moment theorem and moment distribution method.	9	CO2
	Lab experiment: Determination of deflection in indeterminate beams.	3	CO6, CO7, CO8
3	**Topic 3: Energy Methods** Strain energy evaluation in structural members under axial, shear, torsion, bending and impact loading. Deflection of beam using energy method: Castigliano's first and second theorems; Principle of virtual work, Dummy load, Maxwell's reciprocal theorem.	9	CO3
	Lab experiment: Verification of Maxwell's reciprocal theorem	6	CO6, CO7, CO8
4	**Topic 4: Bending of beams and buckling of thin plates** Bending of beam with unsymmetric cross-sections, Bending of closed and open sections, thin-walled beams, Idealization of thin-walled structures: boomed structures.Buckling of plates; Inelastic buckling of plates; instability of stiffened panels: local buckling stress of thin - walled sections, crippling strength by Needham's and Gerard's methods, load carrying capacity of sheet stiffener panels, effective width, inter-rivet and sheet wrinkling failures.	9	CO4
	Lab experiment: Unsymmetrical Bending of a Beam; Wagner beam-Tension field beam	12	CO6, CO7, CO8

5	**Topic 5: Shear of Open and Closed sections** Shear flow and shear center determination in open section, thin-walled section – structural idealization. Bredt - Batho theory – single-cell and multi-cell tubes subject to torsion, thin-walled single & multi-cell structures subject to combined bending torsion – with walls effective and ineffective in bending.	9	CO5
	Lab experiment: Determine shear center of open sections; Determine shear center of closed sections.	9	CO6, CO7, CO8

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Donaldson, B.K., Analysis of Aircraft Structures – An Introduction, McGraw-Hill,1993.
2. Megson T M G, Aircraft Structures for Engineering Students, Edward Arnold Publishers.
3. Bruhn.E.F., Analysis and design of flight vehicle structures, Tri set of offset company, 1973.

Reference Books:

1. Timoshenko, S., Strength of Materials, Vol. I and II, Princeton D. Von Nostrand Co, 1990.
2. Perry, Aircraft Structures, McGraw-Hill, 1950.
3. Rivello, Theory and Analysis of Flight Structures, McGraw-Hill, 1969.

Other Resources (Online Resources or others)

1. https://onlinecourses.nptel.ac.in/noc20_ae08/preview

U20ASCJ05 Aerospace Propulsion

Part A – Introduction of the Course

To make students to understand the basics of gas turbine engine types and performance characteristics of gas turbine components such as inlet, compressor, combustor, turbine and nozzle.

Course Code	Course Category	Course Title	L	T	P	C
			2	0	2	3
U20ASCJ05	C	Aerospace Propulsion	Pre-requisite: U20ASCT02- Fundamentals of Thermal Engineering			
Name of the Course-Coordinator		Dr. N. Rajamurugu	Contact Hrs: 60			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students

1. To get the knowledge of design and working of gas turbine.
2. To gain the idea of selecting the compressor, turbine for various gas turbine applications.
3. To gain the knowledge of High Mach engines like ramjet, scramjet engines.

Course Outcomes (COs)

CO1	**Compare** the performance characteristics of turbojet, turbofan, turboprop and propeller engines. (**Understand**)
CO2	**Discuss** the types and working and design selection criteria for inlets and nozzles. **(Understand)**
CO3	**Explain** the working principle of axial and centrifugal flow compressors. And turbines **(Understand)**
CO4	**Describe** the working, types, and design of combustion chamber with application **(Understand)**
CO5	**Summarize** the working principle, modes of operation and performance parameters of Ramjet engine and the challenges involved in scramjet design. **(Understand)**
CO6	**Acquire** the knowledge on flow through jets using existing jet setup. **(Manipulation)**
CO7	**Perform** pressure calculation analysis using propulsive devices. **(Manipulation)**
CO8	**Learn** the various performance of power plants/engines. **(Precision)**

Mapping/Alignment of COs with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H											H		H
CO2	H									H		H		H
CO3	H											H		H
CO4	H									H		H		H
CO5	H											H		H
CO6	H							H	H	H		H		H
CO7	H							H	H	H		H		H
CO8	H							H	H	H		H		H

(Tick mark or level of correlation: 3-High, 2-Medium,1-Low)

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment to Cos
1	**FUNDAMENTALS OF ENGINES** Gas turbine engine cycle - Engine performance parameters – Efficiencies, Methods of thrust augmentation-factors affecting thrust – Characteristics of propeller, turboprop, turbofan and turbojet engines.	6	CO1
2	**INLETS AND NOZZLES** 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 –Over expanded and under expanded nozzles-Thrust reversal	6	CO2
3	**COMPRESSORS AND TURBINE** Types of compressors ,Centrifugal compressor– Work done and pressure rise– Velocity diagrams – Concept of pre whirl – Operating Principle of axial flow compressor – Velocity triangles – degree of reaction – Centrifugal and Axial compressor performance characteristics-radial flow turbine-matching of compressors and turbine	6	CO3
4	**COMBUSTION CHAMBERS** Classification of combustion chambers - Combustion process – Important factors affecting combustion chamber design -Combustion chamber performance – Effect of operating variables on performance – Flame tube cooling –Flame stabilization – flame holders.	6	CO4
5	**RAMJET AND SCRAM JET PROPULSION** Operating principle of ramjet engine – Components of ramjet engines and their efficiencies – Combustion in ramjet engine- problems associated with supersonic combustion– Types of scramjet combustors – Fuel injection schemes in scramjet combustors	6	CO5

	Experiments • Study the propeller characteristics • Estimation of the calorific value of the fuel using a bomb calorimeter • Study of gas turbine engine components. • Calculation of viscosity using a Redwood viscometer • Study of the RAMJET engine working model • Determination of Flash point and Fire point.	30	CO6, CO7 CO8

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Loh, Wellington HT, ed. Jet, rocket, nuclear, ion and electric propulsion: theory and design. Vol. 7. Springer Science & Business Media, 2012.
2. V. Ganesan, Gas Turbines, McGraw Hill Education India, 2010.

Reference Books:

1. Sutton, George P., and Oscar Biblarz. Rocket propulsion elements. John Wiley & Sons, 2016.
2. Mishra, D. P. Fundamentals of rocket propulsion. CRC Press, 2017.

Other Resources (Online Resources or others)

1. Nil

U20ASCJ06 Avionics

Part A – Introduction of the Course

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

Course Code	Course Category	Course Title	L 2	T 0	P 2	C 3
U20ASCJ06	C	AVIONICS	Pre-requisite: U20ASCT05-Spacecraft Instrumentation			
Name of the Course Coordinator		Mr. N. Kalaimani	Contact Hrs: 60			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students

1. To introduce the basic of avionics and its need for civil and military aircrafts.
2. To impart knowledge about the avionic architecture and various avionics data buses.
3. To gain more knowledge on various avionics subsystems.
4. To study the stability analysis and design using MATLAB.

Course Outcomes (COs)

CO1	**Discuss** the working principles of various avionic sub-systems and automated flight control systems. **(Understand)**
CO2	**Compare** various display technologies used in civil and military cockpits. **(Understand)**
CO3	**Discuss** Avionics system architecture and various data-buses. **(Understand)**
CO4	**Discuss** the operational principle of Aircraft Navigation Systems. **(Understand)**
CO5	**Explain** Air data Instruments used in modern aircrafts. **(Understand)**
CO6	**Observe** and explain the functionality and importance of each system. (**Imitation**)
CO7	**Carry out** the demonstration and response of the avionics system. (**Manipulation**)
CO8	**Observe** the output of the digital circuits and verify the stability characteristics of the avionics system. (**Imitation**)

Mapping/Alignment of Cos with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H											H	H	
CO2	H											H	H	
CO3	H											H	H	
CO4	H									H		H	H	
CO5	H									H		H	H	
CO6	H			M	H			H	H	H		H	H	
CO7	H	M		M				H	H	H		H	H	
CO8	H			M	H			H	H	H		H	H	

(Tick mark or level of correlation: H-High, M-Medium, L-Low)

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment to COs
1	**Topic 1: INTRODUCTION TO AVIONICS** Need for avionics in civil and military aircraft and space systems – integrated avionics and weapon systems – typical avionics subsystems, design, technologies –Microprocessors - Introduction to digital computer and memories.	6	CO1
2	**Topic 2: COCKPIT DISPLAYS** Display technologies –LED, LCD, CRT, Flat Panel Display, Primary Flight parameter displays – Head UP Display, Helmet Mounted Display, Night vision goggles, Head Down Display, MFD, MFK, Virtual cockpit.	6	CO2
3	**Topic 3: DIGITAL AVIONICS ARCHITECTURE** Avionics system architecture – data buses – MIL-STD-1553B – ARINC – 420 – ARINC – 629	6	CO3
4	**Topic 4: INTRODUCTION TO NAVIGATION SYSTEMS** Radio navigation – ADF, DME, VOR, LORAN, DECCA, OMEGA, ILS, MLS – Inertial Navigation Systems (INS) – Inertial sensors, INS block diagram – Satellite navigation systems – GPS.	6	CO4
5	**Topic 5: AIR DATA SYSTEMS AND AUTOPILOT** Air data quantities – Altitude, Airspeed, Mach no., Vertical speed, Total Air temperature, Stall warning, Altitude warning. Autopilot – basic principles – longitudinal and lateral autopilot. Digital Fly by wire.	6	CO5

6	**Experiments:** 1. Addition/Subtraction of binary numbers. 2. Multiplexer/Demultiplexer Circuits. 3. Encoder/Decoder Circuits. 4. Addition / Subtraction of 8 bit and 16-bit numbers. 5. Sorting of Data in Ascending & Descending order. 6. Root Locus Analysis for Pitch Displacement Autopilot Stability. 7. Bode Plot Analysis for Pitch Displacement Autopilot Stability 8. Design of P, PI, and PID controller for aircraft dynamics.	30	CO6, CO7 & CO8

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

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

Reference Books:

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

Other Resources (Online Resources or others)

1. https://nptel.ac.in/courses/101108056

U20ASCT07 Control Theory

Part A – Introduction of the Course

This course is designed to equip students with the fundamental principles and techniques necessary for understanding, modeling, and designing control systems.

Course Code	Course Category	Course Title	L 3	T 0	P 0	C 3
U20ASCT07	C	Control Theory	Pre-requisite: U20MABT03-Transforms and Boundary Values Problems U20EEEJ01- Basic Electrical and Electronics Engineering			
Name of the Course Coordinator		Ms. S. Praveena	Contact Hrs: 45			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students

1. To understand dynamics, design and analysis of control systems to meet the desired specifications.
2. To understand the significance of steady-state error and explore the application of P, PI, and PID modes in feedback control.
3. To Gain insights into frequency response and its importance in control system analysis.
4. To understand the role of the characteristics equation in stability analysis

Course Outcomes (COs)

CO1	**Explain** the representation of transfer functions in control systems. **(Understand)**
CO2	**Differentiate** between various types of test inputs and their impact on system behavior**. (Understand)**
CO3	**Construct** Bode and polar plots to visually represent the behavior of systems in the frequency domain**. (Apply)**
CO4	**Apply** different stability criteria to assess the stability of control systems**.(Apply**)
CO5	**Analyze** the time domain behavior using lead, lag, and lead-lag compensators**. (Analyze)**

Mapping/Alignment of Cos with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H										H	M	H
CO2	H	H			H					H		H	M	H
CO3	H	H										H	M	H
CO4	H	H			H					H		H	M	H
CO5	H	H										H	M	H

(Tick mark or level of correlation: H-High, M-Medium, L-Low)

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment to COs
1	**Topic 1: SYSTEM REPRESENTATION AND MODELLING** Introduction and need for Control Systems with examples- Feedback systems- Open loop and Closed loop systems- Transfer Function Model- – Mathematical Modelling of Mechanical, Electrical, Pneumatic and Hydraulic systems- Block Diagram reduction- Signal flow graph.	9	CO1
2	**Topic 2: TIME RESPONSE** 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.	9	CO2
3	**Topic 3: FREQUENCY DOMAIN ANALYSIS** Frequency response – Bode plot- polar plot – Determination of closed loop response from open loop response – Correlation between frequency domain and time domain specifications.	9	CO3
4	**Topic 4: CONCEPT OF STABILITY** Characteristics equation – Root Locus construction - Routh Hurwitz stability criterion- Nyquist stability criterion – Stability analysis – Experimental determination of Transfer Functions.	9	CO4
5	**Topic 5: CONTROL SYSTEM DESIGN** Lead, lag, lag-lead compensation using time domain analysis. control system design using frequency domain analysis - lead, lag, lag-lead compensation using frequency domain analysis	9	CO5

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Nagarath.I.J. and Gopal M, "Control System Engineering', New Age International Publishers, New Delhi, 2015.

Reference Books:

1. OGATO, Modern Control Engineering, Fifth Edition, Prentice-Hall, 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
5. Nagoor Kani, "Control Systems", RBA Publications (P) Ltd., 2014

Other Resources (Online Resources or others)

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

U20ASCT08 Orbital Mechanics

Part A – Introduction of the Course

To make students understand the motions of spacecraft moving under the influence of gravity.

Course Code	Course Category	Course Title	L 2	T 1	P 0	C 3
U20ASCT08	C	Orbital Mechanics	Pre-requisite: U20ASCT01-Introduction to Space Science & Applications; U20ASCT03-Applied Dynamics and Vibrations			
Name of the Course-Coordinator		Dr. Hamza Naseem	Contact Hrs: 45			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students

1. To understand the motion of two bodies under the influence of their gravity fields.
2. To calculate orbital position and velocity as a function of time.
3. To understand different orbital frames, transformation and orbital elements.
4. To determine orbit of an object moving in space.
5. To familiarize with the orbital maneuvers of spacecraft.

Course Outcomes (COs)

CO1	**Discover** the motion of two bodies under the influence of their gravity fields (**Understand**)
CO2	**Determine** orbital position and velocity as a function of time (**Apply**)
CO3	**Compare** orbital frames, transformation and orbital elements (**Understand**)
CO4	**Predict** the orbit of an object moving in space (**Apply**)
CO5	**Explain** orbital maneuvers and docking (**Apply**)

Mapping/Alignment of COs with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M										H		H
CO2	H	M										H		H
CO3	H	M								H		H		H
CO4	H	M								H		H		H
CO5	H	M										H		H

(Tick mark or level of correlation: 3-High, 2-Medium,1-Low)

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment to Cos
1	**Topic 1: Motion of Two Bodies** Review of motion of a particle; Newton's law of motion; Relative motion; Momentum conservation; Kepler's law; Orbit equation; Energy law; Conic sections; Circular orbit; Elliptical orbit; Parabolic trajectories; Hyperbolic trajectories;	6+3	CO1
2	**Topic 2: Orbital Position and Velocity as a Function of Time** Position and velocity of orbiting bodies in terms of a known initial conditions; Time of flight as a function of true anomaly: different orbits and trajectories; Universal Formulation for Time-of-Flight; Stumpff functions; Universal Variable Formulation; Classical Formulations of the Kepler Problem.	6+3	CO2
3	**Topic 3: Orbits in Three Dimensions** Heliocentric-ecliptic coordinate system; Geocentric right ascension–declination frame; Geocentric equatorial frame; Perifocal coordinate system; Classical orbital elements; Coordinate transformation; Transformation between geocentric equatorial and perifocal frames; Effects of the earth's oblateness; Topocentric coordinate system.	6+3	CO3
4	**Topic 4: Orbit Determination** Orbit determination from one radar observation; Ground Track of a Satellite; Orbit determination from three position vectors (Gibbs' method); Orbit determination from optical sighting; Lambert's problem; Sidereal time; Gauss's method of preliminary orbit determination; Solution of the Gauss Problem via Universal Variables.	6+3	CO4
5	**Topic 5: Orbital Maneuvers** Low & high altitude earth orbits; In-plane and out-plane orbit maneuvers; Impulsive maneuvers; Hohmann transfer; Phasing maneuvers; Non-Hohmann transfer; Chase maneuvers; Orbital rendezvous in planetary orbits; Docking	6+3	CO5

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Bate, R.R., Mueller, D.D., White, J.E. and Saylor, W.W., 2020. Fundamentals of astrodynamics. Courier Dover Publications.
2. Curtis, H., 2013. Orbital mechanics for engineering students. Butterworth-Heinemann.

Reference Books:

1. Chobotov, V.A. ed., 2002. Orbital Mechanics. AIAA.

Other Resources (Online Resources or others)

1. https://archive.nptel.ac.in/courses/101/105/101105083/

U20MABT05 Probability and Statistics

Part A – Introduction of the Course

Probability helps to bring logic to a world replete with randomness and uncertainty. It will give the tools needed to understand data, science, philosophy, engineering, economics, and finance. Students will learn not only how to solve challenging technical problems, but also how you can apply those solutions in everyday life.

