SMTB1101	MATRICES AND CALCULUS (COMMON TO ALL BRANCHES EXCEPT BIO GROUPS)	L	T	P	EL	Credits	Total Marks
		3	1	0	0	3	100

COURSE OBJECTIVES

- The Objective of this Course is to identify, reflect upon, evaluate and achieve conceptual understanding and knowledge of traditional Calculus to form independent judgements.
- The purpose of this course is for Modeling the Engineering problems and obtaining its solutions mathematically.
- This helps in understanding Science, Engineering and Computer Science analytically and logical thinking is attained.

UNIT 1 MATRICES 9 Hrs.

Characteristic equation of a square matrix – Eigen values and Eigen vectors of a real matrix – Properties of Eigen values and Eigen Vectors – Cayley - Hamilton theorem (without proof) – verification, finding inverse and power of a matrix – Diagonalization of a matrix using orthogonal transformation – Quadratic forms – Nature of quadratic forms – Reduction of quadratic form to canonical form by orthogonal transformation.

UNIT 2 GEOMETRICAL APPLICATIONS OF DIFFERENTIAL CALCULUS 9 Hrs.

Definitions – Derivative of standard functions (Results only) - Differentiation of function of function – Logarithmic differentiation – Derivatives of implicit function- Curvature – Centre, Radius and Circle of Curvature in Cartesian co-ordinates – Evolutes.

UNIT 3 FUNCTIONS OF SEVERAL VARIABLES 9 Hrs.

Partial derivatives (Definition) – Total derivative – Jacobian - Taylor's expansion – Maxima and minima of functions of two variables – Constrained maxima and minima using Lagrange's multiplier method.

UNIT 4 INTEGRAL CALCULUS I 9 Hrs.

Beta and Gamma integrals – Relation between Beta and Gamma integrals – Properties of Beta and Gamma integrals with proofs – Evaluation of definite integrals in terms of Beta and Gamma function.

UNIT 5 INTEGRAL CALCULUS II 9 Hrs.

Double integrals in Cartesian and Polar co-ordinates – Change of order of integration – Change of variables from Cartesian to Polar coordinates – Area of plane curves using double integrals. Triple integrals – Volume using triple integrals in Cartesian co-ordinates -Simple Applications.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Convert the quadratic form to canonical form by orthogonal transformation
CO2 - Construct the Circle of Curvature and Evolute of any curve.
CO3 - Examine the maxima and minima of function of several variables.
CO4 - Analyze the relationship between Beta and Gamma functions and its applications
CO5 - Evaluate double integrals in various coordinate systems
CO6 - Apply the concept of triple integrals in engineering problems

TEXTS / REFERENCE BOOKS

1. Bali and Manish Goyal, A Text book of Engineering Mathematics, Laxmi publications, Reprint, 2008
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10th edition, John Wiley & Sons, Singapore, 2012.
3. Grewal B.S., Higher Engineering Mathematics, 41th Edition, Khanna Publications, Delhi, 2011.
4. Kandaswamy P & Co., Engineering Mathematics for First Year, IX revised edition, S. Chand & Co Pub., 2010.
5. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill, New Delhi, 11th Reprint, 2010.
6. Veerarajan T., Engineering Mathematics for First Year, II Edition, Tata McGraw Hill Publishers, New Delhi, 2008.
7. Venkataraman M.K., Engineering Mathematics – First Year (2nd edition), National Publishing Co., 2000.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SPHB1101	PHYSICS (COMMON TO ALL BRANCHES)	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To understand the concept of crystal structures and symmetry, the physics of scattering and diffraction theory, experimental diffraction from single crystals, instrumentation and powder diffraction.
- Students will be able to understand the Identify and describe properties of matter, including: flexibility, strength and transparency.
- The objective of this course is to develop a working knowledge of the laws and methods of thermodynamics and elementary statistical mechanics and to use this knowledge to explore various applications.
- Differentiate between various acoustic terms and understand how these apply to different materials and acoustic design solutions.
- To give knowledge about semiconductor physics and discus working and applications of basic devices, including p-n junctions, BJTs and FETs.

UNIT 1 QUANTUM MECHANICS 9 Hrs.

Introduction to Quantum mechanics-Energy distribution function, Wave – particle duality-de Broglie matter waves – Concept of wave function and its physical significance – Heisenberg's Uncertainty Principle – Schrodinger's wave equation – Time independent and Time dependent equations – Particle in a one dimensional rigid box – tunnelling (Qualitative) – Scanning Tunnelling Microscope (STM).

UNIT 2 PROPERTIES OF MATTER 9 Hrs.

Introduction- Elasticity- Hooke's law - Torsional stress & deformations – Twisting couple – Torsion pendulum - theory and experiment–bending of beams - bending moment–cantilever:-Theory and experiment–uniform and non-uniform bending: theory and experiment- Magnetism - Basic definitions - Magnetic permeability, susceptibility, relation between permeability and susceptibility - Bohr magneton. Classification of magnetic materials-Hysteresis

UNIT 3 CRYSTAL PHYSICS 9 Hrs.

Single crystalline, polycrystalline and amorphous materials – single crystals: unit cell, crystal systems, Bravais lattices, directions and planes in a crystal, Miller indices – inter-planar distances – coordination number and packing factor for SC, BCC, FCC, HCP– crystal imperfections: point defects, line defects – growth of single crystals: solution and melt growth techniques.

UNIT 4 SEMICONDUCTOR PHYSICS 9 Hrs.

Classification of materials-Theory of semiconductors: Intrinsic and extrinsic semiconductors, band structure of semiconductors - Fermi level in intrinsic and extrinsic semiconductors. Theory of p-n junctions – diode and transistor: p-n junction under thermal equilibrium, forward bias, reverse bias, carrier density, V-I characteristics, junction capacitance and voltage breakdown. Zener diode and its characterization- Avalanche breakdown- JEFT- I-V characteristics- amplifying and switching.

UNIT 5 LASER AND ITS APPLICATIONS 9 Hrs.

Absorption and Emission of Radiation by atoms, ions and molecules. Laser medium Phenomenon of population inversion. Laser cavity (fiber laser, and other cavities), generation of coherent beam, Q-switching, short pulse generation, power amplification. Basic Laser Principles: Theory of Laser, Properties of Laser, Fundamental Optical properties, Modified Optical properties, Laser output – its characteristics.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Solve the time independent Schrodinger wave equation for a particle in a box to obtain the Eigen values and Eigen functions.
CO2 - Understand the dual nature of radiation and matter
CO3 - Estimate the atomic packing factor for SC, BCC & FCC structures.
CO4 - Recognize sound level descriptors and how they are used in architectural acoustics and analyse acoustic properties of typically used materials for design consideration.
CO5 - Understanding the working, design considerations and applications of various semi conducting devices including p-n junctions, BJTs and FETs
CO6 - Demonstrate an understanding of optical fiber communication link, structure, propagation and transmission properties of an optical fiber.

TEXTS / REFERENCE BOOKS

1. Pillai S.O., Solid state Physics, New age International Publishers, 7th Edition.
2. Arthur Beiser, Concepts of Modern Physics, Tata McGraw Hill Publications.
3. M.N.Avadhanulu & P.G.Kshirasagar. A text book of Engineering Physics, S. Ch.Publishing.
4. B. B.Laud, Lasers and nonlinear optics, New age International Publishers, II-Edition.
5. R. Murugesan, Modern Physics, S. Chand Publishing, 15th Edition (2015).
6. D. S. Mathur, Elements of Properties of Matter, S. Chand Publishing (2014).
7. A. K. Bandyopadhyay, Nanomaterials, New age International Publishers,
8. K. K. Chattopadhyay, Introduction to nano science and nano technology, PHI publisher,
9. Sulabha Kulkarni, Introduction to Nanoscience and Nanotechnology 2nd Edition.
10. David Griffiths, Introduction to electrodynamics, Addison-Wesley publishing 3rd Edition.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB1101	INTRODUCTION TO AERONAUTICAL ENGINEERING	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To acquire the knowledge on the Historical evaluation of Airplanes To learn the different component systems and functions
- To know the concepts of basic properties and principles behind the flight To learn the basics of different structures & construction
- To learn the various types of power plants used in aircrafts

UNIT 1 HISTORY OF FLIGHT **9 Hrs.**

Balloon flight-ornithopter-Early Airplanes by Wright Brothers, biplanes and monoplanes, Developments in aerodynamics, materials, structures and propulsion over the years.

UNIT 2 AIRCRAFT CONFIGURATIONS AND ITS CONTROLS **9 Hrs.**

Different types of flight vehicles, Classifications-Components of an airplane and their functions-Conventional control, powered control- Basic instruments for Flying-Typical systems for control actuation.

UNIT 3 BASICS OF AERODYNAMICS **9 Hrs.**

Physical Properties and structures of the Atmosphere, Temperature, pressure and altitude relationships, Newton's Law of Motions applied to Aeronautics-Evolution of lift, drag and moment. Aerofoils, Mach number, Manoeuvres.

UNIT 4 BASICS OF AIRCRAFT STRUCTURES **9 Hrs.**

General types of construction, Monocoque, semi-monocoque and geodesic constructions, typical wing and fuselage structure. Metallic and non-metallic materials. Use of Aluminum alloy, titanium, stainless steel and composite materials. Stresses and Strains-Hooke's law- stress-strain diagrams- elastic Constants-Factor of Safety.

UNIT 5 BASICS OF PROPULSION **9 Hrs.**

Basic ideas about piston, turboprop and jet engines – use of propeller and jets for thrust Production - Comparative merits, Principle of operation of rocket, types of rocket and typical applications, Exploration into space.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Illustrate the history of aircraft & developments over the years
CO2 - Ability to identify the types & classifications of components and control systems
CO3 - Explain the basic concepts of flight & Physical properties of Atmosphere
CO4 - Identify the types of fuselage and constructions.
CO5 - Distinguish the types of Engines and explain the principles of Rocket

TEXTS / REFERENCE BOOKS

1. Anderson, J.D., Introduction to Flight, McGraw-Hill; 8th edition, 2015
2. E Rathakrishnan, "Introduction to Aerospace Engineering: Basic Principles of Flight", John Wiley, NJ, 2021
3. Stephen.A. Brandt, Introduction to aeronautics: A design perspective, 2nd edition, AIAA Education Series, 2004.
4. Sadhu Singh, "Internal Combustion Engines and Gas Turbine", SS Kataraia & Sons, 2015

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SMEB1102	ENGINEERING GRAPHICS AND DESIGN (Common to Aeronautical, Automobile Mechanical and Mechatronics)	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To Understand the concept of graphic communication, develop the drawing skills for communicating concepts, ideas and designs of engineering products and to expose them to existing national standards related to technical drawings.
- To make the student to visualize and read the drawings.
- To make the students to understand the importance of sectioning and development of surfaces.
- To learn about the orthographic and pictorial projections.

UNIT 1 PLANE CURVES 9 Hrs.

Basic Geometrical constructions, Curves used in engineering practices: Conics — Construction of ellipse, parabola and hyperbola by eccentricity method — Construction of cycloid — Drawing of tangents and normal to the above curves.

UNIT 2 PROJECTION OF POINTS AND LINES 9 Hrs.

Projection - Types of projection - Projection of points lying in four quadrants - Projection of lines (First angle projection only) - Projection of lines parallel and inclined to one or both the planes.

UNIT 3 PROJECTION OF SOLIDS 9 Hrs.

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes and parallel to the other by rotating object method. Practicing three-dimensional modeling of simple objects by CAD Software (Not for examination)

UNIT 4 SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES 9 Hrs.

Purpose of sectioning - Sectional views - Hatching - Section plane perpendicular to one plane and parallel to other plane -Section plane inclined to HP-True shape of the section. Need for development of surfaces - Types of development of surfaces - Development of lateral surfaces of simple and sectioned solids — Prisms, pyramids, cylinders and cones. Practicing three-dimensional modeling of simple objects by CAD Software (Not for examination)

UNIT 5 ISOMETRIC PROJECTION AND FREEHAND SKETCHING 9 Hrs.

Principles of isometric projection — isometric scale - Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones.

Orthographic Projection-: Visualization concepts and Free Hand sketching: Visualization principles — Representation of Three-Dimensional objects — Layout of views- Freehand sketching of multiple views from pictorial views of objects.

Practicing three-dimensional modeling of simple objects by CAD Software (Not for examination)

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Identify the national standards related to the Engineering drawing based on BIS and construct conic sections and polygons.
CO2 - Solve practical problems involving projection of lines.
CO3 - Draw orthographic projections of solids.
CO4 - Draw orthographic section of solids and improve the Students visualization skill to develop New products and development of surfaces and its applications in manufacturing industry.
CO5 - Draw the isometric projections of simple solids.
CO6 - Draw the orthographic view of solids and learn to convert pictorial into orthographic projection.

TEXT / REFERENCE BOOKS

1. Bhatt N.D. and Panchal V.M., “Engineering Drawing”, Charotar Publishing House,53rd Edition, 2019.
2. Natrajan K.V., “A Text Book of Engineering Graphics”, Dhanalakshmi Publishers, Chennai, 2018.
3. Venugopal K. and Prabhu Raja V., “Engineering Graphics", New Age International (P) Limited,2018.
4. Engineering drawing practice for schools and colleges, SP 46 – 1988 (http://web.iitd.ac.in/~achawla/public_html/201/lectures/sp46.pdf).

Publication of Bureau of Indian Standards

1. IS 10711 — 2001: Technical products Documentation — Size and lay out of drawing sheets.
2. IS 9609 (Parts 0 & 1) — 2001: Technical products Documentation — Lettering.
3. IS 10714 (Part 20) — 2001 & SP 46 — 2003: Lines for technical drawings.
4. IS 11669 — 1986 & SP 46 —2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) — 2001: Technical drawings — Projection Methods.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

S11BLH11	PROBLEM SOLVING TECHNIQUES USING C (Theory + Practical)	L	T	P	E L	Credits	Total Marks
		3	0	2	0	4	100

COURSE OBJECTIVES

- Devise programs using Loops, Control structures and Array in C.
- Construct modules for real time applications using Functions in C.
- Compare and Contrast Structure and Union for implementing coding in data management using C.

UNIT 1 BITS AND BYTES IN COMPUTING 12 Hrs.

Computers: Hardware – Software – Processor – Memory – I/O devices – Interface – Programming Languages – Evolution from COBOL, FORTRAN to C, Python – Need

Algorithms: Role in problem solving – Analysis – Design – Flowcharts: Role in problem solving – Symbols

– Design – Pseudocode: Role in problem solving – Design - Program: Role in problem solving – Design

Practice Problems:

1. Describe a simple real world problem in your domain/department and describe it in the form of problem statement, input, output and provide its solution in terms of algorithm, flowchart, pseudo code and program.

UNIT 2 C: MATH BEHIND CODING 12 Hrs.

C**:** Structure of program – Character set – Tokens – Keywords – Identifiers – Constants – Variables – Datatypes – Strings – Operators and its types – Functions – Header Files

Algorithmic Strategies: Iteration and Recursion – Efficiency – Role of Time and Space consumption while building an algorithm – Complexities

Practice Problems:

1. Describe a simple real world problem in your domain/department and provide a computing and non-computing solution for the same. Calculate the time and space consumed in both solutions. Compare and contrast the pros and cons in both solutions.
2. Write an algorithm, flowchart, pseudo code followed by a simple C code to do find the Factorial and Fibonacci series using both iteration and recursion.

UNIT 3 C: MAGIC BEHIND INSTANT OUTPUTS 12 Hrs.

1. Advanced Coding Concepts: Decision Making using Branching Statements and its types – Decision Making using Looping Statements and its types – Switch Statements – Break – Continue – Goto – Jump Statements Case Study: Fun with Code -- Printing Alphabets / Flags of Countries / Flying Alphabet Screensaver Practice Problems:
2. Describe a problem statement in your domain/department whose solution involves repetition of same steps and provide code as solution involving for, while and do while loops.
3. Describe a problem statement in your domain/department whose solution involves decision making and provide code as solution involving if-else, nested if-else and ladder if-else.

UNIT 4 STORING GROUP OF HOMOGENOUS ELEMENTS: ARRAYS 12 Hrs.