Course Code	Course Category	Course Title	L	T	P	C
			3	1	0	4
U20MABT05	B	Probability and Statistics	Pre-requisite: U20MABT04 – Numerical Methods for Engineers			
Name of the Course-Coordinator		Dr. N. Ramya	Contact Hrs: 60			
Course offering Dept./School		Mathematics & Basic Sciences	Total Marks: 100			

Course Objective and Summary

This course will make students

1. To develop analytical capability and to impart knowledge in probability methods and their applications in Engineering and Technology.
2. To acquire the basic knowledge towards the working principles of random process and its various types.
3. To provide the required skill to apply the statistical tools in engineering problems.

Course Outcomes (COs)

CO1	**Understand** the basic concepts of probability and apply them in Engineering and Technology. (**Apply**)
CO2	**Solve** the problems using the basic concepts of probability, some standard distributions and Random Variables in Engineering. (**Apply**)
CO3	**Explain** the basic concepts of two-dimensional random variables and apply them in solving correlation and regression problems. (**Apply**)
CO4	**Apply** and analyse the concepts of testing of hypothesis for small and large samples. (**Apply**)
CO5	**Apply** the basic concepts of classifications of design of experiments. (**Apply**)

Mapping/Alignment of COs with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	M		M							M		
CO2	H	H	M		M							M		
CO3	H	H	M		M							M		
CO4	H	H	L		M							M		
CO5	H	H	L		M							M		

(Tick mark or level of correlation: 3-High, 2-Medium,1-Low)

Part B – Content of the Course

UNIT I - PROBABILITY AND RANDOM VARIABLES (9+3)

Probability concepts – Conditional Probability – Random Variable – Discrete and Continuous Random Variables – Expectations – Moments – Moment Generating Function – Function of a Random Variables.

UNIT II - STANDARD DISTRIBUTIONS (9+3)

Discrete Distributions: Binomial, Poisson and Geometric Distributions - Continuous Distributions: Exponential, Normal and Uniform Distributions.

UNIT III - TWO DIMENSIONAL RANDOM VARIABLES (9+3)

Joint Distributions -Marginal and Conditional Distributions – Covariance - Correlation and Regression for Two Variables - Transformation of Random Variables.

UNIT IV - TESTING OF HYPOTHESIS (9+3)

Large Sample Test based on Normal Distribution for Single Mean and Difference of Means and Proportion - Tests based on t, and F distributions for Mean and Variance - Chi-Square Test for Goodness of Fit - Contingency table (test for independent).

UNIT V - DESIGN OF EXPERIMENTS (9+3)

One way and Two way classifications – Completely Randomized Design – Randomized Block Design – Latin Square Design.

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Papoulis. A and Unni Krishna pillai. S, "Probability, Random Variables and Stochastic Processes",4th Edition, Mc Graw Hill Education India, 2010.
2. Milton J. S and Arnold. J.C, "Introduction to Probability and Statistics", Tata McGraw Hill, 2007.
3. Johnson R.A. and Gupta. C.B, "Miller and Freund's Probability and Statistics for Engineers", 7th Edition, Pearson Education Asia, 2007.
4. Gupta. S.C & Kapoor. V.K, "Fundamentals of Mathematical Statistics", Sultan Chand and Sons, New Delhi, 2003.

Reference Books:

1. Hwei Hsu, "Schaum's Outline of Theory and Problems of Probability, Random Variables and Random Processes", Tata McGraw Hill Edition, New Delhi, 2004.
2. Veerarajan T, "Fundamentals of Mathematical Statistics", Yes Dee Publishing, 2017.
3. Walpole R.E, Myers R.H, Myers S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", Pearson Education Asia, 2007.
4. Ross, S.M, "Introduction to Probability and Statistics for Engineers and Scientists", Elsevier, 2004.

Other Resources (Online Resources or others)

1. https://nptel.ac.in/courses/117105085
2. https://archive.nptel.ac.in/courses/103/106/103106120/

U20ASCT09 Spacecraft Propulsion

Part A – Introduction of the Course

This course presents students about the Non-conventional propulsion techniques of space flights.

Course Code	Course Category	Course Title	L 3	T 0	P 0	C 3
U20ASCT09	C	Spacecraft Propulsion	Pre-requisite: U20ASCJ05-Aerospace Propulsion			
Name of the Course Coordinator		Mr. P. S. Mohanasaravanan	Contact Hrs: 45			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students

1. To explain concept of various forms of conventional and unconventional energy.
2. To apply the energy derived from the unconventional sources to engineering.

Course Outcomes (COs)

CO1	**Describe** the Environmental effect of rockets fuels and green propulsion technique **(Understand)**
CO2	**Discuss** Nuclear Propulsion Techniques **(Understand)**
CO3	**Discuss** Radioisotope propulsion for space vehicles **(Understand)**
CO4	**Discuss** Electrical and ion propulsion techniques **(Understand)**
CO5	**Summarize** Zero g propulsion mechanism **(Understand)**

Mapping/Alignment of COs with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H											H	M	M
CO2	H									H		H	M	M
CO3	H									H		H	M	M
CO4	H											H	M	M
CO5	H											H	M	M

(Tick mark or level of correlation: 3-High, 2-Medium,1-Low)

Part B – Content of the Course

Sl. No.	SUMMERY OF COURSE CONTENT	Hrs	Alignment to Cos
1	**Topic -1 Green Propellants Propellant-less Propulsion**. Environmental effects of space propellants (toxicity, pollution, performance aspects). Liquid bio-propellant (H2-O2, N2O4-, etc.) for main engines. Solid propellant (NH4ClO4) for the booster. Momentum exchange tether, electro-dynamic tether, Solar thermal propulsion for upper stages, solar sails, magnetic sails. Beamed energy -Earth to Orbit Propulsion	9	CO1
2	**Topic -2 Nuclear Rocket propulsion** Nuclear engine design and performance – Component design – Nuclear rocket reactors – nuclear rocket nozzles – general design consideration and heat transfer analysis – Propellant feed systems – Valves – Nuclear rocket engine control – Thrust vector control systems.	9	CO2
3	**Topic -3 Radioisotope Propulsion** Direct recoil method – Thermal Heating method – Basic thruster configuration – Propulsion systems and upper stage – Relative mission capabilities – Thruster technology – design criteria – Heat source development – Radioisotope fuel – Capsule technology – Thermal design – Fabrication and NDT Technique – Pressure containment – Heat source simulation – Oxidation and Corrosion of encapsulating materials – Nozzle performance.	9	CO3
4	**Topic -4 Electric and Ion Propulsion** Energy source – the separately powered rockets – Effects of variable mass – Power requirement and rocket efficiency – Effects of gravitational fields – Thermal thrusters – Electrostatic thrusters – Plasma thrusters. Introduction to Ion propulsion – Characteristics velocities – pay load – specific power – Electrical thrust device – ion and colloid – Ion source – Electromagnetic fields – Charged colloid source.	9	CO4
5	**Topic -5 Zero g Propulsion Systems** Introduction and Basic definitions – Zero gravity – Engineering consideration of zero g environment - Principle of minimum energy – Hydrostatics – Static configuration in zero g - Hydrodynamics – Propellant slosh – propellant position control – Capillary stability – Gas interface velocity – Propellant accumulation – Gas ingestion – Analytical consideration of gas Ingestion– Capillary barriers – Zero g propellant gauging.	9	CO5

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Loh, Wellington HT, ed. Jet, rocket, nuclear, ion and electric propulsion: theory and design. Vol. 7. Springer Science & Business Media, 2012.

Reference Books:

1. Sutton, George P., and Oscar Biblarz. Rocket propulsion elements. John Wiley & Sons, 2016.
2. Mishra, D. P. Fundamentals of rocket propulsion. CRC Press, 2017.

Other Resources (Online Resources or others)

1. Nil

U20ASCT10 Flight Mechanics

Part A – Introduction of the Course

To provide students the basic knowledge on aircraft performance, flight stability and control.

Course Code	Course Category	Course Title	L 2	T 0	P 0	C 2
U20ASCT10	C	Flight Mechanics	Pre-requisite: U20ASCJ03-Low and High speed Aerodynamics			
Name of the CourseCoordinator		Dr. N. Rajamurugu	Contact Hrs: 30			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students

1. To understand the basic performance of airplane in steady and cruise conditions
2. To understand the importance of stability and control requirements of the airplane.

Course Outcomes (COs)

CO1	**Explain** the governing flight conditions for minimum drag and power. **(Understand)**
CO2	**Describe** the performance of maneuvering flight **(Apply)**
CO3	**Illustrate** the basic dynamic modes of the aircraft. **(Understand)**

Mapping/Alignment of COs with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M								M		H	H	L
CO2	H	M								M		H	H	L
CO3	H	M										H	H	L

(Tick mark or level of correlation: 3-High, 2-Medium,1-Low)

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment of COs
1	**Module -1 Introduction to Airplane Performance** Equation of motion of a rigid flight vehicle - Drag polar of vehicles from low speed to high speeds -Variation of thrust, power with velocity and altitudes for air breathing engines. Performance of airplane in level flight - Power available and power required curves. Maximum speed in level flight -Conditions for minimum drag and power required.	**10**	**CO1**
2	**Module -2: Maneuvering Flight Performance** Range and endurance -Climbing and gliding flight (Maximum rate of climb and steepest angle of climb, minimum rate of sink and shallowest	**10**	**CO2**

	angle of glide) -Turning performance (Turning rate turn radius). Bank angle and load factor –limitations on turn -V-n diagram and load factor		
3	**Module -3 Fundamentals of Stability:** Static and dynamic stability –Static, Longitudinal stability -Stick fixed stability. Dihedral effect - Lateral control - Adverse yaw effects -Aileron reversal -Static directional stability -Weather cocking effect -Rudder requirements -One engine inoperative condition -Rudder lock. dynamic stability -Spiral, divergence, Dutch roll, auto rotation and spin.	**10**	**CO3**

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Perkins, C.D., and Hage, R.E., "Airplane Performance stability and Control", John Wiley & Son, Inc, NY, 1988.
2. Nelson, R.C. "Flight Stability and Automatic Control", McGraw-Hill Book Co., 2004.
3. Mc Cornick. W., "Aerodynamics, Aeronautics and Flight Mechanics", John Wiley, NY, 1979.

Reference Books:

1. Etkin, B., "Dynamics of Flight Stability and Control", John Wiley, NY, 1982.
2. Babister, A.W., "Aircraft Dynamic Stability and Response", Pergamon Press, Oxford, 1980.
3. Dommasch, D.O., Sherby, S.S., and Connolly, T.F., "Aeroplane Aero dynamics", Third Edition, Issac Pitman, London, 1981.
4. Mc Cornick B. W, "Aerodynamics, Aeronautics & Flight Mechanics", John Wiley, NY, 1995.

Other Resources (Online Resources or others)

1. https://nptel.ac.in/courses/101/106/101106042/

U20ASCT11 Navigation and Guidance

Part A – Introduction of the Course

To make students understanding the principles, technologies, and applications that form the foundation of effective aircraft navigation systems.

Course Code	Course Category	Course Title	L 2	T 0	P 0	C 2
U20ASCT11	C	Navigation And Guidance	Pre-requisite: U20ASCT07- Control Theory			
Name of the CourseCoordinator		Mr. N. Kalaimani	Contact Hrs: 30			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students

1. Comprehend the basic concepts of navigation, guidance and control.
2. Acquire the knowledge of radar systems and other guidance systems.
3. Understand the missile guidance and control system.

Course Outcomes (COs)

CO1	**Apply** the basic concepts of navigation, guidance and control. (**Apply**)
CO2	**Discuss** the operational principle of Radar Systems. (**Understand**)
CO3	**Interpret** the root locus diagram and its relevance to missile control system design. **(Apply)**
CO4	**Compare** and contrast proportional navigation guidance with other guidance techniques. (**Analyze)**
CO5	**Describe** the director Fire Control Systems and other aircraft control system.(**Understand**)

Mapping/Alignment of COs with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L										M		H
CO2	M	L	L									M		H
CO3	M	L	L		M					M		M		H
CO4	M	L										M		H
CO5	M	L			M					M		M		H

(Tick mark or level of correlation: 3-High, 2-Medium,1-Low)

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment to COs
1	**Topic 1: Navigation Systems & Inertial Sensors** Introduction to navigation – Categories of navigation- Evolution of Air navigation – Introduction to Inertial Sensors – Accelerometers – Gyroscopes- Mechanical Gyro - Ring Laser gyro- Fiber optic gyro – MEMS system.	6	CO1
2	**Topic 2: Radar systems** Principle of working of radar. MTI and Pulse Doppler radar. Moving target detector. Limitation of MTI performance. MTI from a moving platform (AMTI). Mono pulse tracking. Conical scan and sequential lobbing. Automatic tracking with surveillance radar (ADT).	6	CO2
3	**Topic 3: Missile Control System** Guided missile concept. Roll stabilization. Control of aerodynamic missile. Missile parameters for dynamic analysis. Missile autopilot schematics. Acceleration command and root locus.	6	CO3
4	**Topic 4: Missile Guidance** Proportional navigation guidance; command guidance. Comparison of guidance system performance. Bank to turn missile guidance.	6	CO4
5	**Topic 5: Integrated Flight/Fire Control System** Director fire control system. Tracking control laws. Longitudinal flight control system. Lateral flight control system. Rate of change of Euler angle, Auto Pilot.	6	CO5

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. P.T. Kabamba and A.R. Girard, Fundamentals of Aerospace Navigation and Guidance, Cambridge Aerospace Series, 2014.
2. John H Blakelock, Automatic control of Aircraft & Missiles`, Wile –Inter Science Publication, 2nd edition, May 1990.

Reference Books:

1. George M. Siouris, Missile Guidance and Control Systems, Springer, 2004
2. R.B. Underdown & Tony Palmer, `Navigation`, Black Well Publishing; 2001.
3. Merrilh I. Skolnik, Introduction to Radar Systems`, 3rd edition, Tata McGraw Hill, 2001.
4. Collinson R.P.G, 'Introduction to Avionics', Chapman and Hall, India, 1996.

Other Resources (Online Resources or others)

1. https://archive.nptel.ac.in/courses/101/108/101108054/

U20ASCJ07 Computational Methods in Aerospace Engineering

Part A – Introduction of the Course

This course introduces students to the concepts of computational mechanics and application of commercial software to solve aerospace engineering problems.

Course Code	Course Category	Course Title	L	T	P	C
			1	0	2	2
U20ASCJ07	C	Computational Methods in Aerospace Engineering	Pre-requisite: U20MEEJ01 - Engineering Graphics and Design U20CSEJ01 – Programming and Problem Solving U20MABT04 Numerical Methods for Engineers U20ASCJ03- Low and High speed Aerodynamics U20ASCJ04- Advanced Aerospace Structures U20ASCJ05- Aerospace Propulsion			
Name of the Course Coordinator		Mr. M. K. Karthik	Contact Hrs: 45			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students

1. To introduce students about theoretical basics and practical application of computational techniques.
2. To design and solve practical engineering problems related to solid mechanics, heat transfer and aerodynamics.

Course Outcomes (COs)

CO1	**Explain** the concepts of fluid structure interaction, aeroelastic phenomenon and numerical solutions of aerodynamics problems. (**Understand**)
CO2	**Describe** the process of performing finite element analysis on structural elements to obtain stress and strain. (**Understand**)
CO3	**Discuss** the basics of heat transfer problems and its numerical solutions. (**Understand**)
CO4	**Carry out** modelling, meshing and pre-processing as per the problem statement. (**Imitation**)
CO5	**Acquire** data using the simulation tools from software. (**Manipulation**)
CO6	**Perform** basic post-processing techniques and represent the results in form of graph and table. (**Precision**)

Mapping/Alignment of COs with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H								H		H	H	
CO2	H	H										H	H	
CO3	H	H								H		H	H	
CO4					H			H	H	H		H	H	
CO5					H			H	H	H		H	H	
CO6					H			H	H	H		H	H	

(Tick mark or level of correlation: 3-High, 2-Medium,1-Low)

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment toCOs
1	**Topic 1: Basics of CFD and Fluid Structure Interaction** Review of Aerodynamics and introduction to CFD; Coupling fluid and solid mechanics; Dimensional analysis of interaction – Dimensionless coupled equation; Aeroelastic approximation – Flow induced dynamic instability.	5	CO1
	Lab experiment: Flow over an airfoil; Flow over a flexible 3D wing and its deformation - one way FSI.	10	CO4, CO5, CO6
2	**Topic 2: Structural Analysis** Review of structural analysis; Introduction to FEA- preprocessing- mathematical modeling, Geometry and mesh creation, solver- Discretization method (Basics) and post processing- Contours, vectors, plots, streamlines, Residuals.	5	CO2
	Lab experiment: Structural analysis using 1D element - Truss problem, Structural analysis using 2D element - Plate with hole problem, Stress analysis of plate/beam with hole using 3D element	10	CO4, CO5, CO6
3	**Topic 3: Thermal Analysis** Basic approach in Numerical Heat conduction, one dimensional steady state problem, Introduction to Convection diffusion, Thermal boundary layer flow, transient free convection.	5	CO3
	Lab experiment: 1D transient heat conduction - thermal analysis of a rod, 2D steady state heat transfer analysis of a plate	10	CO4, CO5, CO6

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Reddy. JN, An Introduction to finite element method, Third Edition, 2005, Tata Mc Graw Hill.
2. Versteeg H, Malalasekara W, An Introduction to Computational Fluid Dynamics: The Finite Volume Method, Second Edition, 2007, Pearson India.
3. Blevins RD. Flow-induced vibration. New York. 1977.
4. Suhas V Patankar, Numerical Heat Transfer and Fluid Flow, 2009, Hemisphere Publishing Corporation.