Diving into Arrays: Definition – Syntax – Types – Representation: Row & Colum Order – Dynamic Arrays Idea behind Functions: Declaration – Definition – Types – Calling – Arguments – Prototypes – Call by Value – Call by Reference – Pointers

Case Study: Fun with Code – Simple Game Development using Arrays and Functions Practice

Problems:

1. Describe a problem statement in your domain/department where you need to work with group of same type of data. Provide a solution in terms of C program to store and manage the data effectively.
2. You're playing UNO cards, suddenly a person is getting rev card. Write a C program to reverse the round by storing the number of players in array.
3. Write a C program for Vehicle Regulation System where odd number ending vehicles can use the road on odd days and even number ending vehicles can use the road on even days using two separate arrays to store and display the odd and even numbers.

UNIT 5 STORING GROUP OF HETROGENOUS ELEMENTS: ARRAYS 12 Hrs.

Outset of Structure and Union: Structure Definition & Declaration – Structures Fusion with: Arrays – Pointers – Functions – Union Initiation, Definition & Declaration Working with Files: File Handling Functions – Read – Write – Other Operations – Different File Types Case Study: Report on using File Functions to create Score Board for any game, importing it to program Practice Problems:

1. Describe a problem statement in your domain/department where you need to work with group of different type of data. Provide a solution in terms of C program to store and manage the data effectively.
2. Write a C program to get the details of the student (roll no, name, date of birth, state, 10th percentage and 12th percentage) using Structure. Calculate the age of the student and display the eligibility status for his admission.
3. Eligibility criteria: more than 60 percent in 10th and 12th, age>=17, state==TN.
4. Write a menu driven C program for library management system with ten entries: (i). Add Book (ii). Add Author (iii). Add Category (iv). Book Cost
5. (v). Display - Book by Author, Book by Category, Book under cost
6. Write a C program to create an employee Union with employee details (id, name, salary) Accept the details of 'n' employees, rearrange the data in ascending order of employee name, id and salary as three different functions and display it.

Max. 60 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Interpret the difference between components of problem solving such as algorithm, flowchart, pseudo code and source code.

CO2 - Build simple solution for any given problem statement using various components of problem solving techniques and measure its efficiency in terms of time and space.

CO3 - Infer and examine the roots and foundation of C programming's key concepts like Datatypes, Operators.

CO4 - Devise and correlate the use of different core concepts such as Arrays and Functions in C language.

CO5 - Formulate real time solutions through programs using Structure and Union in C language.

CO6 - Design and Develop various Application Oriented Program for solving real time societal problems.

TEXT / REFERENCE BOOKS

1. Yashavant Kanetkar, 'Let us C', BPB Publications, Fourteenth Edition
2. R.G.Dromey "How to solve it by computer", Pearson Education, Low Price Edition.
3. Balagurusamy, "Programming in ANSI C", McGrawHill Publications, Eighth Edition.
4. Greg Perry, Dean Miller "C Programming Absolute Beginner's Guide", Third Edition.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SPHB2101	PHYSICS LAB	L	T	P	EL	Credits	Total Marks
		1	0	0	0	1	100

COURSE OBJECTIVES

- To achieve perfectness in experimental skills and the study of practical applications will bring more confidence
- Ability to develop and fabricate engineering and technical equipment.
- To develop practical applications of engineering materials

List of Experiments

1. Determine the Rigidity modulus of a given wire by Torsional pendulum
2. To determine the angle of Minimum Deviation by I - D curve method.
3. Determine V-I characteristics of a photodiode
4. To determine the Numerical aperture of an optical fiber
5. To find the Energy gap of a semiconductor
6. Determination of Young's modulus- non-uniform bending
7. Determination of Young's modulus- Uniform bending
8. Determination of the wave length of the laser using grating- Laser.
9. Determination of thickness of a thin sheet/wire- Air wedge.
10. Determination of Numerical Aperture and acceptance angle- Optical fibre.
11. Photoelectric effect
12. Michelson Interferometer
13. V-I characterization of solar cell
14. CRO- FUNCTIONS

Max. 15 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Develop skills to impart practical knowledge in real time solution.

CO2 - Understand principle, concept, working and application of new technology **CO3**: comparison of results with theoretical calculations.

CO4 - Design new instruments with practical knowledge.

CO5 - Gain knowledge of new concept in the solution of practical oriented problems and to understand more deep knowledge about the solution to theoretical problems.

CO6 - Understand measurement technology, usage of new instruments and real time applications in engineering studies

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 50 **Exam Duration: 2 Hrs.**

CAE	**Evaluation of Regular Lab class**	**15 Marks**	**25 Marks**
	Model practical exam	**10 Marks**	
ESE	**University Assessment Exam**		**25 marks**

SMEB2101	COMPUTER AIDED DESIGN LAB	L	T	P	EL	Credits	Total Marks
		0	0	4	0	2	100

COURSE OBJECTIVES

- To gain practical knowledge in engineering modeling through computer aided systems.
- To understand the functioning of 2D drafting and 3D modeling software's.
- To Study the capabilities of software for Drafting and Modeling.

SUGGESTED LIST OF EXPERIMENTS

INTRODUCTION TO CAD

1. Basics, Fundamentals of feature-based modeling.

TWO DIMENSIONAL OBJECTS

1. Create basic drawing objects: Points, Lines, Circles, Arcs, Planes and their combinations. Layout and sketching.
2. Setup a drawing with correct scales. Draw with precision using Coordinate input and object Snaps, Isometric drawings, Orthographic projections, Auxiliary views.
3. Dimensioning, Dimension styles.
4. Various other AutoCAD commands and relevant keyboard shortcuts.

THREE DIMENSIONAL OBJECTS

1. Creating and editing 3D solid objects.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the fundamentals of computer aided design
CO2 - Implement their knowledge in designing a model.
CO3 - Understand the various limits and tolerances
CO4 - Understand various dimensioning styles.
CO5 - Implement their knowledge to model various 2D and 3D models.
CO6 - Understand various commands and keyboard shortcuts for faster modelling skills

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

CAE	**Evaluation of Regular Lab class** **Model practical exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 marks**

SMTB1201	ADVANCED CALCULUS AND STATISTICS (COMMON TO ALL BRANCHES EXCEPT BIO GROUPS)	L	T	P	EL	Credits	Total Marks
		3	1	0	0	3	100

COURSE OBJECTIVES

- The Objective of this Course is to identify, reflect upon, evaluate and achieve conceptual understanding and knowledge of traditional Calculus to form independent judgements.
- The purpose of this course is for modeling the Engineering problems and obtaining its solutions mathematically.
- This helps in understanding Science, Engineering and Computer Science analytically and logical thinking is attained.

UNIT 1 DIFFERENTIAL EQUATIONS 9 Hrs.

Higher order linear differential equations with constant coefficients – Particular Integral for e^{ax}, sinax or cosax, x^n, $x^n e^{ax}$, xsinax, xcosax, e^{ax}sinbx or e^{ax}cosbx – Method of Variation of Parameters – Homogeneous equation of Euler's and Legendre's type.

UNIT 2 VECTOR CALCULUS 9 Hrs.

Vector Differentiation - Gradient, divergence and curl – Directional derivative – Irrotational and Solenoidal vector fields - Vector Integration – Simple problems on line, surface and volume Integrals – Green's theorem in a plane, Gauss divergence theorem and Stoke's theorem (without proofs)– Simple applications involving cubes and rectangular parallelopipeds.

UNIT 3 LAPLACE TRANSORMATION 9 Hrs.

Laplace transform – Transforms of standard functions – properties – Transforms of derivatives and integrals – Transforms of the type $e^{at}f(t)$, tf(t), f(t)/t – Transform of periodic functions – Transform of unit step function and impulse function – Inverse Laplace transforms – Convolution theorem – Initial and final value theorems – Applications - Linear ordinary differential equation with constant coefficients.

UNIT 4 PROBABILITY AND STATISTICS 9 Hrs.

Measures of central tendency: Mean, Median, Mode – Measures of dispersion: Standard deviation for discrete and grouped data. Definitions: Sample Space, Events – Addition Law of probability – Multiplication law of probability – Conditional probability – Baye's theorem (without proof).

UNIT 5 THEORY OF SAMPLING AND TESTING OF HYPOTHESIS 9 Hrs.

Test of Hypothesis – Large samples – Z test – Single proportion – Difference of proportions – Single mean – Difference of means – Small samples – Student's t test – Single mean – Difference of means –Test of variance – Fisher's test – Chi square test: Goodness of fit, Independence of attributes.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Solve any higher order linear differential equations
CO2 - Apply concepts of calculus on vector and scalar valued functions
CO3 - Use Laplace Transform for transformation of functions.
CO4 - Evaluate problems on conditional probability using Baye's theorem.
CO5 - Analyze the concept of testing of hypothesis in small and large samples
CO6 - Construct the Chi-Square test for goodness of fit and independence of attributes

TEXT / REFERENCE BOOKS

1. Bali N.P and Manish Goyal, A Text book of Engineering Mathematics, Eigth Edition, Laxmi Publications Pvt Ltd., 2011
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10th edition, John Wiley & Sons, Singapore, 2012.
3. Grewal B.S., Higher Engineering Mathematics, 41th Edition, Khanna Publications, Delhi, 2011.
4. Ross L, Differential Equations, 3rd Edition, Wiley India, 2009
5. Veerarajan T, Probability, Statistics and Random Process, 4th Edition, Tata McGraw Hill, 2014.
6. Veerarajan T, Engineering Mathematics for First Year, II Edition, Tata McGraw Hill Publishers, 2008

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SHSB1101	TECHNICAL ENGLISH	L	T	P	E L	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To understand specialized subject areas and skills included for their study.
- To comprehend and react in oral and written forms to the specialized texts
- To respond to listening, reading and writing tasks by using digital tools
- To enhance communication, collaboration and critical thinking skills
- To explore creativity through blended learning contexts

UNIT 1 **9 Hrs.**

Listening : Listening to choose the correct answer from the options given (MCQ)
Speaking : Self Introduction, talking about likes and dislikes
Reading : Comprehending a passage- Skimming, scanning, detailed reading
Writing : Letter of Job Application, Resume, Letter to the Editor (problems and solutions)
Vocabulary : Kinds of Sentences, Affixes, Collocations, Sequence words, contextual guessing of words
Language Focus : Parts of Speech, Tense and its types, Voice - Impersonal Passive
Language Lab work : Focus Digital literacy: students join zoom platform/ using online tools

UNIT 2 **9 Hrs.**

Listening : Listening to advertisements about a product, say true or false
Speaking : JAM on current topics, mini presentations
Reading : Identifying topic sentences by reading content
Writing : Writing compare/ contrast paragraphs, process description, E-Mail Writing
Vocabulary : Verbal phrases, Prepositions and Prepositional phrases, Concord, Discourse Markers
Language Focus : Clauses, Conjunctions, Sentence Types - Simple, Compound & Complex
Language Lab : Digital literacy: Responding to quiz using Kahoot application

UNIT 3 **9 Hrs.**

Listening : Listening to summarize the information, debates/ discussions.
Speaking : Group discussion on a given topic
Reading : To find specific information and to prepare notes using the format
Writing : Framing open ended questions- Survey Report- Arranging the sentences in the right order
Vocabulary : Paired expressions, Adjectives/ adverbs, Technical definitions, Compound Nouns
Language Focus : Punctuation, Editing, Same words used as different parts of speech
Language Lab : Digital literacy: Power point tools –Slide share to make presentation on the survey report

UNIT 4 **9 Hrs.**

Listening : Listening to differentiate instructions and recommendations
Speaking : Debate on current issues
Reading Reading to understand and classify the information
Writing : Instructions, Recommendations, Preparation of User Manual
Vocabulary : Classification of words, Abbreviations, Acronyms,
Language Focus : Reported Speech, Causatives, Basic Sentence Patterns
Language Lab : Digital literacy: Using online discussion forum

UNIT 5 **9 Hrs.**

Listening and Summarizing	:	Listening to identify the structure of sentences, small talks, TED talks
Speaking	:	Giving impromptu talks, Speech Writing
Reading	:	Read argumentative essays and paragraphs
Writing	:	Essay writing, Checklist preparation, Note making
Vocabulary	:	Homophones/Homonyms, Idioms and Phrases
Language Focus	:	Negatives, Tag questions, Similes and Metaphors
Language Lab	:	Digital literacy: Creating own Blogs and interactive exercises and quizzes online

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Classify technical words to use them in sentences framing, compose problem solving paragraphs.
CO2 - Categorize information based on the understanding of reading materials to prepare notes.
CO3 - Prepare and document to report, identify elements of editing.
CO4 - Interpret technical definitions related to the text and design a user manual using instructions.
CO5 - Summarize reading materials and outline an essay on any topic given.
CO6 - Demonstrate their language learning activities in the classroom/ online group environment.

PRESCRIBED TEXT

1. Technical English [2019], Department of English, Sathyabama Institute of Science & Technology.

TEXT / REFERENCE BOOKS

1. Beer, David F., and David McMurrey. A Guide to Writing as an Engineer. 4th ed., Wiley, 2013
2. Alred, Gerald J., et al. Handbook of Technical Writing. 11th ed., Bedford/St. Martin's, 2019.
3. Pearsall, Thomas Edward. Technical Writing: A Practical Guide for Engineers, Scientists, and Nontechnical Professionals. McGraw-Hill Education, 2017.
4. Straus, Jane. The Blue Book of Grammar and Punctuation. John Wiley & Sons, 2014.
5. O'Conner, Patricia T. Woe is I: The Grammarphobe's Guide to Better English in Plain English. Riverhead Books, 2019.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SEEB1203	BASIC ELECTRICAL ENGINEERING (Common to Auto, Aero, Mech, Biomed, Chemical, Mechatronics, Bio Tech)	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To understand the fundamental concepts of electrical wiring and its components
- To analyze DC and AC circuit behavior.
- To impart and explore Knowledge on magnetic circuits and electrical machines.

UNIT 1 INTRODUCTION TO ELECTRICAL SYSTEMS 9 Hrs.

Basic Element Resistors, inductors and capacitors - Domestic Wiring - Wiring Materials and Accessories - Staircase Wiring - Fluorescent Tubes-Earthing-Types & Benefits

UNIT 2 D.C. CIRCUITS 9 Hrs.

Electrical Quantities - Ohm's law - Kirchoff's laws -Resistance in series and parallel combinations - Current and Voltage division rules - Mesh analysis and Nodal analysis.

UNIT 3 A.C. CIRCUITS 9 Hrs.

Sinusoidal functions - R.M.S and Average values for Sinusoidal waveform - Phasor representation - Sinusoidal excitation applied to purely resistive, inductive and capacitive circuits - RL , RC and RLC series circuits - power and power factor - Introduction to three phase circuits.

UNIT 4 MAGNETIC CIRCUITS 9 Hrs.

Definition of MMF, Flux and Reluctance - Leakage Factor - Reluctances in Series and Parallel (Series and Parallel Magnetic Circuits)-Electromagnetic Induction-Fleming's Rule-Lenz's Law-Faraday's laws- statically and dynamically induced EMF -Self and mutual inductance-Analogy of Electric and Magnetic.

UNIT 5 INTRODUCTION TO MACHINES 9 Hrs.

Construction and Principle of Operation of DC Generators - DC Motors - Single Phase Transformer - Stepper Motor.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the fundamental electrical concepts.
CO2 - Analyze simple DC circuits using appropriate techniques.
CO3 - Apply phasor analysis techniques to solve AC circuits
CO4 - Develop the ability to solve problems involving magnetic circuits using analytical techniques
CO5 - demonstrate the principles and operation of various electrical machines,
CO6 - Understand the principles, construction, and applications of special machines

TEXT / REFERENCE BOOKS

1. Ramana Pilla ,HD Mehta, "Basic Electrical Engineering", S CHAND & Company Limited, 2022
2. Mittle B.N. & Aravind Mittle, Basic Electrical Engineering, 2nd Edition, Tata McGraw Hill, 2011.
3. Theraja B.L., Fundamentals of Electrical Engineering and Electronics, 1st Edition, S.Chand & Co., 2009.
4. Smarajit Ghosh, Fundamentals of Electrical and Electronics Engineering, 2nd Edition, PHI Learning Private Ltd, 2010.
5. Thomas L Floyd, " Digital Fundamentals", 11th edtion, Pearson, 2015.
6. Sanjay Sharma, Electronic Devices and Circuits, 2nd Edition, S.K.Kataria & Sons, 2012.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SCYB1101	CHEMISTRY (Common to ALL Branches of B.E/ B. Tech.)	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To understand the basic concepts of quantum chemistry for bonds to bands
- To learn the principles and applications of energy levels in molecules
- To know the importance of electrochemistry in batteries.
- To explore the concept of corrosion mechanism and design principles.
- To study the various synthetic approaches in nano chemistry.

UNIT 1 ATOMIC AND MOLECULAR STRUCTURE 9 Hrs.

Introduction to quantum chemistry – Motion of a quantum mechanical particle in one dimension (time-independent) – Physical meaning of wave function – Schrodinger equation for Hydrogen atom (No derivation. Only wave function). Angular and radial wave functions and probability densities – Quantum numbers – Principal, azimuthal, spin and magnetic quantum numbers – Wave functions and orbital shapes - s,p,d,f - LCAO-MO of H_2 – Band theory of solids: Conductors, semi-conductors– Role of As and Ga doping on band structures.

UNIT 2 MOLECULAR SPECTROSCOPY 9 Hrs.

Electromagnetic spectrum – Interaction of radiation with matter – Energy levels in molecules – Microwave spectroscopy – Principle – Classification of molecules based on moment of Inertia – Rotational energy expression (J levels) – Calculation of J for CO molecule – Vibrational spectroscopy – Normal modes of vibrations – Vibrations of polyatomic molecules (**CO_2** and H_2O) – Determination of Force constant – Electronic transitions in organic molecules – Mathematical derivation of Beer-Lambert's law.

UNIT 3 ELECTROCHEMISTRY 9 Hrs.

Electrochemistry: Galvanic cell - Electrochemical cell representation - EMF series and its significance. Batteries: Terminology – Mechanism of Lead-acid accumulator - Mechanism of Nickel-cadmium batteries. Mechanism of Lithium batteries: Li/$SOCl_2$ cell - Li/I_2 cell - Lithium ion batteries. Mechanism of Fuel Cells: Hydrogen-oxygen fuel cells - Solid oxide fuel cell (SOFC).

UNIT 4 CORROSION SCIENCE 9 Hrs.

Introduction: Definition. Types: Dry corrosion: Mechanism - Pilling-Bedworth rule - Wet Corrosion: Mechanism. Types: Galvanic corrosion and differential aeration cell corrosion. Galvanic series and its significance. Factors influencing corrosion. Corrosion prevention: Material selection and design - Cathodic protection – Sacrificial anodic method and Impressed current method – Inhibitors – Anodic and Cathodic inhibitors.

UNIT 5 NANOCHEMISTRY 9 Hrs.

Introduction - Classification based on dimensions - Size dependent properties - Types of nanomaterials: Nanoparticles: Synthesis by chemical reduction method. Nanoporous materials: Synthesis by sol-gel method. Nanowires: Synthesis by VLS mechanism. Carbon Nanotubes (CNTs): Single walled and multi walled nanotubes - Mechanical and electrical properties of CNTs - Applications of CNTs - Synthesis of CNTs by electric arc discharge method and laser ablation method.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Apply the principles of quantum chemistry for energy quantization in molecules.
CO2 - Analyze the interaction of EMR with matter to study molecular transition.
CO3 - Assess the mechanism of energy conversion.
CO4 - Comprehend the corrosion mechanism for environmental sustainability.
CO5 - Examine the synthetic approaches to promote size dependent properties.
CO6 - Evaluate the application of chemical science concept in real world applications.

TEXT / REFERENCE BOOKS

1. A.K.Chandra, Introductory Quantum Chemistry, Tata McGraw-Hill, 4th edition, 2010.
2. Ira N. Levine, Physical chemistry, 6th Edition, 2008.
3. Ira N. Levine, Quantum chemistry, 7th Edition, 2013.
4. David W. Ball and Thomas Baer, Physical Chemistry, Wadsworth Cengage Learning, 2nd Edition, 2014.
5. Mars G Fontana, Corrosion Engineering, 3rd Edition, Tata McGraw Hill, 2008.
6. Douglas A. Skoog and Donald M.West, Principles of Instrumental Analysis, Cengage, 6th Edition, 2014.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SMEB1201	ENGINEERING MECHANICS (For Mech, Mechatronics, Aero and Auto)	L	T	P	EL	Credits	Total Marks
		3	1	0	0	3	100

COURSE OBJECTIVES

- To understand the concept of Statics.
- To appreciate the concept of Equilibrium.
- To recognize properties of surfaces and solids.
- To learn the theory of Friction.
- To acquire the concept of Dynamics.

UNIT 1 BASICS & STATICS OF PARTICLES 9 Hrs.

Introduction-Units and Dimensions-Laws of Mechanics-Vectors-Vectorial representation of forces and moments - Vector operations-resolution and composition of forces - equilibrium of a particle - Free body diagram - forces in space-equilibrium of a particle in space-equivalent systems of forces- principle of transmissibility–Resultant and Equilibrant.

UNIT 2 EQUILIBRIUMOF RIGID BODIES 9 Hrs.

Types of supports and their reactions - requirements of stable equilibrium – Moments and Couples-Varignon's theorem- Equilibrium of Rigid bodies in two dimensions- Equilibrium of Rigid bodies in three dimensions.

UNIT 3 PROPERTIES OF SURFACES AND SOLIDS 9 Hrs.

Determination of Areas - First moment of Area and the centroid - simple problems involving composite figures. Second moment of plane area-Parallel axis theorem and perpendicular axis theorem-Polar moment of Inertia – Principal moments of Inertia of plane areas – Principle axes of inertia – relation to area moments of Inertia. Second moment of plane area of simple sections like C,I,T,Z etc. - Basic Concept of Mass moment of Inertia.

UNIT 4 FRICTION 9 Hrs.

Frictional Force - Laws of Coulomb friction - Cone of friction-Angle of repose-relation between cone of friction and angle of repose- limiting friction-Rolling resistance- Simple contact friction - Screw - Wedge–Ladder- Belt friction.

UNIT 5 KINETICS OF RIGID BODIES AND DYNAMICS OF PARTICLES 9 Hrs.

Dynamics- Classification- Kinematics- Kinetics- Types of energy-Displacement, Velocity and acceleration their relation- Relative motion - Curvilinear motion - Newton's Law - D'Alembert's Principle, Work Energy Equation- Impulse and Momentum- Impact of elastic bodies- General plane motion.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the fundamentals of Statics.
CO2 - Apply the concept of Equilibrium.
CO3 - Evaluate the Centroid and Area Moment of Inertia.
CO4 - Analyze the Friction in different applications.
CO5 - Understand the fundamentals of Dynamics.
CO6 - Analyze overall Rigid body system of Kinematics and Kinetics.

TEXT / REFERENCE BOOKS

1. Bhavikatti S.S., Engineering Mechanics,1st Edition, New Age International publishers, 2017.
2. Bansal R.K., A Textbook of Engineering Mechanics, 4th edition, Laxmi Publications, 2002.
3. Bedi D.S., Engineering Mechanics,1st Edition, Khanna Publishing Co. (P) Ltd l, 2013.
4. Khurmi R.S. and Khurmi N, Engineering Mechanics, S.Chand Publishing, 2018.
5. Beer & Johnston, "Vector Mechanics for engineers - Vol I &II", 9th Edition, Tata McGraw Hill, 2010.
6. Sharma, D.P., Engineering Mechanics, Pearson, 2010.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB1201	AIRCRAFT MATERIALS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- The aim of this course is to provide a general overview of the field of Aircraft materials testing to interested students.

UNIT 1 PROPERTIES OF ENGINEERING MATERIALS 9 Hrs.

Engineering Materials, Structural properties of materials, Atomic and lattice structure, Bonding in Solids, Imperfections in crystals, Solid phase and phase diagrams, mechanical properties and testing, Isotropy, Orthotropy, True stress and strain, Strength and elasticity, Stiffness, Resistance, Plasticity, Ductility, Toughness and Hardness of materials.

UNIT 2 CLASSIFICATION OF AIRCRAFT MATERIALS 9 Hrs.

Concept of Fatigue and Creep. Mechanical Testing. Factors Affecting Strength. Deformation, Plasticity and Viscoelasticity, Fracture. Heat treatment, Chemical, thermal and Technological Properties, Board classification of aircraft materials. Ferrous materials, nonferrous materials and alloys, ceramic materials and fiber reinforced composite materials, polymers, metal matrix particulate.

UNIT 3 FURNISHING MATERIALS 9 Hrs.

Furnishing Materials: Plastic, wood, plywood, glue, dopes and rubber used in aircraft manufacture. Methods of testing and storage. Paints, surface finishes and materials. Specifications: Indian Standard, British, American, French, German, and International specifications.

UNIT 4 CORROSION AND TESTING 9 Hrs.

Corrosion, its detection and prevention. Protective finishes. Testing: Destructive and non- destructive testing techniques. Crack detection, inspection of parts by hot oil and chalk, dye-penetrant, fluorescent and magnetic particles, X-ray, ultrasonic, eddy current and acoustic emission methods.

UNIT 5 METROLOGY AND MEASUREMENTS 9 Hrs.

Metrology: Measuring instruments like vernier, screw gauges, slip gauges, height gauges, comparators, CMM, optical tooling for jig setting, principles and application. Knowledge of instruments and devices of accurate physical dimensional checks covering linear measurements, intricate geometric shapes, contours and profiles. Internal and external diameters of screw threads etc and gear testing. Measuring surface roughness, flatness and clearance between mating surfaces.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Classify the properties of materials subjected to loads such as physical and environmental disturbances.
CO2 - Classify the aircraft materials based on ferrous and non-ferrous substances.
CO3 - Demonstrate the furnishing materials used in aircraft manufacture.
CO4 - Explain the procedure for corrosion prevention and testing of corrosion testing for aircraft materials.
CO5 - Categorize the metrological instruments applied for suitable surface measurements.
CO6 - Explain the measuring instruments that are used in metrology

TEXT / REFERENCE BOOKS

1. R K Jain, Metrology, Khanna Publications, Delhi 198
2. S K Hajra Chowdhary, Materials, Science and Engineering Processes, Media Promoters
3. George E. F. Titterton, Aircraft Materials, English Book Stores, Delhi
4. M L Begman, Manufacturing Processes, Asia Publishing House, Bombay
5. King and Butler, Principles of Engineering Inspection, Clever Humes Press.
6. C G K Nair, Aircraft Materials, Interline
7. Balram Gupta, Aerospace Materials, S Chand

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SCYB2101	CHEMISTRY LAB	L	T	P	EL	Credits	Total Marks
		0	0	2	0	1	50

COURSE OBJECTIVES

- To understand the basic principle involved in volumetric and instrumental analysis.
- To acquire practical knowledge in pHmetry, potentiometry and conductometry.
- To develop the skill in water analysis.

LIST OF EXPERIMENTS

1. Estimation of mixture of acids by conductometry.
2. Estimation of ferrous ion by potentiometry.
3. Determination of pKa value of glycine by pHmetry.
4. Estimation of hardness of water by EDTA method.
5. Determination of alkalinity of water
6. Estimation of Iron by photocolorimetry.
7. Estimation of copper in brass
8. Determination of high molecular weight polymer using Ostwald viscometer.

Max. 15 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Estimate the ionic conductance of mixture of acids.
CO2 - Construct a redox cell and measure its emf.
CO3 - Interpret the concept of Zwitter ion in amino acids
CO4 - Predict the quality of water sample for domestic and industrial applications.
CO5 - Demonstrate the validity of Beer-Lambert's law.
CO6 - Apply Poiseuille's law for molar mass measurements.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 50 **Exam Duration: 2 Hrs.**

CAE	**Evaluation of Regular Lab class**	**15 Marks**	**25 Marks**
	Model practical exam	**10 Marks**	
ESE	**University Assessment Exam**		**25 marks**

SMEB2201	WORKSHOP PRACTICE	L	T	P	EL	Credits	Total Marks
		0	0	4	0	2	100

COURSE OBJECTIVES

- To provide the students with hands on experience on different trades of engineering like Plumbing Works, Fitting, Carpentry, Plumbing, Foundry, Welding and Sheet metal.

LIST OF EXPERIMENTS

A. PLUMBING WORKS

(a) Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, and elbows in household fittings.
(b) Preparation of plumbing line sketches for water supply and sewage works.
(c) Hands-on-exercise: Basic pipe connections – Mixed pipe material connection – Pipe connections with different joining components.

B. CARPENTRY

a) Handling of carpentry tools, A practice in marking, sawing planning and chiseling to size. Making simple joints such as half-lap, dove-tail, TEE joint and mortise and Tenon joints. (Any two joints to be practiced)
b) Use of modern materials such as plywood, chip board, Nova pan, laminated sheets (Demonstration only).

C. FITTING

Use of fitting tools-practice in marketing, fitting to size and drilling-making of simple mating and profiles such as V, Square, Dove-tail, Half-round and TEE - joints. (Any two joints to be practiced)

D. WELDING

i) Electric Arc Welding.
a) Study on Edge preparation techniques for Arc welding.
b) List of Welding Exercises.
1. Lap Joint 2. Butt Joint 3. Fillet Joint 4. Tee Joint 5. V Joint 6. Corner Joint (Any two joints to be practiced)
i) Study on gas welding and gas cutting.

E. FOUNDRY

i. Sand testing - Grain fineness - Permeability test.
ii. Study on Pattern Allowances.
iii. Preparation of green sand moulding (Solid and Split pattern)
1. Flanges 2. Bush 3. Hexagon 4. Dumbbell
i. Metal casting technique (Demonstration only).

F. SHEET METAL

- Tools and equipments– practice.
- Making rectangular tray, hopper, scoop, etc. (Any one to be practiced)
- Study on Fabrication of a small cabinet, dust bin, etc.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Work with various components used in fluid flow pipelines and to make connections for various applications suitably.

CO2 - Handle carpentry tools for wood working

CO3 - Perform various fitting operations

CO4 - Make precise weld joints using arc and gas welding processes

CO5 - Mould precisely and to place runner, riser at suitable places also they understand how to provide various allowances.

CO6 - Handle sheet metal tools for making various sheet metal components.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100		**Exam Duration: 3 Hrs.**
CAE	**Evaluation of Regular Lab class** **Model practical exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 marks**

SMTB1301	TRANSFORM TECHNIQUES AND COMPLEX ANALYSIS (COMMON TO ALL BRANCHES EXCEPT BIO GROUPS, CSE & IT)	L	T	P	EL	Credits	Total Marks
		3	1	0	0	3	100

COURSE OBJECTIVES

- The Objective of this Course is to identify, reflect upon, evaluate and achieve conceptual understanding and knowledge of traditional Calculus to form independent judgements. The purpose of this course is for modeling the Engineering problems and obtaining its solutions mathematically. This helps in understanding Science, Engineering and Computer Science analytically and logical thinking is attained.

UNIT 1 FOURIER TRANSFORMATION 9 Hrs.

The infinite Fourier transform – Sine and Cosine transform – Properties – Inversion theorem – Convolution theorem – Parseval's identity – Finite Fourier sine and cosine transform.

UNIT 2 VECTOR CALCULUS 9 Hrs.

Z Transform – Elementary properties – Inverse Z Transform – Partial fraction method, Convolution method, Residue method – Formation of difference equations – Solution of difference equations using Z Transform.

UNIT 3 COMPLEX VARIABLES 9 Hrs.

Analytic functions – Cauchy - Riemann equations in Cartesian and polar form – Harmonic functions – Properties of analytic functions – Construction of analytic functions using Milne – Thompson method – Some Standard Transformations – Translation, Magnification and Rotation, Inversion and Reflection and simple problems based on the above - Bilinear transformation.

UNIT 4 COMPLEX INTEGRATION 9 Hrs.

Cauchy's integral theorem – Cauchy's integral formula – problems – Taylor's and Laurent's series – Singularities – Poles and Residues – Cauchy's residue theorem and problems.

UNIT 5 PARTIAL DIFFERENTIAL EQUATION 9 Hrs.