Reference Books:

1. Muralidhar K and Sundararajan T, Computational Fluid flow and Heat transfer, Second edition, 2008, Narosa Publishing House, Newdelhi.
2. Ghoshdasdidar PS, Computer Simulation of fluid flow and heat transfer, 1998, Tata McGraw Hill Publishing Company Ltd, India.
3. Tirupathi R Chandrupatla, Ashok D Belegundu, Introduction to Finite Elements in Engineering, Fourth Edition, 2012, Pearson India.
4. Mc Cornick B. W, "Aerodynamics, Aeronautics & Flight Mechanics", John Wiley, NY, 1995.

Other Resources (Online Resources or others)

1. https://mitocw.ups.edu.ec/courses/aeronautics-and-astronautics/16-90-computational-methods-in-aerospace-engineering-spring-2014/#

U20ASCT12 Satellite Technology

Part A – Introduction of the Course

This course is structured to provide students with a deep understanding of the fundamental principles and practical considerations associated with satellite missions.

Course Code	Course Category	Course Title	L 3	T 0	P 0	C 3
U20ASCT12	C	Satellite Technology	Pre-requisite: U20ASCJ06-Avionics			
Name of the Course-Coordinator		Mr. N. Kalaimani	Contact Hrs: 45			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students

1. To introduce satellite systems and their different configurations.
2. To introduce satellite sub systems like power system, telemetry system, attitude and orbit control system, their design and problems involved with it.
3. To provide knowledge on propulsion systems, structures and thermal control.

Course Outcomes (COs)

CO1	**Explain** the basics of satellites and its system's functions. (**Understand**)
CO2	**Discuss** the fundamentals of orbital mechanics and the coordinate systems. (**Understand**)
CO3	**Express** the attitude controls and its stabilization schemes. (**Understand**)
CO4	**Discuss** the satellite structures and thermal protection systems. (**Understand**)
CO5	**Summarize** various types of power systems and bus electronics. (**Understand**)

Mapping/Alignment of COs with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H											H		H
CO2	H									M		H		H
CO3	H											H		H
CO4	H									M		H		H
CO5	H											H		H

(Tick mark or level of correlation: 3-High, 2-Medium,1-Low)

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment to COs
1	**Topic 1: Satellite Mission and Configuration** Mission Overview – Requirements for different missions – Space Environment, Spacecraft configuration- Spacecraft Bus – Payload – Requirements and constraints – Initial configuration decisions and Trade-offs – Spacecraft configuration process – Broad design of Spacecraft Bus – Subsystem layout – Types of Satellites – Constellations – Applications	9	CO1
2	**Topic 2: Satellite Dynamics** 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.	8	CO2
3	**Topic 3: Spacecraft Control** 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.	9	CO3
4	**Topic 4: Propulsion Systems, Structures and Thermal Control** Systems Trade-off – Mono-propellant systems – Thermal consideration – System integration design factors – Pre-flight test requirements – System reliability Configuration design of Spacecraft structure – Structural elements – Material selection –Environmental Loads -Vibrations– Structural fabrication –Orbital environments - Average temperature in Space – Transient temperature evaluation – Thermal control techniques – Temperature calculation for a spacecraft –Thermal design and analysis program structure – Thermal design verification – Active thermal control techniques.	11	CO4
5	**Topic 5: Power System and Bus Electronics** 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 Check-out Systems.	8	CO5

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Spacecraft Thermal Control, Hand Book, Aerospace Press, 2002.
2. Marcel J.Sidi ―Spacecraft Dynamics and Control‖, Cambridge University press, 1997.

Reference Books:

1. Space Mission Analysis and Design (Third Edition) by James R.Wertz and Wiley J.Larson – 1999.
2. Space Communications Systems, Richard.F, FilipowskyEugen I Muehllorf Prentice Hall,1995
3. James R.Wertz ―Spacecraft Attitude Determination and Control‖, Kluwer Academic Publisher, 1988.

Other Resources (Online Resources or others)

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

U20ASPL01 UAV Design

Part A – Introduction of the Course

This course introduces students to understand the features of UAV, elements, navigation and guidance of UAV and to design and simulate UAV.

Course Code	Course Category	Course Title	L 0	T 0	P 2	C 1
U20ASPL01	P	UAV Design	Pre-requisite: U20MEEJ01 - Engineering Graphics and Design; U20ASCJ06-Avionics; U20ASCT07- Control Theory; U20ASCJ03- Low and High speed Aerodynamics; U20ASCJ04- Advanced Aerospace Structures; U20ASCJ05- Aerospace Propulsion; U20CSEJ01 – Programming and Problem Solving; U20ASCT11- Navigation and Guidance			
Name of the Course-Coordinator		Ms. Praveena S	Contact Hrs: 30			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks:100			

Course Objective and Summary

This course will make students

1. To develop Unmanned Aerial Vehicle (UAV) design and implementation, fostering a comprehensive understanding of the technology
2. To integrate fundamental principles of unmanned aerial vehicle design for efficient and reliable Unmanned Aerial Vehicle (UAV) performance.
3. To integrate CAD simulation in designing and analyzing Unmanned Aerial Vehicle (UAV)
4. Focuses on practical aspects of Unmanned Aerial Vehicle (UAV)

Course Outcomes (COs)

CO1	**Acquire** the data and aerodynamic parameters from the existing model.**(Manipulation)**
CO2	**Perform** weight and thrust, endurance calculation. **(Precision)**
CO3	**Perform** technical documentation of the carried out UAV design. **(Precision)**

Mapping/Alignment of COs with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H				H			H	H	H				H
CO2	H				H			H	H	H				H
CO3	H				H			H	H	H				H

(Tick mark or level of correlation: 3-High, 2-Medium,1-Low)

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment to Cos
1	Collection of data from existing UAV's and selection of UAV type.	4	CO1
2	Finalize the aerodynamic and structural parameter specifications of UAVs.	2	CO1
3	Selection of Components and Weight estimation	4	CO2
4	Motor selection and propeller selection for various UAVs.	2	CO2
5	Thrust and Endurance calculation.	2	CO2
6	Balance diagram and Centre of gravity location estimation	3	CO2
7	Flight control board selection and programming.	6	CO2
8	Draft the UAV design procedure	7	CO3

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Reg Austin., Unmanned Aircraft Systems, John Wiley and Sons., 2010.

Reference Books:

1. Armand J.Chaput, "Design of Unmanned Air Vehicle Systems", Lockheed Martin Aeronautics Company, 2001.
2. Kimon P. Valavanis, "Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy", Springer, 2007
3. Paul G Fahlstrom, Thomas J Gleason, "Introduction to UAV Systems", UAV Systems, Inc, 1998.
4. Reg Austin "Unmanned aircraft systems UAV design, development and deployment", Wiley, 2010.
5. Robert C. Nelson, Flight Stability and Automatic Control, McGraw- Hill, Inc, 1998

Other Resources (Online Resources or others)

1. https://nptel.ac.in/courses/101104073
2. https://onlinecourses.nptel.ac.in/noc21_ae14/preview

U20AEPL03 Internship

Introduction of the Course

To enable the student to get acquainted with current industry trends and demands.

Course Code	Course Category	Course Title	L 0	T 0	P 0	C 1
U20AEPL03	P	Internship	Pre-requisite: U20MBHT01 – Management Principles for Engineers U20LEHJ01 – Technical English U20PDHJ01 – Employability Skills and Practices U20CYHT01 – Social and Environmental Engineering All Professional Core Courses			
Name of the Course-Coordinator		Dr. Hamza Naseem	Contact Hrs: NA			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks:100			

Course Objective and Summary

This course will make students

1. To introduce the students with industry culture.
2. To enable the students with an opportunity for learning new tools, processes and skills – commonly followed in industry

Course Outcomes (COs)

CO1	**Observe** the ethical conduct and professional accountability while working in a team. **(Imitation)**
CO2	**Observe** different process of resources management and planning used in industry **(Imitation)**
CO3	**Demonstrate** the use of modern tools employed in the field of Aerospace Engineering for product development**. (Precision)**

Mapping/Alignment of COs with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H		L		L	H	M	H	H	H	H	H	H	H
CO2	H		L		L	H	M	H	H	H	H	H	H	H
CO3	H		L		L	H	M	H	H	H	H	H	H	H

(Tick mark or level of correlation: 3-High, 2-Medium,1-Low)

U20ASPL02 Satellite Design

Part A – Introduction of the Course

To enable the student to carry out a preliminary design of a satellite.

Course Code	Course Category	Course Title	L 0	T 0	P 2	C 1
U20ASPL02	P	Satellite Design	Pre-requisite: U20ASPL01 UAV Design			
Name of the Course Coordinator		Mr. N. Kalaimani	Contact Hrs: 30			
Course offering Dept./School		School of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students

1. To gain hands-on experience in designing and simulating a satellite.
2. To develop a satellite mission concept, design the satellite subsystems, and perform simulations to evaluate its performance.

Course Outcomes (COs)

CO1	**Acquire** knowledge about satellite mission requirements, payload requirements, and its constraints**. (Manipulation)**
CO2	**Demonstrate** the ability to design various satellite subsystems, including power systems, communication systems, attitude control, and thermal management. (**Precision**)
CO3	**Demonstrate** the ability to integrate satellite subsystems. (**Precision**)

Mapping/Alignment of COs with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	H		H	M	M	H	H	H	-	H	H	H
CO2	H	H	H		H	M	M	H	H	H	-	H	H	H
CO3	H	H	H		H	M	M	H	H	H	-	H	H	H

(Tick mark or level of correlation: 3-High, 2-Medium,1-Low)

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment to Cos
1	**Topic 1 Introduction to Satellite Design** Overview of satellite components, mission types, and applications. Satellite Orbits and Launch Considerations: Understanding different orbits and launch options.	4	CO1
2	**Topic 2 Mission Analysis and Requirements** Defining mission objectives, requirements, and constraints. Payload Design: Selection and design of the payload based on the mission goals.	5	CO1
3	**Topic 3 Attitude Determination and Control** Principles of satellite attitude determination and control systems. Power Subsystem Design: Designing power generation, storage, and distribution systems.	5	CO2
4	**Topic 4 Communication Subsystem** Designing the communication system for downlink and uplink data transmission. Thermal Control Design - Managing satellite thermal environment through proper design.	6	CO2
5	**Topic 5 Structural Design** Understanding the structural requirements and materials selection for satellite components. Integration and Testing - Procedures for integration and testing of satellite subsystems.	5	CO2
6	**Topic 6 Software and On-board Systems:** Designing satellite on-board software and control systems. Understanding environmental testing (vibration, thermal, vacuum) of satellite prototypes.	5	CO3

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Space Mission Engineering: The New SMAD by James R. Wertz and Wiley J. Larson.
2. "Introduction to Space Systems: Design and Synthesis" by Miguel R. Aguirre.
3. "Small Satellite Design" by James Wertz and Wiley J. Larson.

Reference Books:

1. "Spacecraft Systems Engineering" by Peter Fortescue, John Stark, and Graham Swinerd.
2. "Spacecraft Thermal Control Handbook: Fundamental Technologies" by David G. Gilmore.
3. "Spacecraft Dynamics and Control: A Practical Engineering Approach" by Marcel J. Sidi.

Other Resources (Online Resources or others)

1. Nil

U20ASPL03 Project Phase-1

Part A – Introduction of the Course

This course disseminates the students to understand various phenomena from the existing literatures to identify the research gap, problem statement, objective and methodology to develop new products / models for the societal needs.

Course Code	Course Category	Course Title	L 0	T 0	P 4	C 2
U20ASPL03	P	Project Phase-1	Pre-requisite: U20MBHT01 – Management Principles for Engineers U20LEHJ01 – Technical English U20PDHJ01 – Employability Skills and Practices U20CYHT01 – Social and Environmental Engineering All Professional Core Courses			
Name of the Course-Coordinator		Dr. C. Suresh Kumar	Contact Hrs: 60			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks:100			

Course Objective and Summary

This course will make students

1. To acquaint the students with theoretical and experimental studies related to aerospace engineering.
2. To enable the students to involve in key area of research in the field of aerospace engineering
3. To perform literature survey that will help in formulating the problem statement.
4. To enable the students to understand the concept of the acquired statement to get an idea about the work.
5. To work according to the acquired idea and to develop a report in the format as specified in the guidelines.

Course Outcomes (COs)

CO1	**Observe** the current market scenario to develop new or modify the existing product. **(Imitation)**
CO2	**Complete** the conceptual design of the project. **(Manipulation)**
CO3	**Point** out the methodology for implementation of design. **(Manipulation)**

Mapping/Alignment of COs with PO & PSO

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

(Tick mark or level of correlation: 3-High, 2-Medium,1-Low)

U20ASPL04 Project Phase-2

Part A – Introduction of the Course

This course enables the students to carry out their simulations and or experiments to achieve the substantial conclusions about their project work.

Course Code	Course Category	Course Title	L 0	T 0	P 20	C 10
U20ASPL04	P	Project Phase-2	Pre-requisite: U20ASPL03 -Project Phase-1			
Name of the Course-Coordinator		Dr. C. Suresh Kumar	Contact Hrs: 300			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks:100			

Course Objective and Summary

This course will make students

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

Course Outcomes (COs)

CO1	**Express** the method of achieving perfection in project implementation & completion. **(Imitation)**
CO2	**Build** the skills, competencies and point of view of designed concepts. **(Naturalization)**
CO3	**Replicate** professional skills in Presentation, Technical report writing, critical thinking and decision making. **(Manipulation)**

Mapping/Alignment of COs with PO & PSO

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

(Tick mark or level of correlation: 3-High, 2-Medium,1-Low)

U20ASST01 Boundary Layer Theory

Part A – Introduction of the Course

To make students understand flow characteristics and different types of flow.

Course Code	Course Category	Course Title	L 3	T 0	P 0	C 3
U20ASST01	S	Boundary Layer Theory	Pre-requisite: U20ASCJ03-Low and High-speed Aerodynamics			
Name of the Course Coordinator		Dr Surekha Rathi Samundi D	Contact Hrs: 45			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students understand about the various aspects of viscous flow, laminar, turbulent boundary layer and the prediction of skin friction drag.

Course Outcomes (COs)

CO1	**Recall** the fundamental equations of viscous flow and basics of boundary layer theory. (**Understand**)
CO2	**Discuss** the solutions of simplified viscous flow equations. (**Understand**)
CO3	**Discuss** the equations and methods used for solving the flow field of laminar boundary layer over a flat plate. (**Understand**)
CO4	**Describe** the basics of turbulent boundary layer. (**Understand**)
CO5	**Describe** the basics of compressible boundary layer. (**Understand**)

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment to Cos
1	**Topic 1: FUNDAMENTAL EQUATIONS OF VISCOUS FLOW** 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 dimensionalizing the basic equations and boundary conditions, vorticity considerations, creeping flow, boundary layer flow.	6	CO1
2	**Topic 2: SOLUTIONS OF VISCOUS FLOW EQUATIONS** Solutions of viscous flow equations, Couette flows, Hagen-Poisuelle flow, Flow between rotating concentric cylinders, Combined Couette-Poiseuille Flow between parallel plates, Stokes's solution for an immersed sphere.	9	CO2

3	**Topic 3: LAMINAR BOUNDARY LAYER** Development of boundary layer – Estimation of boundary layer thickness, Displacement thickness- Momentum and energy thicknesses for two dimensional flow – Two dimensional boundary layer equations – Similarity solutions - Blasius solution	10	CO3
4	**Topic 4: TURBULENT BOUNDARY LAYER** Physical and mathematical description of turbulence, two-dimensional turbulent boundary layer equations, Velocity profiles – Inner, outer and overlap layers, Transition from laminar to turbulent boundary layers, turbulent boundary layer on a flat plate, Von-Karman similarity hypothesis.	10	CO4
5	**Topic 5: THERMAL BOUNDARY LAYER** Introduction to thermal boundary layer – Heat transfer in boundary layer - Convective heat transfer, importance of non-dimensional numbers – Prandtl number, Nusselt number, Lewis number etc.	10	CO5

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. White, F. M., Viscous Fluid Flow, McGraw-Hill & Co., Inc., New York, 2005.
2. H. Schlichting, "Boundary Layer Theory", McGraw-Hill, New York, 1979.