Formation of equations by elimination of arbitrary constants and arbitrary functions – Solutions of First order Linear PDE – Lagrange's linear equation – Solution of Linear Homogeneous PDE of higher order with constant coefficients.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Analyze Fourier Transform with its properties
CO2 - Apply Z Transform with its properties to solve difference equations.
CO3 - Create analytic function, bilinear transformation with its properties.
CO4 - Evaluate complex integration using Cauchy Integral theorem and Cauchy Residue theorem
CO5 - Create partial differential equation by eliminating arbitrary constant or functions
CO6 - Solve first order linear PDE and homogeneous higher order PDE's

TEXT / REFERENCE BOOKS

1. Bali N.P and Manish Goyal, A Text book of Engineering Mathematics, Eighth Edition, Laxmi Publications Pvt Ltd., 2011.
2. J.W. Brown and R.V. Churchill, Complex Variables and Applications, 7th Edition, Mc.Graw Hill, 2004.
3. Erwin Kreyszig, Advanced Engineering Mathematics (8th Edition), John Wiley and Sons, Singapore, 2001.Grewal B.S., Higher Engineering Mathematics, 41th Edition, Khanna Publications, Delhi,2011.
4. Kandasamy P., Thilagavathy K. &Gunavathy K., Engineering Mathematics, (4th Revised Edition), S.Chand & Co., New Delhi, 2001.
5. Veerarajan T., Higher Engineering Mathematics, Tata Mcgraw Hill Publishing Co., NewDelhi, First Edition, 2015.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB1301	APPLIED THERMODYNAMICS	L	T	P	EL	Credits	Total Marks
		3	1	0	0	3	100

COURSE OBJECTIVES

- To make the student understand the quantitative analysis of machine and processes for transformation of energy and between work and heat.
- To Make the student understand the Laws of thermodynamics would be able to quantify through measurement of related
- To Apply the thermodynamic properties, energies and their interactions in real time problems To develop basic concept of air cycle, gas turbine engines and heat transfer.
- To analyse different types of Heat transfer
- To identify the different components of Jet Engines

UNIT 1 FUNDAMENTAL CONCEPT AND FIRST LAW 9 Hrs.

Concept of continuum, macroscopic approach, thermodynamic systems – closed, open and isolated. Property, state, path and process, quasi-static process, work, internal energy, enthalpy, specific heat capacities and heat transfer, SFEE, application of SFEE to jet engine components, First law of thermodynamics, relation between pressure, volume and temperature for various processes, Zeroth law of thermodynamics.

UNIT 2 FUNDAMENTAL CONCEPT AND FIRST LAW 9 Hrs.

Second law of thermodynamics – Kelvin Planck and Clausius statements of second law. Reversibility and Irreversibility, Thermal reservoir, Carnot theorem. Carnot cycle, Reversed Carnot cycle, efficiency, COP, Thermodynamic temperature scale - Clausius inequality, Concept of entropy, Entropy changes for various processes.

UNIT 3 AIR STANDARD CYCLES 9 Hrs.

Otto, Diesel, Dual, Ericsson, Atkinson, Stirling and Brayton cycles - Air standard efficiency – Mean effective pressure.

UNIT 4 FUNDAMENTALS OF VAPOUR POWER CYCLES 9 Hrs.

Properties of pure substances – solid, liquid and vapour phases, phase rule, p-v, p-T, T-v, T-s, h-s diagrams, p-v-T surfaces, thermodynamic properties of steam - calculations of work done and heat transfer in non-flow and flow processes - standard Rankine cycle, Reheat and Regeneration cycle. Heat rate, Specific steam consumption, Tonne of refrigeration.

UNIT 5 BASICS OF PROPULSION AND HEAT TRANSFER 9 Hrs.

Classification of jet engines - basic jet propulsion arrangement, thrust equation – Specific thrust, SFC, TSFC, specific impulse, actual cycles, isentropic efficiencies of jet engine components, polytropic efficiency, conduction in parallel, radial and composite wall, Basics of convective and radiation heat transfer.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Apply the laws of thermodynamics in real time problems.
CO2 - Demonstrate the principal operation of piston engine and jet engines.
CO3 - Demonstrate the efficiency of different air standard cycles.
CO4 - Determine the heat transfer in different conditions of working medium.
CO5 - Solve heat transfer problems in complex systems.
CO6 - Solve problems related to conduction convention and radiation

TEXT / REFERENCE BOOKS

1. Nag.P.K., “Engineering Thermodynamics”, Tata McGraw-Hill, New Delhi, 2013.
2. Rathakrishnan E., “Fundamentals of Engineering Thermodynamics”, Prentice-Hall India, 2005.
3. Yunus A. Cengel and Michael A. Boles, “Thermodynamics: An Engineering Approach” McGraw-Hill Science/Engineering/Math; 7thedition 2010.
4. Arora C.P, “Thermodynamics”, Tata McGraw-Hill, New Delhi, 2003.
5. Holman.J.P., “Thermodynamics”, 3rd Edition, McGraw-Hill, 2007.
6. Merala C, Pother, Craig W, Somerton, “Thermodynamics for Engineers”, Schaum Outline Series,Tata McGraw-Hill, New Delhi, 2004.
7. Ramalingam K.K. “Thermodynamics”, Sci-Tech Publications, 2006
8. Venwylen and Sontag, “Classical Thermodynamics”, Wiley Eastern, 2010.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB1302	AIRCRAFT FABRICATION TECHNOLOGY	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To gain in depth knowledge of fundamentals of Aircraft Engineering tools and to study the various measurement tools for aircraft production.
- To discuss conventional and non-conventional machine tools used in Aircraft production.
- To understand Lathe and Special purpose machines.

UNIT 1 AIRCRAFT GENERAL ENGINEERING TOOLS AND MEASUREMENTS 9 Hrs.

Aircraft tools, vice, hammers, chisels, files, hacksaw, marking tools-surface plate, scriber, punch, v-block, angle plate, tri- square; marking out; tools-inspection, maintenance & safety precautions. Linear measurements – non-precision & precision instruments; Angular measurements - non- precision & precision instruments; Taper measurements, surface measurements & Gauges

UNIT 2 LATHE AND SPECIAL PURPOSE LATHES 9 Hrs.

Process – theory of metal cutting, lathe- constructional features, cutting tool, geometry, various operations, taper turning methods, thread cutting methods; capstan and turret lathes; Automats – single spindle, multi spindle, automatic screw type.

UNIT 3 CONVENTIONAL MACHINE TOOLS 9 Hrs.

Machine tools; principle operation, construction and working of shaper, planer, slotter machines; Milling Machines - types, milling cutters – Hole making; drilling – reaming, boring, taping.

UNIT 4 CASTING AND METAL JOINING PROCESS 9 Hrs.

Production processes – comparison – sand casting – mould, pattern, die – pattern Allowances – materials – types – steps involved in core function and core making – runner, riser, gate-purpose – construction, principle of die-casting, shell moulding, investment casting, centrifugal casting. Types of joining process, welding process - Construction and applications of gas and arc welding, equipment used, flame characteristics, filler, flux materials – soldering and brazing – rivets; purpose, types, classification, riveting tools

UNIT 5 SURFACE FINISHING AND PROTECTIVE COATING 9 Hrs.

Grinding process; cylindrical grinding, surface grinding, center less grinding – honing, lapping, super finishing, polishing, buffing and hobbing. Metallic Coatings; electro plating, galvanizing, tin coating, anodizing. Organic Finishes; primers, oil paint, brushing, spraying and rubber base coatings, Additive Technology.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Choose the appropriate aircraft tools and precision measurements for Aircraft Production
CO2 - Compare the working principles and various features of Conventional and special purpose Lathe.
CO3 - Demonstrate the Constructional and operational features of shapers, planners, millers and boring machines.
CO4 - Suggest a suitable casting process and metal joining process for Aircraft Applications.
CO5 - Choose the appropriate Surface finishing process for Aircraft Production
CO6 - Aggregate the appropriate coating techniques used for aircraft components

TEXT / REFERENCE BOOKS

1. Khanna. O.P. Lal. M., Production Technology – Dhanpat Rai Publication, New Delhi, 2016.
2. Champman W.A.J., Production Technology, 4th Edition, Arnold Publisher, New Delhi, 2016.
3. HajraChoudhury S.K. Elements of Workshop Technology, Vol.1 & 2, Media Promoters & Publisher Pvt Ltd, Mumbai.
4. Keshu, S.C., Ganapathy K.K., Aircraft Production Techniques – Interline Publishing House, Bangalore.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB1303	BASIC STRUCTURAL ANALYSIS OF AIRCRAFT STRUCTURES	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To provide the students an understanding on the linear static analysis of determinate and indeterminate aircraft structural components.
- To provide the students an understanding on energy methods to statically determinate and indeterminate structures
- To make the students to Create a structure to carry the given load.
- To make the students to Calculate the response of statically indeterminate structures under various loading conditions.
- To provide the design process using different failure theories

UNIT 1 STATICALLY DETERMINATE & INDETERMINATE STRUCTURES 9 Hrs.

Plane truss analysis – method of joints – method of sections – method of shear – 3-D trusses – principle of super position, Clapeyron's 3 moment equation and moment distribution method for indeterminate beams.

UNIT 2 ENERGY METHODS 9 Hrs.

Strain Energy in axial, bending, torsion and shear loadings. Castigliano's theorems and their applications. Energy theorems – dummy load & unit load methods – energy methods applied to statically determinate and indeterminate beams, frames, rings & trusses.

UNIT 3 COLUMNS 9 Hrs.

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

UNIT 4 FAILURE THEORIES 9 Hrs.

Ductile and brittle materials – maximum principal stress theory - maximum principal strain theory - maximum shear stress theory - distortion energy theory – octahedral shear stress theory.

UNIT 5 COLUMNS AND FAILURE THEORIES 9 Hrs.

Columns- Member subjected to combined bending and axial loads, Euler's theory, Crippling load, Rankine's theory. Failure theories - Maximum Stress theory – Maximum Strain Theory – Maximum Shear Stress Theory – Distortion Theory – Maximum Strain energy theory.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Infer the stress and strain relationship through direct method and Mohr's circle method.
CO2 - Analyse the shear force and bending moment for beams and sections.
CO3 - Deduct the deflection of beams through moment-area and Macaulay's method.
CO4 - Simplify the twisting moment and stresses in solid shafts and thin-walled pressure vessels.
CO5 - Evaluate the crippling load of the column through Rankine's and Euler's Theory.
CO6 - Distinguish the different types of failure theories subjected to stress, strain, distortion and energy.

TEXT / REFERENCE BOOKS

1. Malhotra,D.R. and Gupta,H.C. ,“The Strength of Materials”, Satya Prakasan Tech. India Publications, New Delhi, 2016.
2. Kazimi.S.M.A., “Solid Mechanics”, TataMcGrawHill,1976. Dym.C.L. and Shames I.H., Solid Mechanics”, McGraw hill, Kogakusha, Tokyo, 2016.
3. Timoshenko.S., Young, "Elements of Strength of Material", Vol. I & II, T.Van Nostrand CoInc, Princeton, N.J. 2016.
4. Ferdinand P.Beer, and Rusel I Johnston, E .,”Mechanics of Materials”, SI Metric Edition, McGrawHill, 2016.
5. Rajput. R.K.,”Strength of materials”, Fourth Edition,S.ChandLimited,2017.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

S26BLH31	FLUID MECHANICS IN AERONAUTICAL ENGINEERING (Theory +Practical)	L	T	P	E L	Credits	Total Marks
		3	0	2	0	4	100

COURSE OBJECTIVES

- To understand the concepts of fluids and its properties.
- To evaluate the performance of fluids and fluid flows in International standard atmosphere.
- To know the basic functions of fluids and fluid flows and measuring instruments.
- To discuss fluid properties in the basis of the structural, aerodynamics

UNIT 1 FLUID PROPERTIES & EQUATIONS OF MOTION 9 Hrs.

Properties of fluids–Specific gravity, specific weight, viscosity, compressibility, vapor pressure and gas laws – capillarity and surface tension. Flow characteristics: concepts of system and control volume. Application of control volume to continuity equation, energy equation, momentum equation and Bernoulli's principle and its applications– Orifice meter, Venturimeter, pitot –tube.

UNIT 2 DIMENSIONAL ANALYSIS AND FLUID FLOW IN CLOSED CONDUICTS 9 Hrs.

Dimensional Analysis Buckingham Pi - theorem, Derivations and applications of important dimensionless numbers, basic modeling and similitude. Pipe friction, Darcy-Weisbach equation and Chezy's formula, Pipe losses - Major and Minor losses - Problems of parallel, series and branched pipes.

UNIT 3 FLUID FLOW OVER BODIES AND BOUNDARY LAYER THEORY 9 Hrs.

Boundary layer theory-boundary layer development on a flat plate, displacement thickness, momentum thickness, Energy thickness, momentum integral equation, drag on flat plate.

UNIT 4 PUMPS AND TURBINES 9 Hrs.

Impact of jets Centrifugal Pumps, Hydraulic Turbines: Classification of hydraulic turbines – Working principle of Pelton wheel, Francis and Kaplan turbines –velocity triangles- Propeller fundamentals.

UNIT 5 BASIC AERODYNAMICS 9 Hrs.

Types of flow - velocity field and acceleration. Viscous fluid flow - Laminar and turbulent flow. Theory of streamline, Stream function, velocity potential, relation between stream function and velocity potential, circulation. Basic elementary flows– Source, sink, free and forced vortex, uniform parallel flow.

PRACTICAL - SUGGESTED LIST OF EXPERIMENTS 15 Hrs.

1. Study and Performance characteristics of Centrifugal Pump.
2. Study and Performance characteristics of Pelton Wheel Turbine.
3. Study and Performance Characteristics of Francis Turbine.
4. Determination of Co-efficient of discharge of Orifice and Mouth Piece.
5. Determination of Co-efficient of velocity in Pitot tube.

Max. 60 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Estimate the governing equations of fluid flow through the identification of fluid properties.
CO2 - Illustrate the fluid flow problems theoretically through dimensional analysis and losses in pipes.
CO3 - Compile the combinations of elementary flow models utilized for solving the practical flow problems.
CO4 - Solve the boundary layer problems for streamlined and bluff bodies
CO5 - Discriminate the different types of pumps and its performance curves.
CO6 - Analogize the different types of hydraulic turbines and its characteristics

TEXT / REFERENCE BOOKS

1. Bansal.R.K,". Fluid Mechanics & Hydraulics Machines", 9th Edition, Laxmi Publications, 2016.
2. Kumar, K.L., Fluid Mechanics, 2nd Edition, Tata McGraw-Hill, New Delhi,2016.
3. Irving H. Shames, Fluid Mechanics, 3rd Edition, McGraw-Hill, 2016.
4. Robert W. Fox and Alan T. McDonald, Introduction to Fluid Mechanics, 5th Edition, John Willey and Sons, Inc., U.K.
5. Douglas. J. F., Gasiorek. J. M., Swaffield. J. A., "Fluid Mechanics ELBS", 4th Edition, Prentice Hall, 2016.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SISB4301	UNIVERSAL HUMAN VALUES	L	T	P	EL	Credits	Total Marks
		2	0	0	3	3	100

COURSE OBJECTIVES

- To develop a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence
- To understand (or developing clarity) the harmony in the human being, family, society and nature/existence
- To strengthen self-reflection
- To develop commitment and courage to act

UNIT 1 COURSE INTRODUCTION - NEED, BASIC GUIDELINES, CONTENT AND PROCESS FOR VALUE EDUCATION 9 Hrs.

Purpose and motivation for the course, recapitulation from Universal Human Values-I
Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self- exploration Continuous Happiness and Prosperity- A look at basic Human Aspirations Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario Method to fulfil the above human aspirations: understanding and living in harmony at various levels. Practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking.

UNIT 2 UNDERSTANDING HARMONY IN THE HUMAN BEING - HARMONY IN MYSELF! 9 Hrs.

Understanding human being as a co-existence of the sentient 'I' and the material 'Body'
Understanding the needs of Self ('I') and 'Body' - happiness and physical facility
Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer)
Understanding the characteristics and activities of 'I' and harmony in 'I'
Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail
Programs to ensure Sanyam and Health.
Practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life.
Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease

UNIT 3 UNDERSTANDING HARMONY IN THE FAMILY AND SOCIETY- HARMONY IN HUMAN-HUMAN RELATIONSHIP 9 Hrs.

Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship Understanding the meaning of Trust; Difference between intention and competence Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family. Practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives.

UNIT 4 UNDERSTANDING HARMONY IN THE NATURE AND EXISTENCE – WHOLE EXISTENCE AS COEXISTENCE 9 Hrs.

Understanding the harmony in the Nature

Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self regulation in nature

Understanding Existence as Co-existence of mutually interacting units in all-pervasive space

Holistic perception of harmony at all levels of existence.

Practice sessions to discuss human being as cause of imbalance in nature (film “Home” can be used), pollution, depletion of resources and role of technology etc.

UNIT 5 IMPLICATIONS OF THE ABOVE HOLISTIC UNDERSTANDING OF HARMONY ON PROFESSIONAL ETHICS 9 Hrs.