Reference Books:

1. J. Reynolds, "Turbulent flows in Engineering", John Wiley & Sons, 1980.
2. Ronald L., Panton, "Incompressible fluid flow", John Wiley & Sons, 1984.
3. Tuncer Cebeci and Peter Bradshaw, "Momentum transfer in boundary layers", Hemisphere Publishing Corporation, 1977.

Other Resources (Online Resources or others)

1. Nil

U20ASSJ02 Experimental Techniques in Fluid Mechanics

Part A – Introduction of the Course

To make students understand flow characteristics and different types of flow.

Course Code	Course Category	Course Title	L 2	T 0	P 2	C 3
U20ASSJ02	S	Experimental Techniques in Fluid Mechanics	Pre-requisite: U20ASCJ03-Low and High-speed Aerodynamics			
Name of the Course Coordinator		Dr Surekha Rathi Samundi D	Contact Hrs: 60			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students

1. To understand the concept of model testing.
2. To understand the types and functions of wind tunnels
3. To understand the types of calibration involved.
4. To get exposed to various types and techniques of aerodynamic data generation on aerospace vehicle configuration.

Course Outcomes (COs)

CO1	**Classify** the types of wind tunnels based on wind speeds for designing the prototypes and their applications aerospace industries. (**Understand**)
CO2	**Identify** the principles of probes and transducers used in pressure, velocity & temperature measurements techniques. (**Understand**)
CO3	**Identify** the necessity of streamlines, streak lines, path lines, tufts, oil film and smoke for flow visualization of wind in wind tunnel. (**Understand**)
CO4	**Demonstrate** the relative merits and demerits of flow visualization techniques followed with their applications for flow visualization in wind tunnel. (**Precision**)
CO5	**Demonstrate** methods used for equipment settings, calibration, measurement data, used in of pressure and velocity measurements. (**Precision**)

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment to Cos
1	**Topic -1 Low and High-Speed Wind Tunnels** Classification –Layout of open circuit and closed-circuit subsonic wind tunnels, Blow down, in draft and induction tunnel layouts and their design features -Transonic, and supersonic tunnels- peculiar features of these tunnels and operational difficulties.	10	CO1
2	**Topic – 2 Wind Tunnel Instrumentation** Instrumentation and sensors required for both steady and unsteady measurements – Force measurements using three component and six component balances – calibration of measuring instruments – error estimation and uncertainty analysis	10	CO2
3	**Topic-3 Flow Visualization and Non-Intrusive Flow Diagnostics** Smoke and Tuft grid techniques – Dye injection special techniques – Oil flow visualization and PSP techniques - Optical methods of flow visualization – PIV and Laser Doppler techniques – Image processing and data deduction.	10	CO3
	Experiments • Study of three and six component balance • Pressure distribution over an unsymmetrical airfoil model. • Pressure distribution over bluff bodies • Force measurement of missile /rocket model • Tuft flow visualization • Oil flow visualization	30	CO4, CO5 & CO6

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Rae, W.H. and Pope, A., "Low Speed Wind Tunnel Testing", John Wiley Publication, 1984.
2. NAL-UNI Lecture Series 12:" Experimental Aerodynamics", NAL SP 98 01 April 1998

Reference Books:

1. Pope, A., and Goin, L., "High Speed Wind Tunnel Testing", John Wiley, 1985.
2. Bradsaw "Experimental Fluid Mechanics". Short term course on Flow visualization techniques, NAL, 2009
3. Lecture course on Advanced Flow diagnostic techniques 17-19 September 2008 NAL, Bangalore

Other Resources (Online Resources or others)

1. https://nptel.ac.in/courses/101106040/
2. https://ocw.metu.edu.tr/course/view.php?id=66

U20ASST02 Theory of Elasticity

Part A – Introduction of the Course

To make students understand the formulation and solutions of some of the basic problems of elasticity.

Course Code	Course Category	Course Title	L 2	T 1	P 0	C 3
U20ASST02	S	Theory of Elasticity	U20ASCJ04- Advanced Aerospace Structures			
Name of the Course Coordinator		Dr. Hamza Naseem	Contact Hrs: 45			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students

1. To understand the concepts of stress and strain at a point in the body.
2. To learn generalized Hook's law
3. To master the formulation procedure of theory of elasticity.
4. To be able to solve 2D problems using theory of elasticity.
5. To find strain/stress field in non-circular bar subjected to torsion.

Course Outcomes (COs)

CO1	**Determine** the states of stress and strain at a point in the body. (**Apply**)
CO2	**Develop** stress/ strain based formulations using generalized Hook's law. (**Apply**)
CO3	**Compute** field variables under plane stress/stress conditions. (**Apply**)
CO4	**Compute** field variables for axi-symmetric problems. (**Apply**)
CO5	**Produce** analytical solutions for non-circular torsional problems. (**Apply**)

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment to Cos
1	**Topic 1: Deformations, Strains and Stress** General deformation; Small deformation theory; State of strain at a point; Strain transformation; Principal strains; Strain compatibility equations; Body and surface forces; State of stress at a point; Stress transformation; Principal stress; Traction vectors; Equations of equilibrium.	9+3	CO1
2	**Topic 2: Material behavior and Problem Formulation** Mechanical properties and constitutive equations; Generalized Hooke's law, Boundary equations; Stress formulation; Strain formulation; Principle of superposition; Saint Venant's principle; Solution strategies	4+2	CO2

3	**Topic 3: Two-dimensional Formulation and Solution in Cartesian Coordinates** Plane stress; Plane strain; Airy's stress function; Solutions using Polynomials: Uniaxial tension of a bar, pure bending of a beam, beam bending under UDL	5+3	CO3
4	**Topic 4: Formulation and Solutions in Polar Coordinates** Equations of equilibrium; Stress and strain, Constitutive equations, Plane strain and stress; Bi-harmonic equations; Michell's solution; Axi-symmetric problems; Dunder's table; Thick walled cylinder; Stressed plate with hole; Curved beam under pure bending; Rotating disc.	7+4	CO4
5	**Topic 5: Torsion problems** Torsion formulation – stress and dispacement based; 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.	5+3	CO5

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Sadhu S., "Theory of Elasticity", Khanna Publications, 2000.
2. Sadd, Martin H., "Elasticity: theory, applications, and numeric", Academic Press, 2009.

Reference Books:

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

Other Resources (Online Resources or others)

1. https://nptel.ac.in/courses/105105177

U20ASSJ03 Mechanics of Composite Materials

Part A – Introduction of the Course

This course introduces students to the significance of composite materials, and their design, fabrication and analysis using different approaches.

Course Code	Course Category	Course Title	L 2	T 0	P 2	C 3
U20ASSJ03	S	Mechanics of Composite Materials	Pre-requisite: U20ASCT04-Aerospace Materials and Process U20ASCJ04-Advanced Aerospace Structures			
Name of the Course Coordinator		Mr. M.K. Karthik	Contact Hrs: 45			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students

1. To impart knowledge in the mechanical behaviour of anisotropic materials and how they differ from conventional structural materials.
2. To familiarize the classical laminate theory to evaluate the strength of the composites.
3. To impart knowledge to design a composite structure with given requirement.
4. To familiarize various failure theories to analyse the composite laminates.
5. To introduce different manufacturing process to fabricate composite structures.

Course Outcomes (COs)

CO1	**Classify** the different composite materials based on fiber and matrix **(Understand)**
CO2	**Solve** problems related to Macromechanics of composite laminas **(Apply)**
CO3	**Analyse** the composite plates using classical laminate theory (**Analyzing**)
CO4	**Explain** different manufacturing processes of composite structures (**Analyzing**)
CO5	**Evaluate** the stress in sandwich panels (**Analyzing**)
CO6	**Carry out** mechanical testing of composite specimens as per ASTM standard **(Imitation)**
CO7	**Acquire** data using the available measuring devices **(Manipulation)**
CO8	**Perform** mechanical properties of composites using appropriate formulae and graph **(Precision)**

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment to COs
1	**Topic 1: Introduction** Classification and application of composite materials – Types of reinforcements and matrices, function and their properties-micromechanics – mechanics of materials approach, elasticity approach- bounding techniques – fiber volume ratio – mass fraction – density of composites – effect of voids in composites.	6	CO1
2	**Topic 2: Macromechanics** Generalized Hooke's Law – elastic constants for anisotropic, orthotropic and isotropic materials – Lamina stress-strain relations with respect to natural and arbitrary axis – Experimental characterization of lamina – failure theories of a lamina.	6	CO2
3	**Topic 3: Laminate Theory** Governing differential equation for a laminate, stress – strain relations for a laminate, different types of laminates, in-plane and flexural constants of a laminate, hygrothermal stresses and strains in a laminate, failure analysis of a laminate, impact resistance and interlaminar stresses.	6	CO3
4	**Topic 4: Manufacturing Process** Processing of PMCs – Various open and closed mould processes, Netting analysis. Processing of MMCs – aluminium, titanium, magnesium, copper alloys – diffusion bonding – powder metallurgy. Processing of CMCs – cold pressing, sintering – chemical vapour deposition, chemical vapour impregnation. Carbon-carbon composites	6	CO4
5	**Topic 5: Sandwich Construction** Basic design concepts of sandwich construction – materials used for sandwich construction – failure modes of sandwich panels – bending and shear stress in sandwich beams. Use of sandwich construction in aerospace structures.	6	CO5
	Lab experiment: • Fabrication of FRP composite laminates using hand layup • Fabrication of FRP composite laminates using vacuum assisted resin transfer moulding (VARTM) • Determination of elastic constants of composite laminates with different fiber orientations. • Flexural testing of composite laminates • Determination of hardness of particulate reinforced polymer composites • Evaluation of mechanical properties of sandwich beams	30	CO6, CO7, CO8

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Autar K Kaw, 'Mechanics of Composite Materials', CRC Press, 2005.
2. Jones, R.M., "Mechanics of Composite Materials", McGraw-Hill, Kogakusha Ltd., Tokyo, 1985.
3. Calcote, L R. "The Analysis of laminated Composite Structures", Von – Nostrand Reinhold Company, New York 1998

Reference Books:

1. Agarwal, B.D., and Broutman, L.J., "Analysis and Performance of Fibre Composites", John Wiley and sons. Inc., New York, 1995.
2. Madhuji Mukhapadhyay, Mechanics of Composite Materials and Structures, University Press, 2004
3. Mallick, P.K. and Newman.S., Composite Materials Technology, Hanser Publishers, 2003.
4. Krishnan K Chawla, Composite Materials: Science and Engineering, International Edition, Springer, 2012.

Other Resources (Online Resources or others)

1. https://onlinecourses.nptel.ac.in/noc22_me40/preview

U20ASST03 Heat Transfer for Aerospace Engineers

Part A – Introduction of the Course

This course describes the applications of the three modes of heat transfer in engineering applications. The course will provide an insight to various types of mechanical system involving phase change. The combined heat and mass transfer are analyzed in detail and enable the student to solve more advanced problems.

Course Code	Course Category	Course Title	L 2	T 1	P 0	C 3
U20ASST03	S	Heat Transfer for Aerospace Engineers	Pre-requisite: U20ASCT02- Fundamentals of Thermal Engineering			
Name of the Course Coordinator		Mr. A. Muthukrishnan	Contact Hrs: 45			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students

1. To understand the steady state and unsteady state conduction in solids.
2. To understand the natural and forced convection heat transfer.
3. To understand the phase change heat transfer.
4. To understand the radiation heat transfer in solids and gases.

Course Outcomes (COs)

CO1	**Apply** the principles of various modes of heat transfer in practical applications and analyze steady state and unsteady conduction in solids. **(Apply)**
CO2	**Describe** about the types of convection and correlations to solve problems on free and forced convection. **(Understand)**
CO3	**Solve** problems on phase change heat transfer like boiling and condensation and to design a heat exchanger. **(Apply)**
CO4	**Illustrate** the mode of heat transfer, radiation and to study about combined heat transfer with convection and radiation**. (Apply)**
CO5	**Analyze** convection and diffusion Mass transfer and explain how heat transfer and mass transfer is analogous. **(Analyze)**

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment to Cos
1	**Topic 1: Conduction Heat Transfer** Modes of heat transfer- One dimensional steady state heat conduction: Composite Medium – Critical thickness – Effect of variation of thermal Conductivity –. Heat Conduction: Lumped System Analysis – Heat Transfer in Semi-infinite and infinite solids – Transient Heat Transfer – Temperature charts	10	CO1
2	**Topic 2: Convective Heat Transfer** 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	9	CO2
3	**Topic 3**: **Radiative Heat Transfer** Concept of black body - Intensity of radiation - Laws of Black body Radiation - Radiation from non-black surfaces - real surfaces –Radiation shape factors-Radiation shields. Radiative equilibrium - Optically thick limit -Radiation spectroscopy- Isothermal gas emissivity	8	CO3
4	**Topic 4: Heat Exchangers** Types of heat exchangers -overall heat transfer coefficient- LMTD- NTU method of heat exchanger Analysis	8	CO4
5	**Topic 5: Heat Transfer Problems in Aerospace Engineering** 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	10	CO5

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. R.C. Sachdeva, (2017), "Fundamentals of Heat & Mass Transfer", New Age Intl. Publishers
2. R.K. Rajput, (2012), "Heat and Mass Transfer", S.Chand Publishers, Fifth Edition.
3. D.S. Kumar, (2013), "Heat and Mass Transfer", S.K.Kataria & Sons.

Reference Books:

1. J.P.Holman, (2013),"Heat Transfer", McGraw Hill Publishers, 10th edition.
2. Yunus A.Cengel,(2017), "Heat and Mass Transfer – Fundamentals & Applications", Fifth edition.
3. P.K.Nag,(2011) "Heat and Mass Transfer", Mcgraw Hill Edition.

Other Resources (Online Resources or others)

1. Nil

U20ASST05 Fundamental of Combustion

Part A – Introduction of the Course

This course introduces students to the basic concepts of combustion, selection of fuel in IC Engines, Jet Engines as well supersonic Engines.

Course Code	Course Category	Course Title	L 3	T 0	P 0	C 3
U20ASST05	S	Fundamental of Combustion	Pre-requisite: U20ASCT02- Fundamentals of Thermal Engineering			
Name of the Course-coordinator		Mr. S. Yaknesh	Contact Hrs: 45			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students

1. To introduce students about theoretical basics and practical application of combustion process and fuels.
2. To acquaint the student with the basics of combustion in aircraft and rocket engines.

Course Outcomes (COs)

CO1	**Explain** thermo chemical reaction associated with combustion process and the various parameters affecting burning velocity. **(Understand)**
CO2	To know the working and to suggest the selection of IC Engine for the aircraft. **(Understand)**
CO3	**Compare** the ramjet and gas turbine combustion chamber design. **(Understand)**
CO4	**Analyze** the challenges associated with supersonic combustion. **(Understand)**
CO5	**Discuss** combustion process in solid, liquid propellant rockets and hybrid rockets. **(Understand)**

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment to Cos
1.	**Topic -1 Introduction to Combustion** Laws of Thermodynamics - 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	10	CO1
2.	**Topic -2 Combustion in Aircraft Piston Engines** 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	10	CO2

3.	**Topic -3 Combustion in Gas Turbine Engines** 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.	8	CO3
4.	**Topic -4 Combustion in Supersonic Engines** 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 - supersonic combustors.	10	CO4
5.	**Topic -5 Combustion in Rocket Engines** Solid propellant combustion - double and composite propellant combustion – various combustion models – combustion in liquid rocket engines – single fuel droplet combustion model – hybrid fuel rocket model – selection of fuel in rocket engine.	7	CO5

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Stephen R turns," An Introduction to Combustion", Tata McGraw Hill Publishing Co., Ltd., New Delhi, 2013.
2. Lefebvre AG and Dilip R ballal, "Gas Turbine Combustion", CRC press, Third Edition, 2010.
3. Corin Segal, "The Scramjet engine", Cambridge University Press, 2009
4. Sutton, G.P., "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 2001.

Reference Books:

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

Other Resources (Online Resources or others)

1. https://swayam.gov.in/course/4339-fundamentals-of-combustion-i

U20ASST06 Applied Aerodynamics

Part A – Introduction of the Course

Course Code	Course Category	Course Title	L 3	T 0	P 0	C 3
U20ASST06	S	Applied Aerodynamics	Pre-requisite: U20ASCJ03-Low and High-speed Aerodynamics			
Name of the Course Coordinator		Mr. E. Mahavishnu	Contact Hrs: 45			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students

1. To understand the concept of atmospheric boundary layer
2. To familiarize with non-aeronautical applications of aerodynamics.