Natural acceptance of human values

Definitiveness of Ethical Human Conduct

Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order

Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems.

Case studies of typical holistic technologies, management models and production systems

Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations

Sum up.

Practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions eg. To discuss the conduct as an engineer or scientist etc

Max: 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - To become more aware of themselves, and their surroundings (family, society, nature)

CO2 - They would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind

CO3 - To have better critical ability

CO4 - To become sensitive to their commitment towards what they have understood (human values, human relationship and human society)

CO5 - To understand what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction

TEXT / REFERENCE BOOKS

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010
2. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
3. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
4. The Story of Stuff (Book).
5. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
6. Small is Beautiful - E. F Schumacher.
7. Slow is Beautiful - Cecile Andrews
8. Economy of Permanence - J C Kumarappa
9. Bharat Mein Angreji Raj – PanditSunderlal
10. Rediscovering India - by Dharampal
11. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
12. India Wins Freedom - Maulana Abdul Kalam Azad
13. Vivekananda - Romain Rolland (English)
14. Gandhi - Romain Rolland (English)

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max Marks: 50 **Exam Duration: 1.5 Hrs.**

Assessment by faculty mentor: 10 marks **Self-assessment: 10 marks**
Assessment by peers: 10 marks Socially relevant project/Group Activities/Assignments: 20 marks

SAEB2301	SIMULATION LAB	L	T	P	EL	Credits	Total Marks
		0	0	4	0	2	100

COURSE OBJECTIVES

- To make students learn the steps involved in CG determination.
- To introduce the methods of calibrating various flight instruments.
- To impart practical knowledge to students on determining various performance parameters.
- To find the neutral points and maneuver points in an aircraft.
- To impart practical knowledge to students about different modes of stability such as Dutch roll, phugoid motion etc.

LIST OF EXPERIMENTS

1. C.G. determination
2. Calibration of ASI and Altimeter
3. Calibration of special instruments
4. Cruise and climb performance
5. Determination of stick fixed & stick free neutral points
6. Determination of stick fixed & stick free maneuver points
7. Verification of Lateral-directional equations of motion for a steady state side slip maneuver
8. Verification of Lateral-directional equations of motion for a steady state coordinated turn
9. Flight determination of drag polar of a glider
10. Demonstration of stall, Phugoid motion and Dutch roll

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Acquire flying experience on a trainer aircraft.
CO2 - Determine the C.G position of an airplane.
CO3 - Calculate the performance parameters such as rate of climb, climb angle etc.
CO4 - Compute the stability parameters such as stick fixed neutral point, stick free neutral point and control parameters such as stick fixed maneuver point, stick free maneuver point.
CO5 - Get practical experience of Dutch roll and phugoid motion.
CO6 - Estimate the drag polar of a glider

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

CAE	**Evaluation of Regular Lab class** **Model practical exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 marks**

SAEB2302	AIRCRAFT STRUCTURAL TESTING LAB	L	T	P	EL	Credits	Total Marks
		0	0	4	0	2	100

COURSE OBJECTIVES

- Experimental analysis of various structures used in aerospace industry

LIST OF EXPERIMENTS

1. Tensile testing using UTM, Mechanical and Electrical extensometers. Stress Strain curves and strength tests for Steel and Aluminum.
2. Comparison of hardness values of steel, copper and aluminum using Brinell and Rockwell hardness measuring machines.
3. Compression test on Aircraft Materials.
4. Estimation of spring constant under tension and compression.
5. Estimation of notch toughness of Steel using Charpy / Izod impact testing machine
6. Tensile tests on riveted and bolted joints.
7. Verification of Castigliano's theorems. Influence coefficients
8. Bending tests, Stress and deflection of beams with various end conditions.
9. Verification of Maxwell's theorem.
10. Compression tests on long columns. Critical buckling loads, Euler load by Southwell plot

Max. 15 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Evaluate the hardness of the given specimen using Vickers, Brinell and Rockwell hardness testers.
CO2 – Perform the tensile and Compression test using the universal testing machine.
CO3 – Analyse the impact strength of the given specimen using Charpy and Izod methods.
CO4 – of Critical Buckling load, Euler load by Southwell Plot
CO5 – Evaluate the Stress and Deflection of beam with various end conditions.
CO6 – Verification of Castigliano's Theorem and Maxwell's Theorem

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

CAE	**Evaluation of Regular Lab class** **Model practical exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 marks**

SMTB1401	FOURIER SERIES AND NUMERICAL METHODS (COMMON TO ALL BRANCHES EXCEPT BIO GROUPS, CSE & IT)	L	T	P	EL	Credits	Total Marks
		3	1	0	0	3	100

COURSE OBJECTIVES

- The Objective of this Course is to identify, reflect upon, evaluate and achieve conceptual understanding and knowledge of traditional Calculus to form independent judgements. The purpose of this course is for modeling the Engineering problems and obtaining its solutions mathematically. This helps in understanding Science, Engineering and Computer Science analytically and logical thinking is attained.

UNIT 1 FOURIER SERIES 9 Hrs.

Fourier series – Euler's formula – Dirichlet's conditions – Fourier series for periodic functions – Parseval's identity (without proof) – Half range cosine series and sine series – simple problems – Harmonic Analysis.

UNIT 2 APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATION 9 Hrs.

One dimensional wave equation – Transverse vibrating of finite elastic string with fixed ends – Boundary and initial value problems – One dimensional heat equation – Steady state problems with zero boundary conditions – Two dimensional heat equation – Steady state heat flow in two dimensions- Laplace equation in Cartesian form (No derivations required).

UNIT 3 NUMERICAL METHODS FOR SOLVING EQUATIONS 9 Hrs.

Solution of algebraic equation and transcendental equation: Regula Falsi Method, Newton Raphson Method (including solving algebraic equations in two variables $f(x,y)=0$ and $g(x,y)=0$) – Solution of simultaneous linear algebraic equations: Gauss Elimination method, Gauss Jacobi method and Gauss Seidel method.

UNIT 4 INTERPOLATION, NUMERICAL DIFFERENTATION AND INTEGRATION 9 Hrs.

Interpolation: Newton forward and backward interpolation formula, Lagrange's formula for unequal intervals – Numerical differentiation: Newton's forward and backward differences to compute first and second order derivatives – Numerical integration: Trapezoidal rule, Simpson's $1/3^{rd}$ rule and Simpson's $3/8^{th}$ rule.

UNIT 5 NUMERICAL SOLUTIONS OF DIFFERENTIAL EQUATIONS 9 Hrs.

Ordinary differential equations: Taylor series method, Runge Kutta method for fourth order – Partial differential equations – Finite differences – Laplace equation and its solutions by Liebmann's process – Solution of Poisson equation – Solutions of parabolic equations by Bender Schmidt Method – Solution of hyperbolic equations.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Develop Fourier series for different types of functions
CO2 - Derive and obtain the solutions of wave and heat equations
CO3 - Formulate numerical solution of algebraic, transcendental and simultaneous linear equations
CO4 - Solve interpolation, numerical differentiation and integration problems
CO5 - Analyze various numerical methods for the solution of ordinary differential equations
CO6 - Apply numerical techniques to solve partil differential equations

TEXT / REFERENCE BOOKS

1. Bali N.P and Manish Goyal, A Text book of Engineering Mathematics, Eighth Edition, Laxmi Publications Pvt Ltd., 2011.
2. Grewal B.S., Higher Engineering Mathematics, , 41th Edition, Khanna Publications, Delhi,2011.
3. Kandasamy P., Thilagavathy K. & Gunavathy K., Engineering Mathematics, (4th Revised Edition), S.Chand & Co., New Delhi, 2001.
4. Veerarajan,T., Engineering Mathematics, Tata Mcgraw Hill Publishing Co., New Delhi, 2005.
5. Steven C. Chapra, Raymond P. Canale, Numerical Methods for Engineers, Tata Mcgraw Hill Publishing Co., New Delhi, 2003.
6. Kandasamy P., Thilagavathy K. and Gunavathy, K., Applied Numerical Methods, S.Chand & Co., New Delhi, 2003.
7. E.Balagurusamy, Numerical Methods, McGraw-Hill Education (India) Pvt Limited, 1999
8. B.S. Grewal, Numerical Methods In Engineering Science , Khanna Publisher, 2016

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB1401	LOW SPEED AERODYNAMICS	L	T	P	EL	Credits	Total Marks
		2	1	0	3	3	100

COURSE OBJECTIVES

- Introduce the concepts of mass, momentum and energy conservation relating to aerodynamics.
- To make the student understand the concept of vorticity, irrationality, theory of airfoils and wing sections.
- To introduce the basics of viscous flow.

UNIT 1 REVIEW OF BASIC AERODYNAMICS 9 Hrs.

Euler equation, incompressible Bernoulli's equation. circulation and vorticity, green's lemma and Stoke's theorem, barotropic flow, kelvin's theorem, streamline, stream function, irrotational flow, potential function, Equipotential lines, elementary flows and their combinations.

UNIT 2 LOW SPEED FLOW 9 Hrs.

Ideal Flow over a circular cylinder, D'Alembert's paradox, magnus effect, Kutta Joukowski's theorem, starting vortex, Kutta condition, real flow over smooth and rough cylinder. Continuity, momentum and energy equations using finite control volume method.

UNIT 3 AIRFOIL AND CONFORMAL TRANSFORMATION 9 Hrs.

Airfoils Nomenclature and NACA series, Cauchy-Riemann relations, complex potential, methodology of conformal transformation, Kutta- Joukowski transformation and its applications, thin airfoil theory and its applications

UNIT 4 FINITE WING THEORY 9 Hrs.

Introduction to Finite wing, Downwash and Induced Drag, Biot -Savart law and Helmhotz's theorems, Horse shoe vortex, Prandtl's Classical Lifting line theory and its limitations.

UNIT 5 VISCOUS FLOW 9 Hrs.

Derivation of Navier-Stokes equation for two-dimensional flows, boundary layer approximations, laminar boundary equations and boundary conditions, Blasius solution, qualitative features of boundary layer flow under pressure gradients, Integral method, aspects of transition to turbulence, turbulent boundary layer properties over a flat plate at low speeds. Separation of flow over bodies stream lined and bluff bodies.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Review of Complex potential, singularities, equation of Vortex-doublet and Rankine oval on cylinders and Aero foil.

CO2 - Interpret the continuity, Momentum and Energy equation for Low-speed flow

CO3 - Derive the Vortex sheet, Kelvin Circulation theorem Thin aerofoil theory, Joukowski transformation and its application to fluid flow problems

CO4 - Estimation of Drag, Biot -Savart law and Helmhotz's theorems, Horse shoe vortex, Prandtl's Classical Lifting line theory and its limitations

CO5 - Simplify the boundary layer equations through integral method and Blasius solution.

CO6 - Examine the effect of turbulence and various turbulence modelling for aircraft models.

TEXT / REFERENCE BOOKS

1. Aerodynamics for. Engineering Students. Sixth Edition. E.L. Houghton. P.W. Carpenter. Steven H. Collicott. Daniel T. Valentine, 2013 Elsevier, Ltd.
2. Bertin, John J., Aerodynamics for Engineers, Pearson Education Inc., 2002.
3. John J. Bertin, Russell M. Cummings, "Aerodynamics for Engineering students", Sixth Edition,Pearson,2013.
4. Anderson J.D., "Fundamentals of Aerodynamics", Sixth Edition , McGraw Hill Book Co., NewYork,2017.
5. Schlichting H., "Boundary layer theory" , Seventh Edition, McGraw Hill, NewYork 2014.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

S26BLH41	UNMANNED AERIAL SYSTEMS	L	T	P	EL	Credits	Total Marks
		3	0	2	0	4	100

COURSE OBJECTIVES

- To introduce the concepts of applying aerodynamics to UAV Design.
- To familiarize the student's ability to analyse the concepts of Avionics.
- To understand the basics of navigation in UAV Design.
- To understand the basics of Image Processing.

UNIT 1 INTRODUCTION TO UAV 9 Hrs.

History of UAV –classification –basic terminology- The Systemic Basis of UAV-System Composition-Conceptual Phase- Preliminary Design-Selection of the System- Some Applications of UAV-Characteristics Of Aircraft Types.

UNIT 2 BASICS OF AERODYNAMICS AND AIRFRAME CHARACERTICTICS OF UAV 9 Hrs.

Lift-induced Drag - Parasitic Drag - Rotary-wing Aerodynamics - Response to Air Turbulence- Airframe –dynamics – modelling- structures –wing design- engines types-equipment maintenance and management-control surfaces- specifications.

UNIT 3 AVIONICS HARDWARE 9 Hrs.

Geysering Phenomenon. Autopilot –AGL-pressure sensors-servos-accelerometer –gyros-actuators-power supply processor, integration, installation, configuration, and testing.

UNIT 4 COMMUNICATION PAYLOADS, CONTROLS AND NAVIGATION 9 Hrs.

Payloads-Telemetry-tracking-Aerial photography-controls-PID feedback-radio control frequency, range –SAS-flight director- commands and videos-elements of control loops-flight computer, - Sensors-Waypoints navigation**.**

UNIT 5 DIGITAL IMAGE PROCESSING FOR UAV 9 Hrs.

Principles of digital aerial photography- Sensors for aerial photography - Photo-interpretation, objective analysis and image quality - Image Recognition - Image Classification – Image Fusion – Colour Image Processing - Video Motion Analysis.

PRACTICAL – SUGGESTED LIST OF EXPERIMENTS 15 Hrs.

1. Regulations of DGCA, Civil Aviation Requirements
2. Basic principles of flight
3. ATC procedures & Radio Telephony
4. Fixed wing operations and aerodynamics
5. Multi rotor introduction
6. Drone equipment maintenance
7. Payload, installation, and utilization
8. Image and video interpretation

Max. 60 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Review of Complex potential, singularities, equation of Vortex-doublet and Rankine oval on cylinders and Aero foil.

CO2 - Interpret the continuity, Momentum and Energy equation for Low-speed flow

CO3 - Derive the Vortex sheet, Kelvin Circulation theorem Thin aerofoil theory, Joukowski transformation and its application to fluid flow problems

CO4 - Estimation of Drag, Biot -Savart law and Helmhotz's theorems, Horse shoe vortex, Prandtl's Classical Lifting line theory and its limitations

CO5 - Simplify the boundary layer equations through integral method and Blasius solution.

CO6 - Examine the effect of turbulence and various turbulence modelling for aircraft models.

TEXT / REFERENCE BOOKS

1. Kimon P. Valavanis, George J. Vachtsevanos, " Handbook of Unmanned Aerial Vehicles " olume Set- FIRST Edition, ISBN-13: 978-9048197064, 2015.
2. R. Jha. "Theory, Design, and Applications of Unmanned Aerial Vehicles".1st Edition, 2015.
3. Jane's Unmanned Aerial Vehicles and Targets, Jane' s Information Group; ASIN: 071 061 2575,2016.
4. Alex Elliott,"Build Your Own Drone Manual: The practical guide to safely building, operating and maintaining an Unmanned Aerial Vehicle (UAV)".2016
5. Robert C. Nelson, Flight Stability and Automatic Control, McGraw -Hill, Inc, 2016.
6. Skafidas, "Microcontroller Systems for a UAV", KTH, TRITA-FYS 2002:51 ISSN 0280-316 X.34, 2016.
7. Kimon P. Valavanis, "Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy", Springer, 2017.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SCSBDPRROJ	DESIGN THINKING AND INNOVATIONS	L	T	P	E L	Credits	Total Marks
		0	0	4	0	2	100

COURSE OBJECTIVES

- To apply knowledge in Real time problem solving.
- To foster innovation in design of products, processes or systems.
- To develop creative thinking in finding viable solutions to Engineering /Non Engineering problems.

Activity 1:

Design thinking introduction:

- Phases of design thinking- a study approach
- Group Discussion on Ideation- Users perspective Formation of team – Thinking skills- Brain storming

Activity 2:

Problem identification (phase I)

- Selecting user requirements
- Survey on various user's applications
- Specific Problem selection to proceed with the work – Team presentation on identified problems and various possible solutions.