Course Outcomes (COs)

CO1	**Explain** the causes of the variation of wind**. (Apply)**
CO2	**Distinguish** horizontal and vertical wind machines. **(Evaluate)**
CO3	**Evaluate** flow control techniques for vehicle aerodynamics. **(Analyze)**
CO4	**Explain** effects of wind loading on building and urban planning. **(Analyze)**
CO5	**Explain** wind structure induced vibration. **(Analyze)**

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment to Cos
1	**ATMOSPHERE** Types of winds, Causes of variation of winds, Atmospheric boundary layer, Effect of terrain on gradient height, Structure of turbulent flows.	9	CO1
2	**WIND ENERGY COLLECTORS** Horizontal axis and vertical axis machines, Power coefficient, Betz coefficient by momentum theory – Piezo wind energy collectors – various bladeless wind energy harvesting methods.	9	CO2
3	**VEHICLE AERODYNAMICS** Power requirements and drag coefficients of automobiles, Effects of cut back angle, Aerodynamics of trains and Hovercraft, Various drag reduction and optimization techniques, flow control and its applications	9	CO3

4	**BUILDING AERODYNAMICS** Pressure distribution on low rise buildings, wind forces on buildings. Environmental winds in city blocks, Special problems of tall buildings, building codes, Building ventilation and architectural aerodynamics, urban planning and human comfort.	9	CO4
5	**FLOW INDUCED VIBRATIONS** Effects of Reynolds number on wake formation of bluff shapes, Vortex induced vibrations, Galloping and stall flutter, Vibration of stay cables under wind load.	9	CO5

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. M.Sovran (Ed), "Aerodynamics and drag mechanisms of bluff bodies and road vehicles", Plenum press, New York, 1978.
2. P. Sachs, "Winds forces in engineering", Pergamon Press, 1978.

Reference Books:

1. R.D. Blevins, "Flow induced vibrations", Van Nostrand, 1990.
2. N.G. Calvent, "Wind Power Principles", Charles Griffin & Co., London, 1979.

Other Resources (Online Resources or others)

1. Nil

U20ASSJ04 CFD for Aerospace Engineers

Part A – Introduction of the Course

To make students understand the numerical modeling and its role in the field of fluid flow.

Course Code	Course Category	Course Title	L 2	T 0	P 2	C 3
U20ASSJ04	S	CFD for Aerospace Engineers	Pre-requisite: U20ASCJ07-Computational Methods in Aerospace Engineering			
Name of the Course Coordinator		Dr Surekha Rathi Samundi D	Contact Hrs: 60			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students

1. To introduce numerical modelling and its role in the field of fluid flow.
2. To enable the students, understand various Algorithms in CFD.
3. To enable the students to understand the various discretization methods, solution procedures and turbulence modelling.

Course Outcomes (COs)

CO1	**Identify** different CFD techniques available for relevant partial differential equations for analytical solutions of fluid flow. **(Understand)**
CO2	**Select** the type of flow from the finite control volume and infinitesimal small fluid element for the fluid flow analysis. **(Analyze)**
CO3	**Develop** the governing equations for computational fluid dynamics CFD analysis by setting appropriate boundary conditions. **(Apply)**
CO4	**Carry out** modelling, meshing and pre-processing as per the problem statement**. (Imitation)**
CO5	**Acquire** data using the simulation tools from software**. (Manipulation)**
CO6	**Perform** basic post-processing techniques and represent the results in form of graph and table **(Precision)**

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment to Cos
1	**Classification of physical behavior** Basics of computational fluid dynamics - Mathematical behavior of PDEs on CFD -Elliptic, Parabolic and Hyperbolic equations - Well posed problems. **Turbulence models** Mixing length model, K-ε model, Reynolds stress equation models, Algebraic stress equation models.	10	**CO1**

2	**Solution Algorithm for pressure-Velocity coupling in steady flows** Introduction, Staggered grid, Momentum equations, SIMPLE algorithm, SIMPLER algorithm, SIMPLEC algorithm, PISO algorithm.	10	**CO2**
3	**Implementation of Boundary conditions** Inlet boundary conditions, Outlet boundary conditions, wall boundary conditions, Constant pressure boundary condition, symmetric boundary condition, periodic or cyclic boundary condition and potential pitfalls.	10	**CO3**
4	**Experiments:** • Model the laminar flow over a flat plate. • Model the turbulent flow over a flat plate. • Model the velocity boundary layer for internal flow. • Model the convective boundary layer for internal flow. • Model the flow over an airfoil moving at Mach 0.3, through air, at tropopause. • Model the flow over a wedge/cone moving at Mach 1.5, through air, at an altitude of 15 km from the sea level.	30	**CO4, CO5, CO6**

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. J. D. Anderson, "Computational Fluid Dynamics", McGraw Hill International, 2012.
2. T. J. Chung, "Computational Fluid Dynamics", Cambridge University Press, 2002.
3. H.K. Versteeg and W. Malalasekera "An Introduction to Computational Fluid Dynamics, The Finite Volume Method", Longman Scientific & Technical, 2007.

Reference Books:

1. JiyuanTu, Guan, HengYeoh, Chaoqun Liu, "Computational Fluid Dynamics A Practical Approach" Springer Verlag, 2012. (Units 4 & 5)
2. C. Hirch, "Numerical Computation of Internal and External Flows" Volume-2, John Wiley and Sons, 1994.
3. Patankar, S.V. "Numerical Heat Transfer and Fluid Flow", Hemisphere Publishing Corporation, 2004.
4. Anil W. Date, "Introduction to Computational Fluid Dynamics", Cambridge University Press, 2005.

Other Resources (Online Resources or others)

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

U20ASST08 Mechanics of Fatigue and Fracture

Part A – Introduction of the Course

To make students understand the numerical modeling and its role in the field of fluid flow.

Course Code	Course Category	Course Title	L 3	T 0	P 0	C 3
U20ASST08	S	Mechanics of Fatigue and Fracture	Pre-requisite: U20ASCT04-Aerospace Materials and Process U20ASCJ04-Advanced Aerospace Structures			
Name of the Course Coordinator		Mr. N. Elumalai	Contact Hrs: 45			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students

1. To evaluate the fatigue of structures.
2. To determine the strength of cracked bodies.
3. To distinguish the safe life and fail safe design.

Course Outcomes (COs)

CO1	**Calculate** the stress concentration in structures subjected to fatigue loads. (**Analyze**)
CO2	**Describe** statistical methods to determine the strain in structures under fatigue loading. (**Understand**)
CO3	**Describe** various stages of failures due to fatigue load. (**Understand**)
CO4	**Determine** stress in cracked structures. (**Apply**)
CO5	**Analyze** damage tolerant structures **(Analyze)**

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment to Cos
1	**Topic 1: Fatigue of Structures** Introduction to fatigue and fatigue design philosophies, Fatigue test, endurance limit, S-N diagram, Effect of mean stress, Goodman, Gerber and Soderberg relations and diagrams, Notches and stress concentrations, Neuber's stress concentration factors, Plastic stress concentration factors - Notched S.N. curves.	9	CO1
2	**Topic 2: Statistical Aspects of Fatigue Behaviour** Un-Notched Fatigue, Low cycle and high cycle fatigue, Coffin - Manson's relation, Transition life, Cyclic strain hardening and	9	CO2

	softening, Analysis of load histories, Cycle counting techniques, Cumulative damage, Miner's theory - Other theories.		
3	**Topic 3: Physical Aspects of Fatigue** Phase in fatigue life, Crack Nucleation, Fatigue crack growth in ductile and brittle materials, Final Fracture, Notched Fatigue, Fatigue crack propagation, Role of microstructure, Overloading on fatigue, Corrosion fatigue and high temperature fatigue. Life estimates and dimensioning against fatigue, Dislocations, Fatigue fracture surfaces.	9	CO3
4	**Topic 4: Fracture Mechanics** Strength of cracked bodies, Potential energy and surface energy, Griffith's theory, Extension of Griffith Theory by Irwin and Orowan, Stress analysis of "cracked bodies, Effect of thickness on fracture toughness, Stress intensity factors for typical geometries.	10	CO4
5	**Topic 5: Fatigue Design and Testing** Safe life and Fail safe design philosophies, Importance of Fracture Mechanics in aerospace structures, Fracture and delamination in composite materials, Application to composite materials and structures.	8	CO5

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. D. Brock, "Elementary Engineering Fracture Mechanics", Noordhoff International, London, 1994.
2. J.F. Knott, "Fundamentals of Fracture Mechanics", Butterworth & Co. Ltd., London, 1983.
3. Anderson T. L. – 'Fracture Mechanics: Fundamentals and Applications' – CRC Press – 2012

Reference Books:

1. W. Barrois and L. Ripley, "Fatigue of Aircraft Structures", Pergamon Press, Oxford, 1983.
2. Dahlberg T. and Ekberg S. – 'Failure Fracture Fatigue: An Introduction' Overseas Press, 2006.
3. Janssen M., Zuidema and Wanhill R. J. H. – 'Fracture Mechanics' – VSSD (Delft University of Technology) – 2006.
4. Prashant Kumar, Elements of Fracture Mechanics, Tata McGraw Hill, New Delhi, India, 2009.

Other Resources (Online Resources or others)

1. https://home.iitm.ac.in/kramesh/EFM.html

U20ASSJ08 FEM in Aerospace Structures

Part A – Introduction of the Course

To make students understand the fundamentals of finite element method and its applications in the structural analysis.

Course Code	Course Category	Course Title	L 2	T 0	P 2	C 3
U20ASSJ08	S	FEM in Aerospace Structures	Pre-requisite: U20ASCJ07 - Computational Methods in Aerospace Engineering			
Name of the Course Coordinator		Mr. M. K. Karthik	Contact Hrs: 60			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students

1. To study about the Basics of Finite Element Analysis.
2. To Understand the mathematical principles behind the Finite Element Method: A numeric strategy to solve partial differential equations (PDEs).
3. To capitalize on your knowledge of mechanics, reinforce your knowledge, and solve problems that can only be tackled numerically on the computer.

Course Outcomes (COs)

CO1	**Compare** various functional approximation methods for structural problems. **(Analyze)**
CO2	**Calculate** the nodal field variables for one dimensional structure. **(Apply)**
CO3	**Determine** the stiffness matrix and stress developed in two dimensional structures. **(Apply)**
CO4	**Calculate** the nodal displacements and stress for axi-symmetric structures. **(Apply)**
CO5	**Determine** the nodal temperature for thermal structures and fluid velocity for flow problems. **(Apply)**
CO6	**Design** the structural components under static and dynamic loading**. (Precision)**
CO7	**Observe** displacement distribution for structure under various loading**. (Imitation)**
CO8	**Carry out** the stress analysis for the different structural components**. (Imitation)**

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment toCOs
1	**Topic 1: Introduction** 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.	4	CO1
2	**Topic 2: One-Dimensional System** Direct stiffness method – Derivation of the stiffness matrix - Assembly of global stiffness matrix - Types of boundary conditions - Potential energy approach – Bar element – Coordinate systems and Shape Functions - Assembly of Global Stiffness Matrix and Load Vector - Boundary Conditions - Temperature Effects.	6	CO2
	Lab experiment: Stress Analysis of a bar subjected to axial load	6	CO6, CO7, CO8
3	**Topic 3: Two-Dimensional System** Beam element – element stiffness – load vector – global stiffness matrix – boundary conditions – solution, Plane truss structure - Coordinate Transformation – Local & Global Coordinate - Element Stiffness Matrix- Stress Calculations- Temperature Effects, Plane stress & strain – Constant Strain Triangle (CST)- Potential Energy Approach - Element Stiffness; Force Terms, Stress Calculations- Temperature Effects.	6	CO3
	Lab experiment: Stress Analysis of a beam subjected to transverse load, Deflection analysis of a truss, Stress Analysis of a plate with circular hole.	9	CO6, CO7, CO8
4	**Topic 4: Three-Dimensional System** 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.	8	CO4
	Lab experiment: Stress Analysis of axi-symmetric element.	9	CO6, CO7, CO8
5	**Topic 5: Field Problems** Heat transfer problems – Steady state fin problems – Derivation of element matrices for two dimensional problems – Fluid flow problems.	6	CO5
	Lab experiment: Steady state two – dimensional heat conduction in L – bars, Transient two – dimensional heat conduction in L – bars.	6	CO6, CO7, CO8

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Tirupathi R Chandrupatla, Ashok D. Belgundu, Introduction of finite elements in engineering, Fourth Edition, Pearson India.
2. Rao, S. S, Finite Element Method in Engineering, Pergaman Int. Library of Science, 2010.

Reference Books:

1. J. N. Reddy, Finite Element Method, McGraw -Hill International Edition.
2. Logan, D. L, A first course in the Finite Element Method, Cengage Learning 6th Edition 2016.
3. Cook, Robert D. Concepts and applications of finite element analysis. John wiley & sons, 2007.

Other Resources (Online Resources or others)

1. https://onlinecourses.nptel.ac.in/noc22_me43/preview
2. https://ocw.mit.edu/courses/2-092-finite-element-analysis-of-solids-and-fluids-i-fall-2009/

U20ASST15 Cryogenic Technology

Part A – Introduction of the Course

To make students to understand the basic concepts in production, handling and storing of Cryogenics.

Course Code	Course Category	Course Title	L 3	T 0	P 0	C 3
U20ASST15	S	Cryogenic Technology	Pre-requisite: U20ASCT09-Spacecraft Propulsion			
Name of the Course Coordinator		Mr. Abinicks Raja G	Contact Hrs: 45			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students

1. To present a problem oriented knowledge of Cryogenic Engineering
2. To address the underlying concepts and methods behind Cryogenic Engineering

Course Outcomes (COs)

CO1	**Describe** the properties of Cryogenic Substances **(Understand)**
CO2	**Apply** the knowledge of Gas Liquefaction systems in Cryogenics for better performance **(Apply)**
CO3	**Discuss** the various refrigeration systems in cryogenic Engineering **(Understand)**
CO4	**Describe** different storage units that are used in handling cryogenics **(Understand)**
CO5	**List** the instruments used in Cryogenic systems **(Apply)**

Part B – Content of the Course

Sl. No.	SUMMARYOFCOURSECONTENT	Hrs.	Alignment to Cos
1	**CRYOGENIC SYSTEMS** Introduction to cryogenic systems, Evolution of Cryogenic substances, Properties of Cryogenic fluids, Electrical and Mechanical properties, Applications.	9	CO1
2	**GAS LIQUEFACTION IN CRYOGENICS:** Liquefaction Cycles – Carnot Liquefaction Cycle, F.O.M. and Yield of Liquefaction Cycles. Inversion Curve – Joule Thomson Effect. Linde Hampson Cycle, Precooled Linde-Hampsoncycle, Claude cycle, Types of Heat Exchangers used in cryogenic Systems- Gas Liquefaction cycle Problems.	9	CO2
3	**CRYOGENIC REFRIGERATION SYSTEMS:** Ideal Refrigeration systems-Carnot Refrigerator-Refrigeration using liquids and gases as refrigerant-Magnetic Cooling-Adiabatic Demagnetization.	9	CO3

4	**CRYOGENIC STORAGE SYSTEMS:** Fluid storage systems, Thermal insulation and their performance at cryogenic temperatures-Cryogenic fluid Transfer systems-Safety measures for thestorage and transportation of Cryogenics.	9	CO4
5	**CRYOGENIC INSTRUMENTATION:** Temperature measurements-Flow measurements-Liquid Level measurement- Pressure measurements-Types of heat exchangers used in cryogenic systems-Cryo pumping Applications.	9	CO5

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Randall F. Barron, "Cryogenics Systems", Second Edition Oxford Univesity,Press NewYork, Clarendon Press, Oxford, 1985.
2. Timmerhaus, Flynn, "Cryogenics Process Engineering", Plenum Press, New York.
3. Pipkov, "Fundamentals of Vacuum Engineering", Meer Publication.

Reference Books:

1. G.M Walker. "Cryocooler-Part 1 Fundamentals" Plenum Press, New York and London.
2. G.M Walker. "Cryocooler-Part 2" Plenum Press, New York and London.

Other Resources (Online Resources or others)

1. Nil

U20ASSJ10 Numerical Heat Transfer

Part A – Introduction of the Course

To make students to develop the problem-solving skills essential to obtain good engineering practice of numerical heat transfer in real-world applications.