Activity 3:

Problem identification (Phase II)

- Study of an application and its importance to end user.
- Various models of an applications
- Finalize the identified problem

Activity 4:

- Design ideation and various stages
- Sketch design diagram
- Architecture or full diagrammatic study

Activity 5:

- Review and upgradation
- Review of the ideation (one to one interaction)
- Feedback
- Upgradation Plan

Activity 6:

Implementation (Phase I)

- Build the prototype using available resources
- Record Module diagrams

Activity 7:

Implementation(Phase II)

- Display and review of the prototype.
- Record its functionality and its Usage-Technical manual

Activity 8:

Testing

- To test the product design with real time environment
- Record cord Process-user manual

Activity 9:

IPR-Activity I

- To study various IPR activities
- To prepare for IPR Process
- To file an IPR

Activity 10:

Start-ups Formation

- To exhibit the product to public: feedback approach
- To prepare full documentation
- Start-ups registration/apply patent/publish paper/submit model/prototype/Apply for seed/submit as research proposal

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Solve real world problems by applying knowledge across domains

CO2 - Develop various design products, processes or technologies for sustainable and socially relevant applications

CO3 - Demonstrate knowledge of resource utilization/budgets to Implement appropriate methodologies

CO4 - Execute tasks by application of engineering standards/ requirements/ design criteria, within timelines

CO5 - Conduct extended investigation that results in the translation of idea to product / production of a research thesis/ developing a proof of concept.

CO6 - Communicate well organized technical and scientific findings effectively in written and oral forms, following ethical and professional norms

TEXT / REFERENCE BOOKS

1. Kimon P. Valavanis, George J. Vachtsevanos, " Handbook of Unmanned Aerial Vehicles " olume Set- FIRST Edition, ISBN-13: 978-9048197064, 2015.
2. R. Jha. "Theory, Design, and Applications of Unmanned Aerial Vehicles".1st Edition, 2015.
3. Jane's Unmanned Aerial Vehicles and Targets, Jane' s Information Group; ASIN: 071 061 2575,2016.
4. Alex Elliott,"Build Your Own Drone Manual: The practical guide to safely building, operating and maintaining an Unmanned Aerial Vehicle (UAV)".2016
5. Robert C. Nelson, Flight Stability and Automatic Control, McGraw -Hill, Inc, 2016.
6. Skafidas, "Microcontroller Systems for a UAV", KTH, TRITA-FYS 2002:51 ISSN 0280-316 X.34, 2016.
7. Kimon P. Valavanis, "Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy", Springer, 2017.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB2401	AERODYNAMICS LAB	L	T	P	EL	Credits	Total Marks
		0	0	4	0	2	100

COURSE OBJECTIVES

- To predict different aerodynamics used in aero application.

LIST OF EXPERIMENTS

1. Calibration of subsonic wind tunnel.
2. Pressure distribution computations over cylinder.
3. Estimation of lift, drag characteristics of symmetrical airfoil.
4. Estimation of lift, drag characteristics of cambered airfoil.
5. Calibration of forces and moments in a symmetrical 3D airfoil.
6. Flow visualization technique by using water flow channel.
7. Calibration of forces and moments in a cambered 3D airfoil.
8. Flow visualization technique by Hele Shaw Apparatus for different bluff bodies.
9. Flow visualization technique by smoke flow apparatus for different bluff bodies.
10. Calibration of Supersonic Wind Tunnel.
11. Flow visualization technique by Schlieren Image system for different wedge and blunt bodies.
12. Flow visualization of Scramjet step combustor model.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Evaluate the calibration of subsonic wind tunnel and utilization of precision measurement instrument.

CO2 - Evaluate the pressure distribution over cylinder and airfoil models in Subsonic Wind Tunnel.

CO3 - Estimating the lift, drag and pitching moment of airfoils from the pressure distribution calculation.

CO4 - Inspect the model by flow visualization technique called water flow channel to visualize the boundary layer separation.

CO5 - Inspect the model by Hele Shaw, smoke flow apparatus to visualize the boundary layer separation in airfoil and cylindrical.

CO6 - Evaluate Pressure, Mach number and temperature measurements for supersonic wind tunnel.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

CAE	**Evaluation of Regular Lab class** **Model practical exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 marks**

SAEB2402	FIXED WING DRONE LAB	L	T	P	EL	Credits	Total Marks
		0	0	4	0	2	100

COURSE OBJECTIVES

- To design and construct the fixed wing drone used in aeronautical application.

LIST OF EXPERIMENTS

1. Study about historical background of airplanes.
2. Component of airplanes and its functions
3. Construction of glider airplane (rubber powered).
4. Construction of aircraft fuselage (semi-monocoque structure)
5. Construction of aircraft wing (semi-monocoque structure)
6. Construction of tail plane (empennage)
7. Assembly of a fixed wing drone.
8. Mounting of engine and controls.
9. Training in flight maneuvering through computer simulation.
10. Testing of fixed wing drone in open field.

Max. 45 Hrs

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the components of airplanes and its functions
CO2 - Construct the rubber powered airplane
CO3 - Construct the fuselage and wing of a fixed wing drone.
CO4 - Construct the tail plane assembly of a fixed wing drone.
CO5 - Assembly of a fixed wing drone.
CO6 - Evaluate the fixed wing drone field test in open area.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

CAE	**Evaluation of Regular Lab class** **Model practical exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 marks**

SAEB1501	AIRCRAFT PROPULSION	L	T	P	EL	Credits	Total Marks
		3	1	0	0	3	100

COURSE OBJECTIVES

- To introduce the concepts of applying Aero thermodynamics to air breathing propulsion.
- To familiarize the student's ability to analyze the concepts of compressor.
- To understand the basics of Axial Turbine.
- To understand the basics of Ramjet and Scramjet.

UNIT 1 THERMODYNAMICS OF AIR BREATHING PROPULSION 9 Hrs.

History and classifications of Aero engines, Working of gas turbine engine – Thrust equation – Factors affecting thrust – Engine performance parameters – Efficiency, Specific fuel consumption, Methods of thrust augmentation – The propeller, turboprop, turbofan and turbojet engines characteristics.

UNIT 2 INLETS, COMBUSTION CHAMBER AND NOZZLES 9 Hrs.

Introduction-Subsonic inlets-Supersonic inlets-Modes of Inlet operation- Gas turbine combustors- Types of combustion chamber-Fuel injector- Flame Tube cooling-Flame Stabilization-Flame holders- Theory of flow in isentropic nozzles – Losses in nozzles –Nozzle efficiency—nozzle choking –Over expanded and under expanded nozzles – Ejector and variable area nozzles.

UNIT 3 AIR COMPRESSOR 9 Hrs.

Compressor and its classification- Centrifugal compressor - Work and compression ratio - Performance characteristics- Centrifugal compressor staging- Axial compressor-Work and compression ratio- Degree of reaction- Characteristic performance of a single stage axial compressor- Characteristic performance of a multistage axial compressor- Cascading of axial compressor- Compressor efficiency.

UNIT 4 AXIAL TURBINES 9 Hrs.

Axial turbine stage -Velocity triangles and Power output - Elementary theory - Vortex theory- Limiting Factors of gas turbine design-Turbine performance- Turbine Blade cooling- Axial flow Turbine and compressor matching.

UNIT 5 RAMJET AND SCRAMJET 9 Hrs.

Operating principle of RAMJET engine- RAMJET with afterburner- RAMJET performance- SCRAMJET working principle- Problems faced in supersonic combustion.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Interpret the performance and characteristics of turboprop, turbofan and turbojet.
CO2 - Measure the performance of inlets and nozzles and its modes of operation with respect to Mach number regimes.
CO3 - Compile the process and performance of combustion chambers and its cooling methods.
CO4 - Design the compressor blades by utilizing the elementary theory of compressors.
CO5 - Analyze the different types of turbines and its elementary theory of blades.
CO6 - Estimate the stage performance and overall turbine performance for matching the compressors and turbines

TEXT / REFERENCE BOOKS

1. Philip Hill and Carl Peterson, “Mechanics and thermodynamics of propulsion”, Pearson India, second edition 2010.
2. V.Ganesan., “Gas Turbines”, Tata McGraw-Hill Education, third edition, 2010.
3. Cohen.H, Rogers.G.F.C. and Saravanamuttoo.H.I.H, “Gas turbine theory”. Pearson education, fifth edition,2001.
4. Rathakrishnan E., “Fundamentals of Engineering Thermodynamics”, Prentice-Hall India, 2012.
5. Saeed Farokhi, “Aircraft Propulsion”, John Wiley & Sons, Inc ., 2009.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

S26BLH51	AIRCRAFT SYSTEMS AND INSTRUMENTS	L	T	P	EL	Credits	Total Marks
		3	0	2	0	4	100

COURSE OBJECTIVES

- To impart knowledge of the hydraulic and pneumatic systems components.
- To understand the types of instruments and its operation including navigational instruments to the students.

UNIT 1 AIRCRAFT SYSTEMS 9 Hrs.

Hydraulic Systems – Types of Hydraulic oil -and its properties. Study of Typical Workable System – Components– Hydraulic System Components – Modes of Operation – Pneumatic Systems – Advantages – Working Principles –Components, case studies in modern aircrafts.

UNIT 2 LANDING GEAR SYSTEMS 9 Hrs.

Landing Gear Systems – Classification – Purpose and types of Shock Absorbers. Construction and its operation– LG – Retraction/extension Mechanism. Brake System types, components and advantages, antiskid system. Conventional and tubeless tires construction, advantages and common defects, modern advancements in tyre technologies. Brake systems.

UNIT 3 FUEL AND PRESSURIZING SYSTEM 9 Hrs.

Fuel system – Layout, Types of fuel tanks, locations, control pressure, sequence of fuel consumption, Basic Air Cycle Systems – Vapour Cycle Systems. Pressurization system – Principle-components-limitation- Oxygen systems – Fire Protection Systems, Deicing and Anti Icing Systems.

UNIT 4 AIRPLANE CONTROL SYSTEMS 9 Hrs.

Conventional Systems –Modern Flight Control Systems Control Actuation Digital Fly by Wire systems -Autopilot System. Active Control Technology – CCV, The Control Problem, Principles of actuation systems, Types of actuation systems.

UNIT 5 AIRCRAFT INSTRUMENTS 9 Hrs.

Flight Instrument and Navigation Instruments – Accelerometers, Air data instruments-airspeed, altitude, Vertical speed indicators. Static Air temperature, Angle of attack, Air Speed Indicators – Mach Meters – Altimeters – Gyroscopic Instruments – principles and Operation and types– Study of Various Types of Engine Instruments – Tachometers – Temperature Gauges – Pressure Gauges – Operation and Principles.

Max. 45 Hrs.

PRACTICAL – SUGGESTED LIST OF EXPERIMENTS 15 Hrs.

1. Aircraft “Jacking Up” procedure.
2. Aircraft “Leveling” procedure.
3. Control System “Rigging check” procedure.
4. Aircraft “Symmetry Check” procedure.
5. Checking of Aircraft rudder and flaps

Max. 60 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Choose the suitable hydraulic and pneumatic systems for different modes of operation in aircraft systems.

CO2 - Illustrate the functions of landing gear systems possessing retraction/ extension mechanism of an aircraft.

CO3 - Scrutinize the airplane control systems and control actuation systems utilized in control surfaces.

CO4 - Categorize the different types of fuel systems and environmental control systems of aircraft components.

CO5 - Recommend the types of flight navigation instruments used in aircraft.

CO6 - Recommend the types of gyroscopic and engine instruments to be used in aircrafts..

TEXT / REFERENCE BOOKS

1. Mekinly, J.L. and Bent, R.D., “Aircraft Power Plants”, McGraw Hill, 2016
2. Pallet, E.H.J., “Aircraft Instruments & Principles”, Pitman & Co., 2016.
3. Treager, S., “Gas Turbine Technology”, McGraw Hill, 2016.
4. Mckinley, K.L., and Bent, R.D., “Aircraft Maintenance & Repair”, McGraw Hill 2016.
5. General Hand Books of Airframe and Power plant Mechanics”, U.S. Dept. of Transportation, Federal Aviation Administration, .the English Book Store, New Delhi, 2016.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB1502	AIRCRAFT STRUCTURES	L	T	P	EL	Credits	Total Marks
		3	1	0	0	3	100

COURSE OBJECTIVES

- To provide the students various methods for analysis of aircraft wings and fuselage.
- To provide the behavior of major aircraft structural components.

UNIT 1 STATICALLY DETERMINATE AND INDETERMINATE STRUCTURE 9 Hrs.

Truss: Analysis of plane truss–Method of joints–3DTruss. - Load transmission in multiple span beam-Clapeyron's Three Moment Equation.

UNIT 2 ENERGY METHODS 9 Hrs.

Strain Energy due to axial, bending and Tensional loads-Castigliano's theorem-Maxwell's Reciprocal theorem ,UNIT load method ,The principle of virtual work- application to beams ,trusses, -redundant center.

UNIT 3 UNSYMMETRICAL BENDING 9 Hrs.

Bending stresses in beams of unsymmetrical sections– Bending of symmetric sections with skew loads.

UNIT 4 SHEAR FLOW IN OPEN AND CLOSED SECTIONS 9 Hrs.

Concept of shear flow, shear centre, Elastic axis. With one axis of symmetry, with wall effective and ineffective in bending, unsymmetrical beam sections. Bredt–Batho formula, Shear flow in single & multi cell structure sunder torsion.

UNIT 5 STRESS ANALYSIS IN WING AND FUSELAGE 9 Hrs.

Structural lay out of the Airplane and components, loads acting on major components such as wing, fuselage, tails, landing gear etc., Concept of allowable stress and margin of safety. Procedure–Shear and bending moment distribution for semi cantilever and other types of wings and fuselage, thin webbed beam. With parallel and nonparallel flanges, Shear resistant web beams, Tension field web beams(Wagner's).

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Analyze the trusses and beams using method of joints and moment distribution method.
CO2 - Evaluate the stresses using energy methods in trusses, beams, frames and rings of the aircraft structure.
CO3 - Estimate the bending stresses in beams under skew loads and calculate the nonlinear stress distributions during unsymmetrical bending cases.
CO4 - Analyse the shear flow and shear centre for open and closed loop sections. **CO5** - Estimate the stress analysis in airplane wing and its components.
CO6 - Evaluate the stress analysis in airplane fuselage and its components., fuselage, tails, landing gear.

TEXT / REFERENCE BOOKS

1. Megson, T.M.G., "Aircraft Structures for Engineering Students", Edward Arnold, 2012.
2. Bruhn. E.H. "Analysis and Design of Flight vehicles Structures", Tri– stateoff set Company, USA, 2015.
3. Millard V.Barton, 'Fundamentals of Aircraft Structures " Prentice Hall, 2012.
4. Timoshenko,S., "Strength of Materials",Vol.I and II, Princeton D. Von Nostrand Co,2012.
5. Donaldson, B.K., "Analysis of Aircraft Structures– An Introduction", McGraw-Hill, 2011.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB1503	HIGH SPEED AERODYNAMICS	L	T	P	EL	Credits	Total Marks
		2	0	0	3	3	100

COURSE OBJECTIVES

- To introduce the concepts of compressibility.
- To make the student understand the theory behind the formation of shocks and expansion fans in Supersonic flows.
- To introduce the methodology of measurements in Supersonic flows.

UNIT 1 CONCEPTS OF COMPRESSIBLE FLOW 9 Hrs.

Basic concepts of compressible flow, Review of continuity, energy and momentum equations. One dimensional inviscid flow; Stagnation quantities; Isentropic conditions. Speed of sound and Mach number; Isentropic relations; Area-velocity relation.

UNIT 2 COMPRESSION AND EXPANSION WAVES 9 Hrs.

Normal shock –Prandtl equation and Rankine–Hugonoit relation .Oblique shock and supersonic compression by turning. Weak shocks and Mach waves; Supersonic expansion by turning. Prandtl- Meyer expansion fan; Reflection and intersection of shocks. Shock detachment and bow shock; Shock Expansion theory with application to thin airfoils.

UNIT 3 AIRFOIL IN HIGH SPEED FLOWS 9 Hrs.

Small perturbation potential theory, solutions for supersonic flows, Mach waves and Mach angles, Prandtl-Glauert rule - affine transformation relations for subsonic flows, linearized two dimensional supersonic flow theory - Lift, drag, pitching moment and center of pressure of supersonic profiles.

UNIT 4 TRANSONIC FLOW OVER WING 9 Hrs.

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, Tip effects.

UNIT 5 EXPERIMENTAL TECHNIQUES FOR HIGH SPEED FLOWS 9 Hrs.

Blow down, indraft and induction tunnel layouts and their design features. Transonic, supersonic and hypersonic tunnels and their peculiarities. Helium and gun tunnels, Shock tubes, Optical methods of flow visualization.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Acquire knowledge on the basic concepts of compressible flow

CO2 - Distinguish the compression and expansion waves on arbitrary bodies and open deflected conduits.

CO3 - Solve the lift, drag and center of pressure of supersonic airfoils.

CO4 - Differentiate the transonic flow effects over Wings and wing fuselage compartment.

CO5 - Understand the different types of tunnel layouts and their design features.

CO6 - Analyse the shock tube effect and application of flow visualization in it.

TEXT / REFERENCE BOOKS

1. Radhakrishnan, Ethirajan., Gas Dynamics, John Wiley & Sons,2016.
2. Anderson J. D., Jr., Modern Compressible Flow with Historical Perspective, McGraw Hill Publishing Co.,2016.
3. H W Liepmann and A Roshko, Elements of Gas Dynamics, John Wiley & Sons.
4. Shapiro, A.H., "Dynamics and Thermodynamics of Compressible Fluid Flow", Ronold Press.
5. Zucrow, M.J. and Anderson, J.D., "Elements of gas dynamics", McGraw-Hill Book Co., New York.
6. Clancy,L,J., “Aerodynamics”, Pitman, Shroff Publishing co.,2016.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB2502	PROPULSION LAB	L	T	P	EL	Credits	Total Marks
		0	0	2	0	1	50

COURSE OBJECTIVES

- To familiarize with basic aero engineering thermodynamics.
- To familiarize Aircraft engine components.
- To familiarize Aerospace propulsion.
- To familiarize Computational analysis in propulsion.

LIST OF EXPERIMENTS

1. Determination of heat of combustion of aviation fuel.
2. Determination of free jet characteristics and velocity profile.
3. Determination of wall jet characteristics and velocity profile.
4. Determination of axial flow compressor performance.
5. Estimation of pressure distribution in Convergent nozzle duct.
6. Estimation of pressure distribution in Divergent diffuser duct.
7. Study of Aircraft piston and Turbojet engine propeller.
8. Study of free convective heat transfer over a square plate.
9. Study of forced convective heat transfer over a cylindrical duct.
10. Evaluation of performance of Gas turbine Engine.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Estimate the flash point and fire point of the aviation fuel.
CO2 - Evaluate the characteristics of free jet, wall jet and axial flow compressor.
CO3 - Demonstrate the pressure distribution of Convergent and Divergent Nozzle.
CO4 - Perform the study of Aircraft piston and Turbojet engine
CO5 - Evaluate the free and forced convection heat transfer.
CO6 - Elucidate the performance of Gas turbine Engine.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

CAE	**Evaluation of Regular Lab class** **Model practical exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 marks**

SAEB1601	AIRCRAFT PERFROMANCE	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To evaluate the performance of air vehicles in real atmosphere versus standard atmosphere.
- To study the different forces acting on a vehicle in flight, drag, variation of thrust, performance during different conditions, and flight testing.
- To perform various testing methods to compare different aircrafts performances.

UNIT 1 PREREQUSITES TO EVALUATEAIRCRAFT PERFORMANCE 9 Hrs.

Properties of earth's atmosphere and standard atmosphere, Forces and moments acting on a flight vehicle - Equation of motion of a rigid flight vehicle- Different types of drag – estimation of parasite drag co-efficient by proper area method- Drag polar of vehicles from low speed to high speeds.

UNIT 2 ENGINE CHARACTERISTICS 9 Hrs.

Variation of thrust, power with velocity and altitudes for air breathing engines – specific fuel consumption of piston engine and jet engine – ideal efficiency of engines- power plants for flight vehicles – limitations of power plants with Mach number and altitude.

UNIT 3 EVALUATION OF UN - ACCELERATED FLIGHT PERFORMANCE 9 Hrs.

Airplane performance in steady level flight - Power available and power required curves. Maximum speed in level flight - Conditions for minimum drag and power required - steady climb descent and glide performance. Climb and Glide Hodograph, Range and Endurance.

UNIT 4 ACCELERATED AND MANOEUVERING FLIGHT PERFORMANCE 9 Hrs.

Accelerated level flight - Climbing and gliding flight, Maximum rate of climb and steepest angle of climb, minimum rate of sink and shallowest angle of glide –Take off – Landing-Turning performance. Bank angle and load factor – limitations on turn V-n diagram.

UNIT 5 FLIGHT TESTING METHODS TO EVALUATE PERFORMANCE 9 Hrs.

Flight - testing: Altitude definitions, Speed definitions, Air speed, altitude and temperature measurements. Errors and calibration. Measurement of engine power, charts and corrections. Flight determination of drag polar.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Estimate the forces, moments, drag polar acting on a flight vehicle
CO2 - Analyse the flight performance with variations of pressure and density with altitude.
CO3 - Estimation of total drag and drag polar that influence the performance.
CO4 - Analyze the performance in un-accelerated flight conditions
CO5 - Determination of speed limit, load limit, landing and take-off distances of the aircraft.
CO6 - Design the performance of Engine power during flight by determining the drag polar.

TEXT / REFERENCE BOOKS

1. Perkins, C.D., and Hage, R.E., “Airplane Performance stability and Control”, John Wiley & Son:,Inc, NY, 2016.
2. McCornick. W., “Aerodynamics, Aeronautics and Flight Mechanics”, John Wiley, NY, 2016.
3. McCornick B. W, “Aerodynamics, Aeronautics and Flight Mechanics”, John Wiley, NY, 2017.
4. Babister, A.W., “Aircraft Stability and Response”, Pergamon Press, 2017.
5. McCormik, B. W., “Aerodynamics, Aeronautics and Flight Mechanics”, John Wiley, 2016.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

S26BLH61	AVIONICS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To introduce the basic of avionics and its need for civil and military aircrafts.
- To impart knowledge about the avionic architecture and various avionics data buses.
- To gain more knowledge on various avionics subsystems.

UNIT 1 DISPLAY TECHNOLOGY 9 Hrs.

Basics of Avionics-Basics of Cockpits-Need for Avionics in civil and military aircraft and space systems –Attitude Direction Indicator-The Horizontal Situation Indicator-altimeter-Airspeed Indicator (ASI) –glass cockpit-Display system architectures- Electronic flight instrument systems - CRT-The Active Matrix Liquid Crystal Display-Large area HDD-Three-dimensional and four-dimensional display formats -Touch screen.

UNIT 2 AVIONICS TECHNOLOGY 9 Hrs.

Avionics Bus architecture–Data buses MIL–Aircraft system Interface Digital data buses -integration of aircraft systems - Fiber-optic buses-avionics packaging – LRU-Integrated Modular Avionics-System design-Open architecture definition of IMA cabinets – first-, second-, and third-generation Implementations.

UNIT 3 SENSORS 9 Hrs.

Air data - Air Data and Inertial Reference Systems (ADIRS) -Magnetic sensing - Magnetic Heading Reference System (MHRS) - Inertial navigation -Inertial platforms- Nature of Radar and Applications, Simple form of Radar Equation, Radar Block Diagram and Operation, Prediction of Range Performance, Minimum Detectable Signal, Radar Receivers Radar sensors -Radar altimeter - Doppler radar -Weather radar.

UNIT 4 ACCELERATED AND MANOEUVERING FLIGHT PERFORMANCE NAVIGATION AND LANDING AIDS 9 Hrs.

Basic navigation - Radio navigation - Oceanic crossings - Inertial navigation - Satellite navigation – GPS -Terrain Awareness and Warning System - Satellite navigation systems- Instrument Landing System-Transponder Landing System -Microwave Landing System (MLS).

UNIT 5 FLIGHT TESTING METHODS TO EVALUATE PERFORMANCE 9 Hrs.

Radio Frequency spectrum -Communications systems-HF-VHF-Satellite communications-Air Traffic Control (ATC) transponder -Traffic Collision and Avoidance System- Airborne early warning -Ground surveillance -Electronic warfare principles.

Max. 45 Hrs.

PRACTICAL - LIST OF EXPERIMENTS 15 Hrs.

MATLAB EXPERIMENTS

1. Working with Matrices
2. Expressions
3. Relational and Logical Operations

MICROPROCESSORS EXPERIMENTS

1. Addition and Subtraction of 8-bit and 16-bit numbers.
2. Sorting of Data in Ascending & Descending order.
3. Sum of a given series with and without carry.
4. Greatest in a given series & Multi-byte addition in BCD mode.

AVIONICS DATA BUSES EXPERIMENTS

1. Study of Different Avionics Data Buses.

Max. 60 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Estimate the forces, moments, drag polar acting on a flight vehicle
CO2 - Analyse the flight performance with variations of pressure and density with altitude.
CO3 - Estimation of total drag and drag polar that influence the performance.
CO4 - Analyze the performance in un-accelerated flight conditions
CO5 - Determination of speed limit, load limit, landing and take-off distances of the aircraft.
CO6 - Design the performance of Engine power during flight by determining the drag polar.

TEXT / REFERENCE BOOKS

1. Collinson R.P.G. “Introduction to Avionics”, Chapman & Hall Publications, 2011.
2. N.S. Gopalakrishnan & T.G. Ajitha, Principles of Intellectual Property, Eastern Book Company, 2nd ed., 2014.
3. Civil Avionics Systems ,Ian Moir , Allan G Sea bridge, Professional Engineering Publishing Limited, London, UK,2013.
4. Myron Kyton, Walfred Fried, Avionics Navigation systems, 2nd Edition, John Willy & Sons, 1997.
5. Albert D Helfrick, Modern Aviation Electronics, 2nd Edition, PHI, 1994.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB1602	AEROSPACE PROPULSION	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To introduce the concepts of applying Aero thermodynamics to non air breathing propulsion.
- To familiarize the student's ability to analyze the concepts of Advance Propulsion.
- To understand the basics of Solid Propellant, Liquid Propellant and Cryogenics.
- To understand the basics of Micro propellants.

UNIT 1 FUNDAMENTALS OF ROCKET PROPULSION 9 Hrs.

History and evolution of rockets - Rocket principle and Rocket equation - Classification of rockets - Mass ratio of rocket- Rocket Nozzles - Classifications - Nozzle Performance - Nozzle area ratio - Mass flow rate Characteristic velocity - Thrust coefficient-Performance parameters and Efficiencies of rocket Staging and Clustering.

UNIT 2 SOLID PROPELLANT ROCKET 9 Hrs.

Hardware components and its functions - Mechanism of burning - Ignition system and igniter types- Propellant grain configuration and its applications - Burn rate - Factors influencing burn rates-Burn rate index for stable operation - Action time and burn time - Design of Solid Propellant rocket.

UNIT 3 LIQUID AND CROGENIC PROPELLANT ROCKET 9 Hrs.

Classifications - Hardware components and its functions-Propellant feed systems and Turbo pump feed system - Injectors and types - Thrust chamber and its cooling-Cryogenic propulsion system, Special features of cryogenic systems. Thermo- physical Properties of Cryogenic Propellants; Geysering Phenomenon.

UNIT 4 ADVANCE PROPULSION TECHNIQUES 9 Hrs.

Hybrid propellant rocket and gelled propellants - Electrical rockets - Electro-thermal, Electro-static and Electro-magnetic propulsion system- Arc-jet thruster - Ion thruster - Hall Effect Thruster - Magneto plasma dynamic thruster- Nuclear rockets - Solar sail.

UNIT 5 MICRO PROPULSION SYSTEM 9 Hrs.

Recent Micro Spacecraft Developments; Micro propulsion Options; Primary Set of Micro propulsion Requirements; Chemical Propulsion Options; Review of Electric Propulsion Technologies for Micro and Nano- satellites; Emerging Technologies: MEMS and MEMS- Hybrid Propulsion System.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Analogize the Evolution of rockets with working principles, equation, performance parameters, efficiencies and its classification

CO2 - Discriminate the sound foundation in the design principles of solid propellants Rockets.

CO3 - Differentiate the operation various types of Liquid and Cryogenic Propellant Rocket.

CO4 - Distinguish the Working principles of hybrid rocket propellant rockets, Electrical, Electro thermal, Nuclear, Ion and Solar sail

CO5 - Compare the Working principle and performance of. Micro Spacecraft propulsion system

CO6 - Review of Electric Propulsion Technologies for Micro and Nano- satellites; Emerging Technologies: MEMS and MEMS- Hybrid Propulsion System.

CO6 - Review of Electric Propulsion Technologies for Micro and Nano- satellites; Emerging Technologies: MEMS and MEMS- Hybrid Propulsion System.

TEXT / REFERENCE BOOKS

1. George P. Sutton and Oscar Biblarz. “Rocket Propulsion Elements” 9th Edition, Wiley Publication, 2016.
2. Ramamurthi.K: “Rocket propulsion” Macmillan Publishing Co, India. 1st Edition. 2016.
3. Hill.P.G. and Peterson.C.R: “Mechanics and thermodynamics of propulsion” 2nd Edition .Pearson Education, 2016.
4. V.Ganesan., “Gas Turbines”, Tata McGraw-Hill Education, 3rd Edition, 2016.
5. Philip Hill and Carl Peterson, “Mechanics and thermodynamics of propulsion”, Pearson India, 2nd Edition, 2016.
6. Cohen.H, Rogers.G.F.C. and Saravanamuttoo.H.I.H, “Gas turbine theory”. Pearson education, 5th Edition, 2016.
7. Saeed Farokhi, “Aircraft Propulsion”, John Wiley & Sons, Inc ., 2016.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB1603	FINITE ELEMENT METHODS FOR AIRCRAFT STRUCTURES	L	T	P	EL	Credits	Total Marks
		2	0	0	3	3	100

COURSE OBJECTIVES

- To understand the concepts of finite elements methods.
- To evaluate the characteristics of structural members.
- To know the basic methods to solve the solid mechanics problems.
- To discuss the structural mechanics and its applications.

UNIT 1 INTRODUCTION **9 Hrs.**

Basic finite element concepts-Basic ideas in a finite element solution, General finite element solution procedure, Finite element equations using modified Galerkin method, Application: Axial deformation of bars, Axial spring element.

UNIT 2 BEAM BENDING **9 Hrs.**

Governing differential equation for beam bending, two node beam element, Exact solution for uniform beams subjected to distributed loads using superposition, Calculation of stresses in beams, Thermal stresses in beams.

UNIT 3 ANALYSIS OF TRUSSES AND FRAMES **9 Hrs.**

Two dimensional truss element, three dimensional space truss element, Stresses due to lack of fit and temperature changes. Plane frame element, Thermal stresses in frames, Three dimensional space frame element.

UNIT 4 TWO DIMENSIONAL ELASTICITY AND AXI-SYMMETRIC ELASTICITY **9 Hrs.**

Governing differential equations, Constant strain triangular element, Four node quadrilateral element, Eight node isoperimetric element. Problems-Governing equations for axisymmetric elasticity, Axisymmetric linear triangular element, Axisymmetric four nodes isoperimetric element

UNIT 5 APPLICATION FINITE ELEMENT METHODS **9 Hrs.**

Applications of FEM software to solve simple problems, types of solver, Applications based on general two dimensional boundary value Problem-Ideal fluid flows around an irregular object, Two dimensional steady state heat flow, Torsion of prismatic bars.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Derive the Finite element equations using modified Galerkin method for the Axial deformation of bars and Axial spring element.

CO2 - Derive the Governing differential equation for beam bending, two node beam element and thermal stresses on the beams

CO3 - Analyse the three-dimensional space truss element and space free element **CO4** - Analyse the Two-dimensional Elasticity and Axisymmetric Elasticity elements.

CO5 - Apply FEM software to solve two-dimensional boundary value Problem and Ideal fluid flows around an irregular object

CO6 - Apply FEM software to solve Two-dimensional steady state heat flow, Torsion of prismatic bars

TEXT / REFERENCE BOOKS

1. J.N Reddy. “An Introduction to the Finite Element Method” ,McGraw Hill, International Edition, 2016.
2. Seshu, P, “Text Book of Finite Element Analysis”, Prentice-Hall of India Pvt. Ltd., New Delhi,2016.
3. Segerlind L.J, “Applied Finite Element Analysis”, John Wiley, 2016.
4. Rao. S.S, “Finite Element Method in Engineering”, Pergamon Press, 2016.
5. Chandrupatla & Belagundu , “Finite Elements in Engineering”, Prentice Hall of India Private Ltd., 2016.
6. Cook, Robert Davis et al, “Concepts and Applications of Finite Element Analysis” , Wiley, John & Sons,2016.
7. George R Buchanan, “Schaum’s Outline of Finite Element Analysis”, McGraw Hill Company, 2016.
8. Taylor.C and Hughes.J.B. “Finite Element Programming of the Navier Stoke equation” Pineridge Press Limited, UK 2016.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB2601	AIRCRAFT DESIGN PROJECT LAB	L	T	P	EL	Credits	Total Marks
		0	0	4	0	2	100

COURSE OBJECTIVES

- To classify the types of Aircrafts and its data collection.
- To estimate the weight of an Aircraft pertaining to preliminary hand calculations
- To select the appropriate airfoil, wing tail, control surface and power plant for the preliminary design Aircraft.
- To analyze the performance of the preliminary design Aircraft.
- To perform the structural analysis of the preliminary design Aircraft.
- To design the landing gear opted for the newly designed Aircraft.