Course Code	Course Category	Course Title	L 1	T 0	P 4	C 3
U20ASSJ10	S	Numerical Heat Transfer	Pre-requisite: U20ASCJ07- Computational Methods in Aerospace Engineering			
Name of the Course Coordinator		Mr. S. Yaknesh	Contact Hrs: 75			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students

1. To understand the concept of Numerical Heat Transfer and its application
2. To solve the conduction problems using Numerical technique
3. To understand the converge methodology and techniques
4. To understand the concept of Numerical Heat Transfer in convective heat transfer application
5. To understand the concept of Numerical Heat Transfer in radiative heat transfer

Course Outcomes (COs)

CO1	**Describe** the concepts of Numerical heat transfer and its applications **(Understand)**
CO2	**Apply** Partial Differential Equations to solve the heat transfer problems (**Apply**)
CO3	**Describe** the methods for solving heat transfer problems in conduction (**Understand**)
CO4	**Describe** the methods for solving convective heat transfer problems (**Understand**)
CO5	**Determine** the shape factor of a material using numerical heat transfer analysis. **(Analyze)**
CO6	**Carry out** the numericals on boundary value problems and validate using MATLAB code **(Imitation)**
CO7	**Acquire** data for the steady and unsteady state heat transfer problems using a computer program **(Manipulation)**
CO8	**Perform** basic post-Processing techniques and represent the results in the form of graphs and tables **(Precision).**

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment to Cos
1	**Introduction to Numerical Heat Transfer:** Discretization Methods -Forward, backward and central differencing scheme for first order and second order Derivatives, Finite Difference Method-Introduction-Taylor's series expansion — Types of partial differential equations-Types of errors. Solution to algebraic equation-Direct Method and Indirect Method-Types of boundary condition.	3	CO1
	Experiment: Solve the boundary value problem (differential equation) in MATLAB	10	CO6
2	**Partial Differential Equations and Numerical Methods for Incompressible Fluid Flow**: Classification of PDEs, Initial and Boundary conditions, Initial and boundary value problems.Governing equations, Navier Stokes Equations, Stream function velocity method, general algorithm inviscid flow.	3	CO2
	Experiment: Solve the heat conduction equation (Parabolic PDE) using MATLAB PDE solver	11	CO7
3	**Numerical Methods for Conduction Heat Transfer:** Dimensionality in conduction, Basic approach in Numerical Heat conduction, one dimensional steady state problem. Application of heat conduction, steady and unsteady heat conduction	3	CO3
	Experiment: Steady-state 2D heat transfer problem using MATAB program.	12	CO7
4	**Numerical Methods for Convection Heat Transfer:** Introduction, Convection diffusion, Thermal boundary layer flow, transient free convection.	3	CO4
	Experiment: Mathematical calculation of temperature difference and plotting of temperature variation along the fin using MATAB program.	12	CO8
5	**Numerical methods for Radiative Heat Transfer:** Radiation fundamentals-Shape factor calculation-Radiosity method-Absorption Method -Montacalro method-Introduction to Finite Volume Method- Numerical treatment of radiation enclosures using finite Volume method.	3	CO5
	Experiment: Developing a numerical code for 1D, 2D heat transfer problems**;** Solving of Radiation Equation by using MATLAB	15	CO7

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. P. S. Ghoshdastidar, Computer Simulation of Flow and heat transfer, Tata McGraw Hill Publications, New Delhi.
2. Suhas V. Patankar, Numerical Heat Transfer and Fluid Flow, Tata McGraw Hill Book Company.

Reference Books:

1. Varsteeg, Malalasekera, An introduction to Computational Fluid Dynamics The finite volume method, Pearson Prentice hall. lman J. P, Thermodynamics, McGraw Hill, Fifth edition, 2007.
2. Necati Ozisik, Finite Difference Method in Heat Transfer, CRC Press, 2nd edition, 2017.

Other Resources (Online Resources or others)

1. Nil

U20ASST16 High Temperature Gas Dynamics

Part A – Introduction of the Course

To make students understand the concept of high temperature flows.

Course Code	Course Category	Course Title	L	T	P	C
			3	0	0	3
U20ASST16	S	High Temperature Gas Dynamics	Pre-requisite U20ASCJ03- Low and High speed Aerodynamics			
Name of the Course Coordinator		Dr. Surekha Rathi Samundi D	Contact Hrs: 45			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students

1. To understand the concepts of high temperature flows.
2. To impart knowledge on viscid, inviscid high temperature flow problems.

Course Outcomes (COs)

CO1	**Explain** the nature of high temperature flows. **(Understand)**
CO2	**Solve** the reaction rate dependence on pressure for low and high temperature. (**Apply**)
CO3	**Differentiate** Maxwell-Boltzmann distribution and Maxwell-Boltzmann velocity distribution. (**Analyze**)
CO4	**Explain** the Phases of inviscid high temperature flows (**Analyze**)
CO5	**Explain** radiative heat transfer equations for different high temperature gases. **(Understand)**

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment to COs
1	**Module 1: INTRODUCTION** Importance of high temperature flows – Atmospheric energy – Nature of high temperature flows – Gibb's free energy and entropy by chemical and non-equilibrium – Chemically reacting mixtures and boundary layers.	8	CO1
2	**Module 2: STATISTICAL THERMODYNAMICS** Introduction to statistical thermodynamics –- Microscopic description of gases – Boltzmann distribution – Equilibrium properties of high temperature air.	8	CO2
3	**Module 3: KINETIC THEORY AND HYPERSONIC FLOWS** Chemical equilibrium calculation of equilibrium composition of high temperature air –collision frequency and mean free path – velocity and speed distribution functions.	9	CO3

4	**Module 4: INVISCID HIGH TEMPERATURE FLOWS** 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	10	CO4
5	**Module 5: TRANSPORT PROPERTIES IN HIGH TEMPERATURE GAS** 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	10	CO5

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. John D. Anderson, Jr., Hypersonic and High Temperature Gas Dynamics, McGraw-Hill Series, New York, 1996.
2. Ethirajan Rathakrishnan, High Enthalpy Gas Dynamics, John Wiley and Sons, 2017.

Reference Books:

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

Other Resources (Online Resources or others)

1. Nil

U20ASST17 Space Vehicle Aerodynamics

Part A – Introduction of the Course

To make students to understand the Aerodynamics concepts of Space Vehicles.

Course Code	Course Category	Course Title	L	T	P	C
			3	0	0	3
U20ASST17	S	Space Vehicle Aerodynamics	Pre-requisite: U20ASCJ03- Low and High speed Aerodynamics U20ASCT10- Flight Mechanics			
Name of the Course Coordinator		Mr. M. Edwin	Contact Hrs: 45			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students

1. To gain the knowledge of space vehicle Aerodynamics.
2. To understand the concept behind radiative heat transfer at super-orbital entry velocities.

Course Outcomes (COs)

CO1	**Discuss** the fundamental Aerodynamics in Space Vehicle. **(Understand)**
CO2	**Illustrate** super and hyper three dimensional viscous flows. **(Apply)**
CO3	**Explain** aerodynamics of slender and blunt bodies **(Analyze)**
CO4	**Explain** radiative heat transfer at super-orbital entry velocities. **(Analyze)**
CO5	**Discuss** the Applications of radiative heating and Ablation. **(Understand)**

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment to Cos
1	**Topic 1: Introduction:** Navier-Stokes Equations for Partially Ionized- Multicomponent Gas Mixtures- Hypersonic Thin Viscous Shock Layer- Fully Viscous Shock Layer Equations- Parabolized Navier-Stokes Equations- Navier-Stokes (NS) Solutions	9	CO1

2	**Topic 2: SUPER AND HYPER THREE DIMENSIONAL VISCOUS FLOW** Introduction-Three-Dimensional Boundary Layer Flow-Three-Dimensional Viscous Shock Layer- Parabolized Navier-Stokes (PNS) Equations -The Full Navier-Stokes Equations-Radiative Heal Transfer at Super-orbital Entry Velocities	9	CO2
3	**Topic 3: AERODYNAMICS OF SLENDER AND BLUNTBODIES** 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	10	CO3
4	**Topic 4: RADIATIVE HEAT TRANSFERAT SUPER-ORBITAL ENTRY VELOCITIES** Radiation Properties of Hypersonic Gas Flow-Nongray Absorption in Radiating Flow Problems-. Radiative Heal Transfer in Hypersonic Inviscid Flow -Viscous Non-adiabatic Radiating Shock Layer and the Radiation Blockage Effect of Ablation Products	10	CO4
5	**Topic 5: APPLICATIONS** Engineering Approximations for Radiative Heating-. Body Shape Optimization for Radiative Transfer-Entry Body Mass and Shape Changes Due to Radiation-Driven Ablation	7	CO5

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. G. K. Mikhailov.and V. Z. Parton "Super and Hypersonic Aerodynamics and Heat Transfer", CRC Press, 2010.
2. Anderson, J.D., "Hypersonic and High Temperature Gas Dynamics", AIAA Education Series.

Reference Books:

1. Anderson Jr.,D.,–"Modern compressible flows", McGraw-Hill BookCo.,NewYork1999.
2. Anderson, J.D., "Fundamentals of Aerodynamics", McGraw-Hill BookCo. NewYork, 2010.

Other Resources (Online Resources or others)

1. Nil

U20ASST18 Design of LTA Systems

Part A – Introduction of the Course

To make students to understand the Aerodynamics concepts of Space Vehicles.

Course Code	Course Category	Course Title	L	T	P	C
			3	0	0	3
U20ASST18	S	Design of LTA Systems	Pre-requisite: U20ASCT10- Flight Mechanics			
Name of the Course Coordinator		Dr. N. Rajamurugu	Contact Hrs: 45			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students

1. To impart the knowledge, appreciate the forces generated on LTA structures due to normal wind as well as gusts
2. To analyse the Various shapes and cause effects on performance of LTA
3. To familiarize the control systems of Aerostats and hybrid systems.

Course Outcomes (COs)

CO1	**Compare** the performance characteristics of HTA and LTA Systems **(Understand)**
CO2	**Discuss** the aerodynamics of LTA systems. (**Understand**)
CO3	**Estimate** the static lift generated by an LTA system, given its type, size and operating scenario **(Analyse)**
CO4	**Discuss** the technological challenges in design, development and operation of an LTA system. **(Understand)**
CO5	**Summarize** current developments and future trends of LTA systems **(Understand)**

Part B – Content of the Course

Sl. No.	SUMMARYOFCOURSECONTENT	Hrs	Alignment to Cos
1	**Topic 1: INTRODUCTION** Introduction to LTA Systems - Historical Developments - Key Subsystems and Components of LTA Systems- Variation of Atmospheric Properties -	5	CO1
2	**Topic 2: PHYSICS OF LTA** Static Lift Prediction - Effect of ambient conditions on Static Lift - Climb, Descent and Pressure Height	7	CO2
3	**Topic 3: AIRSHIP TECHNOLOGY** Methodology for airship conceptual design-Aerodynamics & Stability analysis of Airships- Ground Handling and Mooring systems	12	CO3

4	**Topic 4: AEROSTAT TECHNOLOGY** Methodology for sizing of Aerostat sub-systems- Equilibrium and Stability analysis of aerostats-Design and Development of Tethered Aerostats	12	CO4
5	**Topic 5: CURRENT AND FUTURE DEVELOPMENTS** Challenges in design of LTA Systems - Hybrid LTA Systems - Stratospheric Airships	9	CO5

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Taylor, J. A., Principles of Aerostatics, The Theory of Lighter-Than-Air Aircraft, ISBN13:978-1-49481-053-5, 2014.
2. Khoury, G., Ed., Airship Technology, 2nd Edition, Cambridge Aerospace Series, Cambridge University Press, ISBN 978-1107019706, 2012.

Reference Books:

1. Carichner, G. E., and Nicolai, L. M., Fundamentals of Aircraft and Airship Design, Volume 2 – Airship Design and Case Studies, AIAA Education Series, ISBN: 978-1-60086-898-6, 2013, DOI: 10.2514/4.868986
2. Pant, R. S., Course Material for Design and Development of LTA systems, Curriculum Development Program, IIT Bombay, 2010.

Other Resources (Online Resources or others)

1. https://archive.nptel.ac.in/courses/101/101/101101087/

U20ASST19 Aeroelasticity

Part A – Introduction of the Course

This course introduces students to understand the aeroelastic phenomena, including divergence, aileron reversal control, flutter and flexibility effects on stability and control of aircraft wing structures.

Course Code	Course Category	Course Title	L	T	P	C
			2	1	0	3
U20ASST19	S	Aeroelasticity	Pre-requisite: U20ASCT03 – Applied Dynamics and Vibrations; U20ASCJ04- Advanced Aerospace Structures U20ASCT10- Flight Mechanics			
Name of the Course Coordinator		Dr. C. Suresh Kumar	Contact Hrs: 45			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students

1. To explain structural concepts of elastic stiffness, inertia, influence coefficients, shear center and elastic axis.
2. To describe structural dynamics of wings, including bending and torsion modes of vibration and their associated natural frequencies.
3. To apply aeroelastic concepts of divergence, flutter, lift and roll effectiveness, aileron reversal and mode coalescence.
4. To derive static and dynamic aeroelastic equations of motion
5. To apply approximate methods for continuous aeroelastic systems to interpret velocity-damping and velocity-frequency flutter diagrams.

Course Outcomes (COs)

CO1	**Explain** different aeroelastic phenomena encountered in aircraft (**Analyze**)
CO2	**Compare** critical divergence speed of the 2D rigid and elastic wings (**Evaluate**)
CO3	**Assess** the control reversal and aileron efficiency of an aircraft wings (**Evaluate**)
CO4	**Select** the method to determine the solution for flutter of 2D wings (**Evaluate**)
CO5	**Summarize** aeroelastic problems involved in various structures (**Evaluate**)

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment to COs
1	**Topic 1: Aeroelasticity Phenomena** Vibrations of beams due to coupling between bending and torsion – Aeroelastic triangle of forces – Stability versus response problems – Aeroelasticity in aircraft design – Vortex induced vibration – Introduction to aero servo elasticity.	7	CO1
2	**Topic 2: Divergence of a Lifting Surface** Simple 2D idealizations – Strip theory – Fredholm integral equation of the second kind – Exact solutions for simple rectangular wings – Semi rigid assumption and approximate solutions – Generalized coordinates – Successive approximations- Numerical approximations using matrix.	10	CO2
3	**Topic 3: Steady State Aeroelastic Problems** Loss and reversal aileron control – Critical aileron reversal speed – Aileron efficiency – Semi rigid theory and successive approximations – Lift distributions – Rigid and elastic wings.	9	CO3
4	**Topic 4: Flutter Analysis** Non-dimensional parameters – Stiffness criteria – Dynamic mass balancing – Model experiments – Dimensional similarity – Flutter analysis – 2D thin airfoils in steady incompressible flow – Quasi steady aerodynamic derivatives – Galerkin's method for critical speed – Stability of distributed motion – Torsion flexural flutter – Solution of the flutter determinant – Methods for determining critical flutter speed–Flutter prevention & control.	12	CO4
5	**Topic 5: Examples of Aeroelastic Problems** .Galloping of transmission lines and flow induced vibrations of all tall slender structures and suspension bridges – Aircraft wing flutter – Vibrational problems in Helicopters.	7	CO5

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Fung, Y.C. An Introduction to the theory of Aeroelasticity, Dover Publications Inc., 2008.
2. Bisplinghoff., R.L. Ashley, H., and Halfman, R.L, "Aeroelasticity" Addison Wesley Publishing Co., Inc. II ed. 1996.

Reference Books:

1. Broadbent, E.G., Elementary Theory of Aeroelasticity, Bunhill Publications Ltd, 1986.
2. Blevins R.D, "Flow induced vibrations", Krieger Pub Co; 2 Reprint editions, 2001.
3. Scanlan, R.H. and Rosenbaum, R., Introduction to the Study of Aircraft Vibration and Flutter, Macmillan Co., N.Y., 1991.

Other Resources (Online Resources or others)

1. Nil

U20ASSJ05 Experimental Techniques in Structural Mechanics

Part A – Introduction of the Course

This course introduces students to the concepts of measurements of strains and stresses.

Course Code	Course Category	Course Title	L	T	P	C
			2	0	2	3
U20ASSJ05	S	Experimental Techniques in Structural Mechanics	Pre-requisite U20ASCJ04-Advanced Aerospace Structures			
Name of the Course Coordinator		Mr. R. Bhoominathan	Contact Hrs: 60			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students

1. To Introduce the basic principles and methods of experimental stress analysis.
2. To learn the principles and techniques of photoelastic measurements.
3. To gain knowledge of the principles and a technique of strain gage measurements
4. To learn basic principles of operation of electrical resistance strain gauges
5. To learn basic principles of operation of non-destructive methods.

Course Outcomes (COs)

CO1	**Describe** the performance of measuring instruments (**Understand**)
CO2	**Impart** knowledge of electrical resistance strain gauges (**Understand**)
CO3	**Explain** the concepts of strain gauge instrumentation (**Understand**)
CO4	**Acquire** knowledge of photoelastic methods for stress analysis. (**Understand**)
CO5	**Describe** the principles and applications of various non-destructive techniques (**Understand**)
CO6	**Carry out** mechanical measurements using extensometers (**Imitation**)
CO7	**Acquire** stress values using electrical resistance strain gauges techniques (**Manipulation**)
CO8	**Demonstrate** the Nondestructive testing methods for detecting cracks (**Precision**)

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment to Cos
1	**Module -1: EXTENSOMETERS AND DISPLACEMENT SENSORS** Basic Characteristics and Requirements of a Measuring System, Principles of measurements, Accuracy, Sensitivity, range of measurements, Sources of Error. Mechanical, Optical, Acoustical, Electrical extensometers and Capacitance gauges. Vibration measurements-vibration pickups, frequency measuring instruments.	6	CO1
	Lab Experiment: Measurement of displacements using mechanical extensometers	6	CO6, CO7, CO8
2	**Module -2: ELECTRICAL-RESISTANCE STRAIN GAGES** Strain Sensitivity in Metallic Alloys – Gage Construction – Gage Sensitivities and Gage Factor – Performance Characteristics of Foil Strain Gages – Environmental Effects – The Three-Element Rectangular Rosette – Corrections for Transverse Strain Effects –Semiconductor Strain Gages	8	CO2
	Lab: Strain gauge installation & testing; Measurement of strain using strain rosettes	6	CO6, CO7, CO8
3	**Module -3: STRAIN-GAGE CIRCUITS & INSTRUMENTATION** The Potentiometer Circuit and Its Application to Strain Measurement – Variants From The Basic Potentiometer Circuit – Circuit Output – The Wheatstone Bridge Constant Current and Constant Voltage Circuits – Circuit Sensitivity – Calibrating Strain Gage Circuits– Electrical Noise Reduction – Strain Measurement in Bars, Beams and Shafts	6	CO3
	Lab: Calibration of strain gauges; Strain Measurement in Beams.	4	CO6, CO7, CO8
4	**Module -4: PHOTOELASTICITY** Introduction – Stress-Optic Law – Effects of a Stressed Model in a Plane Polariscope – Effects of a Stressed Model in a Circular Polariscope – Tardy Compensation – Two-Dimensional Photoelastic Stress Analysis – Fringe Multiplication and Fringe Sharpening – Properties of Commonly Employed Photoelastic Materials – Material Calibration	6	CO4
5	**Module -5: NON – DESTRUCTIVE TESTING** Fundamentals of NDT, Acoustic Emission Technique, Radiography, Thermography, Ultrasonics, Eddy Current testing, Fluorescent Penetrant Testing, Magnetic particle testing, Challenges in Nondestructive Evaluation, and Concepts of Image Processing Theory.	6	CO5
	Lab: Detection of defects using Fluorescent Penetrant Testing; Magnetic particle testing,	6	CO6, CO7, CO8

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Dally, J.W., and Riley, W.F., "Experimental Stress Analysis", McGraw Hill Inc., New York 1998.
2. Srinath, L.S., Raghava, M.R., Lingaiah, K., Garagesha, G., Pant B., and Ramachandra, K.,"Experimental Stress Analysis", Tata McGraw Hill, New Delhi, 1984.
3. Sadhu Singh, "Experimental Stress Analysis", Khanna Publishers, New Delhi, 1996.

Reference Books:

1. Durelli. A.J., "Applied Stress Analysis", Prentice Hall of India Pvt Ltd., New Delhi, 1970
2. Hetenyi, M., "Hand book of Experimental Stress Analysis", John Wiley and Sons Inc., New York, 1972.
3. Max Mark Frocht, "Photo Elasticity", John Wiley and Sons Inc., New York, 1968
4. Pollock A.A., Acoustic Emission in Acoustics and Vibration Progress, Ed. Stephens R.W.B., Chapman and Hall,1993.
5. K. Ramesh, e-Book on Experimental Stress Analysis, IIT Madras, 2009.
6. PS Theocaris, "Moire Fringes in Strain Analysis", Pergammon Press, 2002.

Other Resources (Online Resources or others)

1. https://nptel.ac.in/courses/112106068

U20ASST20 Materials for High Temperature Application

Part A – Introduction of the Course

To familiarize students with the basic principles of creep, hot corrosion, fracture mechanisms at elevated temperatures, and the selection of alloys suitable for high-temperature applications.

Course Code	Course Category	Course Title	L	T	P	C
			3	0	0	3
U20ASST20	S	Materials for High Temperature Applications	Pre-requisite: U20ASCT04 - Aerospace Materials and Process U20ASCJ04 – Advanced Aerospace Structures			
Name of the Course Coordinator		Mr. R. Karthikeyan	Contact Hrs: 45			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students

1. Understand the concept of creep and its implications in materials subjected to high temperatures.
2. Explore the various fracture mechanisms that occur under elevated temperatures, including ductile, brittle, and creep fracture.
3. Study the principles of alloy selection for high-temperature applications, considering factors such as temperature resistance, mechanical properties, and corrosion resistance.
4. Understand the role of environmental factors, such as atmosphere and impurities, in influencing material degradation at high temperatures.
5. To know about the super alloys types and its applications.

Course Outcomes (COs)

CO1	**Discuss** the suitable materials for high temperature applications **(Understand)**
CO2	**Explain** the creep mechanisms and creep resistance of high temperature materials **(Understand)**
CO3	**Explain various** types of failures and its maps for different alloys and oxides. **(Understand)**
CO4	**Describe** the process of oxidation and different techniques of corrosion resistance **(Understand)**
CO5	**Discuss** various types of super alloys and its strengthening mechanisms. **(Understand)**

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment to Cos
1	**Topic1: INTRODUCTION** Components exposed to high temperatures, significance of high temperature materials, recent trends in high temperature material research	6	CO1
2	**Topic2: CREEP AND CREEP RESISTANCE** 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.	12	CO2
3	**Topic3: FRACTURE** 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.	9	CO3
4	**Topic 4: OXIDATION AND HOT CORROSION** 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.	9	CO4
5	**Topic 5: SUPER ALLOYS AND OTHER MATERIALS** 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.	9	CO5

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Raj. R., “Flow and Fracture at Elevated Temperatures”, American Society for Metals, USA, 1985.
2. David J. Young, “High Temperature Oxidation and Corrosion of Metals”, Second Edition, Elsevier Science Ltd., 2016.

Reference Books:

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.

Other Resources (Online Resources or others)

1. https://nptel.ac.in/courses/113105019/

U20ASST14 Propellant Manufacturing Technology

Part A – Introduction of the Course

To introduce students with the fundamentals of rocket engine design process and testing.

Course Code	Course Category	Course Title	L	T	P	C
U20ASST14	S	Propellant Manufacturing Technology	2	1	0	3
Name of the Course Coordinator		Dr. Hamza Naseem	Contact Hrs: 45			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Pre-requisite: U20ASCT09 - Spacecraft Propulsion

Course Objective and Summary

This course will make students

1. To have adequate understanding of rocket propulsion.
2. To appreciate the various design details of a solid rocket motor.
3. To understand the functioning of the components of a liquid rocket engine.
4. To learn the basics of a rocket motor testing.
5. To learn basics of NASA CEA code.

Course Outcomes (COs)

CO1	**Review** the fundamentals of nozzle theory **(Understand).**
CO2	**Illustrate** the functioning of solid rocket motors **(Apply).**
CO3	**Break down** the design details of a solid propellant grain **(Analyze).**
CO4	**Explain** the functioning of liquid rocket motors **(Apply).**
CO5	**Describe** the significance of rocket motor testing and NASA CEA code **(Understand).**

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment to Cos
1	**Module 1: Introduction to Rocket Propulsion** Rockets in past and in modern era; Classification of rockets; Rocket equation; Ideal rocket propulsion system, Review of nozzle theory- isentropic flow through nozzles, exhaust velocity, choking, nozzle types and nozzle shape, nozzle area expansion ratio, real nozzles; Rocket performance parameters- thrust, characteristics velocity, specific impulse.	6+2	CO1
2	**Module 2: Solid Propellant Rocket Engines** Components of a solid rocket engine; Classification of solid rockets – double base, composites, hybrid; Solid propellant ignition, burning and burn rate – relationships with mass flow, pressure, pressure index, temperature; Internal ballistics; Thrust termination; Sliver; Gas generator and Ignitor propellants	5+2	CO2
3	**Module 3: Construction details of a Solid Propellant Motors** Propellants ingredients- fuel, oxidizer, binder, plasticizer, curing agent, cross-linkers, burn rate modifiers; Propellant grain configurations- end burning, core burning, star grain, segmented and 3D grains; Burning surface area evaluation; Methods of calculating equilibrium composition; Case-metal and composites, liner and insulator; Propellant processing and manufacture; Nozzle configuration-heat transfer; Pyrotechnic and pyrogen igniters.	7+3	CO3
4	**Module 4: Liquid Propellant Rocket Engines** Components of a liquid rocket engine (LRE) and classification – monopropellant thruster, bipropellant engines, cryogenic engines; Performance parameters of LRE; Essential characteristics of liquid propellants – oxidizers and fuels; Storage tanks-pressurization, stratification, ullage and slosh ; Types of feed system in liquid rocket engine; Pumps; Turbine, Thrust chamber; Injectors; Thrust chamber cooling - Regenerative cooling.	6+4	CO4
5	**Module 5: Rocket Testing and NASA CEA code** Types of test and required facilities– test bed and controls; Instrumentation, measurement of test data and data management; Managing transient at start and shutdown; Engine performance map; Safety and environmental concerns; Monitoring and control of toxic materials and exhaust gases; Reliability and quality control – health monitoring; Hot runs and flight testing; Introduction to NASA CEA code.	6+4	CO5

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Rocket Propulsion Elements, Sutton, G.P., Biblarz, O., John Wiley & Sons, Inc., New York, 2001.
2. Understanding Chemical Rocket Propulsion, Mukunda, H.S., I K International Publishing, 2017.
3. Design of Liquid Propellant Rocket Engine – Huzel, D. K. & Huang, D. H., NASA SP-125.
4. Rocket Propulsion, Ramamurthi, K., 2nd Edition, Trinity Press of Laxmi Publications, 2016.

Reference Books:

1. Rocket Propulsion, Barrere, M., Jaumotte, A., Fraeijs de Veubeke, B., Vandenkerckhove, J., Elsevier Publishing Company, 1960.
2. Solid Rocket Technology – Shorr, M., Zaehringer, A.J., John Wiley New York, 1967.
3. Rocket and Spacecraft Propulsion: Principle, Practice and New Developments, Turner, M. J. L., Springer Verlag. 2000.

Other Resources (Online Resources or others)

1. Nil

U20ASSJ09 Experimental Methods in Propulsion

Part A – Introduction of the Course

To make students understand the Experimental concepts and the methods used in the field of propulsion.

Course Code	Course Category	Course Title	L	T	P	C
U20ASSJ09	S	Experimental Methods in Propulsion	2	0	2	3
Name of the Course Coordinator		Mr. Abinicks Raja G	Pre-requisite: U20ASCT09 - Spacecraft Propulsion			
Course offering Dept./School		Department of Aeronautical Engg.	Contact Hrs: 60			
			Total Marks: 100			

Course Objective and Summary

This course will make students

1. To understand the concept of shock wave formation and optical techniques.
2. To understand the basics of jets and its types
3. To understand the jet control methods and jet acoustics

Course Outcomes (COs)

CO1	**Explain** the flow property variation based on different parameters and its measurement techniques (**Understand**)
CO2	**Understand** the submerge jets and its fundamentals characteristics (**Understand**)
CO3	**Identify** the different type of techniques to analyze the jets characteristics (**Apply**)
CO4	**Choose** different type of jet control techniques based on applications (**Apply**)
CO5	**Discuss** about type of jets noise and suppression techniques (**Understand**)
CO6	**Observe** the jet spread rates and the center line decay in jets (**Imitation**)
CO7	**Perform** experiments to measure the temperature distribution in forced and free convection. (**Manipulation**).
CO8	**Experiment** the jet expansion levels based on optical flow visualization techniques. (**Precision**)

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment to Cos
1	**UNIT I FUNDEMTALS OF GAS DYNAMICS.** Perfect gas – velocity of sound – Mach number – Flow with area changes – Normal shock wave – Oblique shock wave – Expansion waves – Flow with friction – flow visualization techniques in compressible flows – Shadow graph – Interferometry – Schlieren - Particle Image Velocimetry.	5	CO1
2	**UNIT II INTRODUCTION TO JETS** Properties of Turbulent Jets-Fundamental Concepts, Submerged Jets-Velocity Profiles in a Submerged Jet- Spread of a turbulent submerged jet- Lines of Constant Velocity in a Submerged Jet. Velocity Variation along the Axis of a Submerged jet, Velocity, Temperature, and Concentration Profiles in a Turbulent Jet Spreading into an External Stream of Fluid- Spread of a Turbulent Jet into a Co-flowing or Counter-flowing External Stream- Turbulence Characteristics in a Free Jet	7	CO2
3	**UNIT III THEORIES OF JETS** Types of Jets-Plane free-jets. Round jets. Plane jets in a co-flowing stream. Round jet in Co flowing stream- Swirling jets-Radial jets-Wall jets- Jet Characteristics & Entrainment, Mathematical treatment of jet profiles- Semi-empirical Theories. Mixing Layers-Computational and Experimental Techniques for Studying the Jets	7	CO3
4	**UNIT IV JETCONTROL METHODS** Active control methods- Actuators-Fluidic, Thermal, Acoustic, Piezoelectric, Electromagnetic, MEMS, Synthetic Jets, Controls and Sensors, Applications. Passive control techniques- Tabs, Grooves, Chevrons, non-circular nozzles, Notches & wires, vortex generators. Optical Flow Visualization, Applications.	5	CO4
5	**UNIT V JET ACOUSTICS** Introduction to Jet Acoustics – Types of jet noise – Source of generation- Travelling wave solution, standing wave solution – multi-dimensional acoustics-Theoretical Concepts of Jet Noise Generation and Suppression–Jet Noise suppression techniques – applications	6	CO5
	Experiment: • Calculation of temperature distribution using Free convection experiments. • Calculation of temperature distribution using Forced convection experiments. • Demonstrate over-expanded jets by using shadowgraph techniques • Demonstrate under expanded jets by using shadowgraph techniques • Estimation of Spread Rate in Incompressible Non-Circular Jets • Estimation of Centre Line Decay in Supersonic Circular Jets	30	CO6, CO7, CO8

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Ethirajan Radhakrishnan, Instrumentation Measurements, and Experiments in Fluids, CRC Press, Second Edition., 2020.

Reference Books:

1. Rocket Propulsion Elements by George P. Sutton and Oscar Biblarz, Wiley, 2016.

Other Resources (Online Resources or others)

1. Nil

U20ASST21 Advances in Aerospace Propulsion

Part A – Introduction of the Course

This course introduces students the propulsion techniques used in space exploration missions. Students will gain a fundamental understanding of advanced propulsion systems and their applications, as well as their potential impact on future space missions.

Course Code	Course Category	Course Title	L	T	P	C
			3	0	0	3
U20ASST21	S	Advances in Aerospace Propulsion	Pre-requisite: U20ASCT09-Spacecraft Propulsion			
Name of the Course Coordinator		Mr. R. Manikandan	Contact Hrs: 45			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course provides an in-depth study of propulsion systems used in space exploration missions. It covers the principles, design, and applications of different propulsion technologies, enabling students to understand the challenges and opportunities in space travel.

Course Outcomes (COs)

CO1	**Summarize** the significance of space propulsion in space exploration **(Understand)**
CO2	**Discuss** the fundamentals of electric propulsion, including power requirements and rocket efficiency. **(Understand)**
CO3	**Demonstrate** advanced electrostatic propulsion systems and its operation. **(Understand)**
CO4	**Describe** the basic principles of solar sailing, including the interaction of solar radiation with spacecraft. **(Understand)**
CO5	**Discuss** the challenges associated with implementing solar thermal propulsion systems, such as thermal management and material limitations. **(Understand)**

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSECONTENT	Hrs	Alignment to Cos
1	**UNIT I-INTRODUCTION TO SPACE PROPULSION** Overview of space propulsion- Significance in space exploration- Classification of propulsion systems: chemical, electric, nuclear, and others- Historical developments and key milestones in space propulsion technology-	6	CO1
2	**UNIT II – ELECTRIC PROPULSION** Basic concepts in electric propulsion – Electricity and Magnetism – Electro thermal Propulsion -Resisto-jets- Electrical Discharges-Arcjets - Electromagnetic Propulsion- Magneto plasma dynamic - Thrusters-Pulsed Plasma Thrusters	10	CO2
3	**UNIT III– ELECTROSTATIC PROPULSION**	10	CO3

	Theory of Charged Particles- Kinetic Theory, Ionization of Gases, & Plasma Physics-Ion Engines-Hall Thrusters-Field Emission Electric Propulsion [FEEP] - Colloid Thrusters		
4	**UNIT IV SOLAR SAIL** Historical development and key milestones in solar sail technology -Basic principles of solar sailing and its advantages over traditional propulsion methods- Types- Applications- Structural design considerations and deployment mechanisms-Concepts of rigid and deployable solar sail designs- Overview of past and current solar sail missions	10	CO4
5	**UNIT V SOLAR THERMAL PROPULSION** Solar Thermal Propulsion-Solar thermal rockets and their working principles-Comparison of solar thermal propulsion with chemical rockets-Challenges and prospects of solar thermal propulsion.	9	CO5

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Advanced Propulsion Systems and Technologies: Today to 2020 edited by Claudio Bruno, Michelangelo, and Antonio Accettura, Springer, 2008.
2. Space Propulsion Analysis and Design by Ronald Humble, Wiley, 1995.

Reference Books:

2. Rocket Propulsion Elements by George P. Sutton and Oscar Biblarz, Wiley, 2016.
3. Solar Sails: A Novel Approach to Interplanetary Travel by Giovanni Vulpetti, Les Johnson, and Gregory L. Matloff, Springer, 2008
4. Electric Propulsion for Spacecraft by Anatoliy S. Bokor and Michael J. Patterson, Springer, 2015.
5. Fundamentals of Electric Propulsion: Ion and Hall Thruster" by Dan M. Goebel and Ira Katz, Wiley, 2008.

Other Resources (Online Resources or others)

1. Nil

REGULATION 2020

B. Tech. - Aerospace Engineering

CURRICULUM AND SYLLABUS

Based on Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

OPEN ELECTIVE COURSES & SYLLABUS

U20AEOT01 Elements of Aeronautics and Astronautics

Part A – Introduction of the Course

This course describes the history of aeronautics and astronautics, early developments of aircraft, spacecraft & their system, principles of flight, aerospace propulsion and essential science behind them.

Course Code	Course Category	Course Title	L	T	P	C
			3	0	0	3
U20AEOT01	O	Elements of Aeronautics and Astronautics	Pre-requisite: +2			
Name of the Course Coordinator		Mr. M. Edwin	Contact Hrs: 45			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students

1. To explore the history of space and atmospheric science
2. To learn the types of aerospace vehicles
3. To learn the basic of aerodynamics
4. To understand the aerospace structures
5. To learn the basic concepts of jet and rocket propulsion.

Course Outcomes (COs)

CO1	**Explore** the basics of space science **(Understand).**
CO2	**Identify** the types of aerospace vehicles **(Understand).**
CO3	**Explain** earth atmosphere and the basic principle of lift generation **(Understand)**
CO4	**Describe** the loads on aerospace structures and their design **(Understand).**
CO5	**Summarize** the operating principles of jet and rockets engines (**Understand**)

Mapping/Alignment of COs with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H									H		H		
CO2	H											H		
CO3	H									H		H		
CO4	H											H		
CO5	H											H		

(Tick mark or level of correlation: 3-High,2-Medium,1-Low)

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment to Cos
1	**MODULE 1: SPACE SCIENCE & EVOLUTION OF FLIGHT** Big-bang theory and Expansion of Universe; Stars- Stellar Characteristics-Stellar evolution and structure; Galaxy-Milky way-Solar System- planets-types- formation of solar system, Planetary motion, Keplar's law – escape velocity; Newton's gravitational laws; Orbits around earth – LEO, GEO. Brief history of Aviation-Hot air balloon and heavier than air flying machines-early airplane configurations.	12	CO1
2	**MODULE 2: TYPES OF AIRCRAFT & SPACE VEHICLE** Modern Airplanes- Aircraft Nomenclatures-Components of airplane and their functions-Rotary wing aircrafts; UAV's MAV's –classification-Application; Space launch vehicles, spacecraft, orbit launcher, re-entry vehicle and satellite.	7	CO2
3	**MODULE 3: EARTH ATMOSPHERE & BASIC AERODYNAMICS** 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. Incompressible Flow; Coanda Effect; Airfoil geometry and nomenclature - airfoil characteristics - lift, drag and moment coefficients-angle of attack-aspect ratio; Mach number.	10	CO3
4	**MODULE 4: AEROSPACE STRUCTURES** Loads on aircrafts and space vehicles; Structural components of an airplane-monocoque and semi monocoque structure; introduction to thin-walled structures; materials for aerospace structural components; composite materials and their significance in aerospace industry.	7	CO4
5	**MODULE 5: AEROSPACE PROPULSION** 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; Basics of Rocket Technology – rocket equation	9	CO5

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Anderson, J.D., Introduction to Flight, McGraw-Hill, 2015
2. Brandt, A. Introduction to Aeronautics: A design perspective, AIAA Education Series, 2004.

Reference Books:

1. Kermode, A.C. Flight without Formulae, Pearson Education; Eleven edition, 2011.
2. E L Houghton and PW Carpenter, "Aerodynamics for Engineering students", Sixth edition, Edward Arnold Publications, 2012
3. Howard D. Curtis, “Orbital Mechanics for Engineering Students”, Elsevier Butterworth Heinemann, Third Edition, 2010.

Other Resources (Online Resources or others)

1. https://nptel.ac.in/courses/101/101/101101079/

U20AEOT02 Wind Tunnel Testing, Instrumentation & Measurements

Part A – Introduction of the Course

To make students understand how to use wind tunnel for validation of their aerodynamic design and learn the measurement techniques for pressure, velocity and temperature.

Course Code	Course Category	Course Title	L	T	P	C
U20AEOT02	O	Wind Tunnel Testing, Instrumentation & Measurements	3	0	0	3
Name of the Course Coordinator		Dr Surekha Rathi Samundi D	Contact Hrs: 45			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students

1. To understand the basic of fluid mechanics.
2. To understand the fundamental of aerodynamics.
3. To understand the model testing procedure.
4. To learn the data analysis of wind tunnel test results.
5. To understand the qualitative wind tunnel techniques.

Course Outcomes (COs)

CO1	**Describe** the basic concepts of fluids. (**Understand**)
CO2	**Discover** the fundamental of aerodynamics. (**Understand**)
CO3	**Identify** the data acquisition and calibration technique. (**Understand**)
CO4	**Interpret** aerodynamic force coefficient and pressure coefficient plots. (**Understand**)
CO5	**Explain** the flow visualization techniques. (**Understand**)

Mapping/Alignment of COs with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H											M		
CO2	H											M		
CO3	H									H		M		
CO4	H									H		M		
CO5	H											M		

(Tick mark or level of correlation: 3-High,2-Medium,1-Low)

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment to Cos
1	**MODULE 1 PHYSICS OF FLUIDS** Introduction – basic properties of fluids, Newton's Law of viscosity, Pascal's Law, Bernoulli's principle, types of pressures, volume flow rate, mass flow rate, continuity equation, measurement of flow properties, similarity laws, Reynolds number, Mach number.	8	CO1
2	**MODULE 2 FUNDAMENTALS OF AERODYNAMICS** Fluids-gases-air, International Standard Atmosphere, barometer and atmospheric pressure measurement, pressure, temperature and density variations in atmosphere, Bernoulli's equation for gases, pitot-static tube, velocity measurements, Airfoil geometry and nomenclature, airfoil characteristics, NACA Airfoils - lift, drag and moment.	10	CO2
3	**MODULE 3 QUANTITATIVE TECHNIQUES** Components of Low Speed Wind Tunnel, model testing procedures, application of similarity laws, uses of manometers, pressure sensors, hot-wire anemometer, balances, Data Acquisition System, calibration of instruments, testing methodologies, collection of data	9	CO3
4	**MODULE 4 DATA ANALYSIS** Coefficient of pressure (C_p), coefficient of lift, drag and moments, C_p plots, variation of pressure and its influence, time averaged plots, uncertainty analysis, variation of lift and drag with flow conditions.	9	CO4
5	**MODULE 5 QUALITATIVE TECHNIQUES** Laser smoke flow visualization, tuft flow visualization, oil flow visualization, pressure sensitive paints, specification of high speed cameras, photography techniques for capturing vortex and flow separation phenomenon.	9	CO5

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Instrumentation, measurements and experiments in fluids, E. Rathakrishnan, CRC Press, 2013.
2. Fundamentals of Aerodynamics, John D Anderson Jr, Sixth edition, Mc Graw Hill, 2017.
3. Rae, W.H. and Pope, A., "Low Speed Wind Tunnel Testing", John Wiley Publication, 1984.

Reference Books:

1. Fluid Mechanics & Hydraulic Machines, Dr R K Bansal, Laxmi Publications.
2. Steven, A. Brandt, Randall J. Stiles, John J. Bertin and Ray Whiteford, Introduction to Aeronautics: A Design Perspective, AIAA Education series (2nd edition),2004.
3. Torenbeek, E and Wittenberg, H, Flight Physics: Essentials of Aeronautical Disciplines and Technology, with Historical Notes, Springer, 2009.

Other Resources (Online Resources or others)

1. Nil

U20AEOT03 Introduction to Composite Materials

Part A – Introduction of the Course

This course introduces students to composite materials, fabrication and testing.

.Course Code	Course Category	Course Title	L 3	T 0	P 0	C 3
U20AEOT03	O	Introduction to Composite Materials	Pre-requisite: +2			
Name of the Course Coordinator		Mr. M. K. Karthik	Contact Hrs: 45			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students

1. To impart knowledge about composite materials and how they differ from conventional materials.
2. To introduce the different manufacturing process for fabrication of composite structures.
3. To familiarize the different testing methods available to characterize the composite materials.
4. To introduce the concept of nanocomposites and their practical applications.

Course Outcomes (COs)

CO1	**Define** the types of matrix and fibers used in composite materials along with their functions. **(Remember)**.
CO2	**Classify** the different composite materials based on the reinforcement and matrix used. **(Understand)**
CO3	**Explain** the different manufacturing process involved in composite structures. **(Understand)**
CO4	**Classify** the nanoparticles based on the processing and binding mechanisms. **(Understand)**
CO5	**Discuss** about the testing methods used to characterize the composite laminates. **(Understand)**

Mapping/Alignment of COs with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H											M		
CO2	H											M		
CO3	H									H		M		
CO4	H									H		M		
CO5	H											M		

(Tick mark or level of correlation: 3-High,2-Medium,1-Low)

Part B – Content of the Course

Sl. No.	SUMMARY OF COURSE CONTENT	Hrs	Alignment to COs
1	**Module 1: Introduction** Classifications of Engineering Materials, Concept of composite materials, Matrix materials, Functions of a Matrix, Desired Properties of a Matrix, Polymer Matrix (Thermosets and Thermoplastics), Metal matrix, Ceramic matrix. Types of Reinforcements: Role and Selection of reinforcement materials, Types of fibers- Glass fibers, Carbon fibers, Aramid fibers, Boron Fibers. Manufacturing and Mechanical properties of fibers.	9	CO1
2	**Module 2: Types of Composites** Classification based on Matrix Material: Organic Matrix composites, Polymer matrix composites (PMC), Carbon matrix Composites or Carbon-Carbon Composites, Metal matrix composites (MMC), Ceramic matrix composites (CMC); Classification based on reinforcements: Fiber Reinforced Composites, Particulate Composites, Comparison with Metals, Advantages, limitations and applications of Composites. Sandwich construction-properties and applications.	9	CO2
3	**Module 3: Manufacturing of Composites** Processing of PMCs-hand lay-up, spray technique, filament winding, Pultrusion, RTM, Vacuum bag molding, injection moulding, Processing of MMCs -solid state, liquid state, vapour state processing.	9	CO3
4	**Module 4: Introduction to nanocomposites** Definition of nano composite materials, Types of nano composites Processing of nanoparticles, binding mechanisms in nanoparticles, dispersion of nanoparticles, and stabilization of nanoparticles. Processing and fabrication of polymer nanocomposites. Effects of nano fibers in polymer composite.	9	CO4
5	**Module 5: Testing of Composites** Characterization of composites using various testing like tensile, Compression, Shear, Flexural, Impact, Aging and thermal testing of laminates.	4	CO5

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Gibson, R.F., Principles of Composite Material Mechanics, McGraw-Hill, Second Edition - CRC press in progress, 1994
2. Krishnan Chawla, Composite Materials: Science and Engineering, Second Edition, Springer, 2008.

Reference Books:

1. Agarwal, B.D., and Broutman, L.J., "Analysis and Performance of Fiber Composites," John Wiley & Sons, 3rd edition, July 2006.
2. Alan Baker, Composite Materials for Aircraft Structures, AIAA Series, 2ndEdition, 2004.
3. Niranjan Karak, Nanomaterials and Polymer Nanocomposites, Elsevier Science, October 2018.

Other Resources (Online Resources or others)

1. https://nptel.ac.in/courses/113/104/113104102

U20AEOT04 Elements of Jet Propulsion Systems

Part A – Introduction of the Course

To make students understand the basics of jet engine and its main components.

Course Code	Course Category	Course Title	L	T	P	C
			3	0	0	3
U20AEOT04	O	Elements of Jet Propulsion Systems	Pre-requisite: +2			
Name of the Course Coordinator		Dr. N. Rajamurugu	Contact Hrs: 45			
Course offering Dept./School		Department of Aeronautical Engg.	Total Marks: 100			

Course Objective and Summary

This course will make students

1. To impart the knowledge internal flow and external characteristics near the inlets. Starting problems and different modes of operation in supersonic inlets.
2. To know the types and working principles of axial compressors
3. To Provide Knowledge about operation of combustion diffuser, chamber, and nozzle.

Course Outcomes (COs)

CO1	**Explain** the performance characteristics of various Gas turbine engines(**Understand**)
CO2	**Describe** the design methods on subsonic and supersonic inlets for jet engines (**Understand**)
CO3	**Describe** the concepts of performance characteristics aircraft compressors. (**Understand**)
CO4	**Describe** the parameters governing the design of combustion chambers (**Understand**)
CO5	**Describe** the performance of nozzles of jet engines (**Understand**)

Mapping/Alignment of COs with PO & PSO

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H											M		
CO2	H											M		
CO3	H									H		M		
CO4	H									H		M		
CO5	H											M		

(Tick mark or level of correlation: 3-High,2-Medium,1-Low)

Part B – Content of the Course

SL NO	SUMMARY OF COURSE CONTENT	Hrs	Alignment to COs
1	**Module 1: INTRODUCTION TO AIRCRAFT PROPULSION** Introduction to propulsion, Fundamental equations, Types of aircraft engines Performance parameters, thrust equation , factors affecting thrust and efficiencies-Working principle of afterburner, afterburner augmentation, Thrust and efficiency	9	CO1
2	**Module 2: DIFFUSER** Subsonic inlet and Internal flow, Major features of external flow, Relation between minimum area ratio and external deceleration ratio, Supersonic inlets, Starting problem on supersonic inlets, Shock swallowing by area variation, External deceleration, Modes of inlet operation.	9	CO2
3	**Module 3: COMPRESSOR** Working principle of axial compressor, Elementary theory, Velocity triangles, Degree of reaction, Three dimensional flow, Compressor blade design & stage performance calculation, Factors affecting stage pressure ratio, off design performance, Axial compressor performance characteristics. Working principle of centrifugal compressor, Work done and pressure rise, Inducer and impellor, Velocity diagrams	9	CO3
4	**Module 4: COMBUSTION CHAMBER** Classification of combustion chambers, Important factors affecting combustion chamber design, Combustion process, Combustion chamber performance, Effect of operating variables on performance, Flame tube cooling, Flame stabilization, Use of flame holders, Numerical problems.	9	CO4
5	**Module 5: NOZZLES** Theory of flow in isentropic nozzles, Convergent nozzles and nozzle choking, Nozzle throat conditions, Nozzle efficiency, Losses in nozzles, Over expanded , under expanded nozzles , Ejector and variable area nozzles.	9	CO5

Part C- Assessment and Evaluation

1. Assessment Strategy (Bloom's Taxonomy and Rubric based: CLA-1, CLA-2, CLA-3, Assignment, Semester Final Exam)
2. Evaluation Policy (Grading System)

Part D - Learning Resources

Text Book:

1. Sutton, G. P. and Biblarz, O., Rocket Propulsion Elements, 7th ed., Wiley (2001).
2. Flack, R. D., Fundamentals of Jet Propulsion with Applications, Cambridge Univ. Press (2005).
3. Hill, P. and Peterson, C., Mechanics and Thermodynamics of Propulsion, 2nd ed., Pearson (1992).

Reference Books:

1. Mattingly, J. D., Elements of Propulsion: Gas Turbines and Rockets, AIAA Edu. Series (2006).

Other Resources (Online Resources or others)

1. Nil