SUGGESTED LIST OF EXPERIMENTS

1. Data collection.
2. Preliminary weight estimation.
3. Airfoil selection, Wing tail and control surfaces
4. Power plant selection
5. Balance diagram.
6. Drag estimation.
7. Rate of climb calculations at various altitudes, Turn performance
8. Range and Endurance, Takeoff and landing distance calculation
9. Stability calculations
10. V-n diagram
11. Wing and fuselage Design.
12. Shear force and bending moment diagrams of various aircraft structures.
13. Structural weight distribution.
14. Landing gear Design.
15. Detailed CAD drawings of wing, fuselage ,tail surfaces and control surfaces and their stress analysis using structural software
16. Detailed Design project report.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1: Categorize the types of Aircraft and its specifications to perform the conceptual design of new Aircraft.

CO2: Estimate the gross weight and payload weight of an Aircraft for the preliminary designed Aircraft.

CO3: Deduct the appropriate selection of airfoil, wing-tail configuration for the preliminary Aircraft.

CO4: Analyze the preliminary designed Aircraft's performance and its control.

CO5: Evaluate the structural analysis of airframe parts of the preliminary designed Aircraft.

CO6: Design the appropriate landing gear that suits the preliminary designed Aircraft.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

CAE	**Evaluation of Regular Lab class** **Model practical exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 marks**

SAEB1701	HEAT TRANSFER TECHNIQUES	L	T	P	EL	Credits	Total Marks
		2	0	0	3	3	100

COURSE OBJECTIVES

- To learn the various modes of heat transfer and understand the basic concepts of mass transfer
- To understand the applications of various experimental heat transfer correlations in engineering applications.
- To discuss the thermal analysis and sizing of heat exchangers
- To understand the concepts of high speed flow heat transfer

UNIT 1 INTRODUCTION AND CONDUCTION HEAT TRANSFER 9 Hrs.

Basic modes of heat transfer – One dimensional steady state heat conduction – Cartesian, cylindrical and spherical coordinates – Composite medium – Critical thickness – Effect of variation of thermal conductivity – Extended surfaces. Conduction with heat generation. Unsteady state heat conduction – Heat transfer analysis of Lumped system, Semi-infinite and infinite solids – Use of Transient-Temperature charts - Applications of numerical techniques.

UNIT 2 CONVECTIVE HEAT TRANSFER 9 Hrs.

Introduction-Forced convection-Development of velocity and thermal boundary layer by a flow on a vertical flat plate – Laminar and turbulent convective heat transfer analysis in flows over a flat plate, circular pipe and spherical surface. Free convective heat transfer over vertical flat plate, cylinders and spheres – Empirical relations , applications of numerical techniques in problem solving.

UNIT 3 RADIATIVE HEAT TRANSFER 9 Hrs.

Introduction – Physical mechanism of radiation – Radiation properties – Characteristics of surfaces-Emissivity – Radiation shaper factor – Heat exchange between non-black bodies – Radiation shields.

UNIT IV HEAT EXCHANGERS 9 Hrs.

Classification of heat exchangers – Temperature distribution – Overall heat transfer coefficient – Heat exchange analysis – LMTD Method and E-NTU Method.

UNIT 5 STORING GROUP OF HETROGENOUS ELEMENTS: ARRAYS 9 Hrs.

High-Speed flow heat transfer - Heat transfer in gas turbine combustion chamber-ablative heat transfer-Aerodynamic heating – Rocket thrust chambers - Numerical treatment.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Compare the various modes of heat transfer and analyse the conduction heat transfer in various systems in both steady and unsteady state conditions

CO2 - Distinguish natural and forced convection phenomena and measure the heat transfer coefficient in external and internal fluid flow problems.

CO3 - Apply the laws of radiation, analyse the radiation exchange between surfaces and the effect of radiation shields

CO4 - Distinguish the types of heat exchangers and design the heat exchanger with LMTD and NTU approach

CO5 - Describe the principles of high speed flow heat transfer and analyse the heat transfer problems in gas turbine combustion chamber

CO6 - Describe the application of high speed flow heat transfer in aerospace components and analyse the heat transfer by numerical methods

TEXT / REFERENCE BOOKS

1. Incropera, F.P. and Dewitt, D.P., Fundamentals of Heat and Mass Transfer, 7th Edition, John Wiley, 2011.
2. Holman, J.P., Heat Transfer, 10th Edition, Tata McGraw-Hill, 2010.
3. Cengel, Y.A., Heat Transfer - A Practical Approach, 2nd Edition, McGraw-Hill, 2002.
4. Sachedva, R.C., Fundamentals of Heat and Mass Transfer, 4th Edition, New Age International, 2012
5. Desmond E. Winterbone and Ali Turan; Advanced Thermodynamics for Engineers, Elsevier Ltd, 2015
6. Bengt Sunden and Juan Fu., Heat Transfer in Aerospace Applications, Academic Press, 2016

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB1702	AIRCRAFT COMPOSITE MATERIALS AND STRUCTURES	L	T	P	EL	Credits	Total Marks
		2	0	0	3	3	100

COURSE OBJECTIVES

- To study the mechanics of composites in micro level and macro level.
- To study the plate, shell and sandwich theories of composites for various applications.
- To understand the fabrication methods and design of composite structures.

UNIT 1 MICRO MECHANICS 9 Hrs.

Basic modes of heat transfer – One dimensional steady state heat conduction – Cartesian, cylindrical and spherical coordinates – Composite medium – Critical thickness – Effect of variation of thermal conductivity – Extended surfaces. Conduction with heat generation. Unsteady state heat conduction – Heat transfer analysis of Lumped system, Semi-infinite and infinite solids – Use of Transient-Temperature charts - Applications of numerical techniques.

UNIT 2 MACRO MECHANICS 9 Hrs.

Introduction-Forced Convection-Development of velocity and thermal boundary layer by a flow on a vertical flat plate – Laminar and turbulent convective heat transfer analysis in flows over a flat plate, circular pipe and spherical surface. Free convective heat transfer over vertical flat plate, cylinders and spheres – Empirical relations , applications of numerical techniques in problem solving.

UNIT 3 LAMINATED PLATE THEORY 9 Hrs.

Introduction – Physical mechanism of radiation – Radiation properties – Characteristics of surfaces-Emissivity – Radiation shaper factor – Heat exchange between non-black bodies – Radiation shields.

UNIT 4 SANDWICH CONSTRUCTIONS 9 Hrs.

Classification of heat exchangers – Temperature distribution – Overall heat transfer coefficient – Heat exchange analysis – LMTD Method and E-NTU Method.

UNIT 5 FABRICATION PROCESS AND REPAIR METHODS 9 Hrs.

High-Speed flow heat transfer - Heat transfer in gas turbine combustion chamber-ablative heat transfer- Aerodynamic heating – Rocket thrust chambers - Numerical treatment.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Summarize the manufacturing processes of composite materials and its classification.
CO2 - Analyse the micromechanics and micromechanics behavior of composite material.
CO3 - Accumulate the failure modes of composite materials and sandwich panels.
CO4 - Determine the mid plane strain and inter laminar stress of composite material.
CO5 - Evaluate the bending and buckling of laminated beams for different boundary conditions
CO6 - Estimate the natural frequency of laminated beams and plates under in-plane loads

TEXT / REFERENCE BOOKS

1. Dam Ishai., "Mechanics of Composite Materials", 2016.
2. Autar K Kaw, 'Mechanics of Composite Materials', CRC Press, 2016.
3. Madhuji Mukhapadhyay, Mechanics of Composite Materials and Structures, University Press, 2016.
4. Agarwal, B.D., and Broutman, L.J., "Analysis and Performance of Fibre Composites," John Wiley and sons. Inc., New York, 2016.
5. Lubin, G., "Handbook on Advanced Plastics and Fibre Glass", Von Nostrand Reinhold Co., New York, 2016.
6. Calcote, LR."The Analysis of laminated Composite Structures", Von– Nostrand Reinhold Company, New York 2016.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB2701	AIRCRAFT COMPOSITE MATERIALS AND STRUCTURES	L	T	P	EL	Credits	Total Marks
		0	0	4	0	2	100

COURSE OBJECTIVES

- To familiarize with basic aircrafts composites.
- To familiarize fabrication methods composites.
- To familiarize for mechanical behavior of composites.

SUGGESTED LIST OF EXPERIMENTS

1. Fabrication of glass fiber reinforced composites.
2. Fabrication of composite using Hand layup method.
3. Determination of Mechanical properties of composite materials.
4. Determination of density and fiber matrix volume fraction of the composite.
5. Thermal analysis of composites.
6. Impact testing on the composites.
7. Moisture absorption on the Composites.
8. Hygro thermal analysis on the Composites.
9. Fabrication of Sandwich composites.
10. Failure modes of the Sandwich Composites.

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Apply the concept of hand layup and wet layup method for fabrication of Fibre reinforced composites

CO2 - Illustrate the material density and fibre matrix volume fraction and mechanical properties of composites

CO3 - Determine the impact strength of the fabricated Composite material using Charpy and Izod test

CO4 - Determine the moisture absorption and hygro-thermal analysis on the composites

CO5 - Elucidate the fabrication of sandwich composites

CO6 - Make use of the model of sandwich panel and determine the failure modes of composite aircraft Part.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

CAE: Evaluation of Regular Lab class practical and model Practical Exam 50 Marks
ESE: End Semester Practical exam 50 Marks

SAEB3001	AVIATION MANAGEMENT	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To study the operation and safety standards of civil and military aircrafts.
- To understand the duties and responsibilities of national and international regulatory bodies.
- To understand the International law regime for Airline Investment and freedoms of Air.

UNIT 1 INTRODUCTION 9 Hrs.

Introduction to Aviation Management – Aviation – Aviation Sector in India - Civil Aviation – Airport – Air Traffic Control – International Air Transport Association (IATA) – Fact Sheet –IATA at the Air Transport Industry - IATA Industrial Priorities – IATA Partners – IATA Corporate and Corporate Governance Structure – IATA Human Capital – IATA Committee's.

UNIT 2 CIVIL AVIATION AND REGULATRY AGENCIES 9 Hrs.

International Civil Aviation Organization – Aerosol Aviation Services Corporation – Aviation Management Consulting Group - AOPA – International Association of Airport Executives – Federal Aviation Interactive Reporting Systems - Inter Agency Committee for Aviation Policy – Active Level of Services Reviews – Aircraft Engineers International Affiliation.

UNIT 3 AVIATION LAW 9 Hrs.

The Distinctiveness and Content of International Aviation Law - Introduction to the Chicago Convention – The Geneva Convention (1948) - The Tokyo Convention (1963)- The Hague Convention (1970)- The Montreal Convention (1971) - The Cape Town Convention (2001), Public and Private International Aviation Law - The Freedoms of the Air - The International Law Regime for Airline Investment - The International Law Regime for Aircraft Financing.

UNIT 4 AIRCRAFT MANAGEMENT SAFETY STANDARDS 9 Hrs.

Air Safety – FAA Aviation Safety Draft Documents – Aircraft Management Interagency Committee for Aviation Policy Safety Standards – Aircraft Management Safety Standards Guidelines for Federal Flight Programmes –National Transportation Safety Board – Airline Water Supplies.

UNIT 5 GLOBAL VERSUS DOMESTIC AVIATION INDUSTRY 9 Hrs.

Overview of Contemporary Global Industry – Airline Industry Profitability – Present State of the Air Transport Industry – Aviation Industry – Global Aviation Industry – Indian Aviation- Case Studies

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Know the history of aviation and its developments.
CO2 - Understand the growth of Indian aviation sector and globalization.
CO3 - Distinguish the public and private International Aviation Law.
CO4 - Understand the safety standards followed by aviation industries for safety.
CO5 - Understand the profitability, financing and leasing in aviation.
CO6 - Analyze the present state of the Air Transport Industry in India.

TEXTS / REFERENCE BOOKS

1. Ratandeep Singh, “Aviation Management”, Kanishka Publishers, 2012.
2. “Aircraft Manual – Volume 1 and Volume 2”, Sterling Book House.
3. Kathleen M. Sweet, “Aviation and Airport Security”, Pearson Education, 2011.
4. “Aircraft Manual – Volume 1 and Volume 2”, Sterling Book House, 2010.
5. Senguttuvan P.S, “Fundamentals of Air Transport Management”, Excel Books, First Edition 2006.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB3002	AIRFRAME MAINTENANCE AND REPAIR PRACTICES	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To make the students to understand the Airframe components and the tools used to maintain the components. Defect investigation, methods to carry out investigation and the detailed maintenance and practice procedures.

UNIT 1 SAFETY PRACTICES 9 Hrs.

Safety – Importance of Flight Safety, Maintenance of Ground Support Equipments, refueling, de-refueling, fire equipments, Hazardous materials storage and handling, Environmental and shop cleanliness – precautions, Aircraft furnishing -practices, Equipments, Hazard zones.

UNIT 2 REVIEW OF HYDRAULIC AND PNEUMATIC SYSTEM 9 Hrs.

Trouble shooting theory and Procedure, Inspection and maintenance of Hydraulic, Pneumatic, Fuel, Landing gear, Inspection and maintenance of Air conditioning, Pressurization systems Oxygen, De-icing, Fire Protection Installation and maintenance of instruments – Handling - Testing – Inspection, Position and warning system Auxiliary Power Units (APUs).

UNIT 3 AIRCRAFT JACKING, ASSEMBLY AND RIGGING 9 Hrs.

Airplane, Jacking and Weighing and C.G. Location .Rigging of control surfaces – Inspection, maintenance. Helicopter flight controls, Tracking and balancing of main rotor.

UNIT 4 MAINTENANCE OF AIRCRAFT STRUCTURALCOMPONENTS 9 Hrs.

Equipments Used In Welding Shop And Their Maintenance – Ensuring Quality Welds – Welding Jigs And Fixtures – Soldering And Brazing – Laser Welding. Sheet Metal Repair And Maintenance: Selection Of Materials; Repair Schemes; Fabrication Of Replacement Patches; Tools – Power/Hand; Repair Techniques; Peening – Close Tolerance Fasteners; Sealing Compounds; Forming/Shaping; Calculation Of Weight Of Completed Repair; Effect Of Weight – Change On Surrounding Structure. Sheet Metal Inspection – N.D.T. Testing. Riveted Repair Design – Damage Investigation – Reverse Engineering.

UNIT 5 PLASTICS AND COMPOSITES IN AIRCRAFT 9 Hrs.

Review of Types of Plastics Used In Airplanes – Maintenance And Repair of Plastic Components – Repair of Cracks, Holes Etc., Various Repairs Schemes – Scopes. Cleaning of Fibre Reinforced Plastic (FRP) Materials Prior To Repair; Break Test – Repair Schemes; FRP/Honeycomb Sandwich Materials; Laminated FRP Structural Members And Skin Panels; Tools/Equipment; Vacuum-Bag Process. Special Precautions – Autoclaves.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understanding importance of Flight Safety, Maintenance of Aircraft Equipments.
CO2 - Understanding Hydraulic and pneumatic system.
CO3 - Understanding Aircraft Jacking, Assembling and Rigging procedures.
CO4 - Understanding the maintenance of Aircraft structural components.
CO5 - Analysis of plastic and composite materials used in aircraft.
CO6 - Familiarize in handling the composite material repair works.

TEXTS / REFERENCE BOOKS

1. Larry Reithmeir, Aircraft Repair Manual – Palamar Books, Marquette, 2012.
2. Brimm D.J.Bogges H.E., Aircraft Maintenance – Pitman Publishing Corp. New York, 2011.
3. Howard Curtis, Antonio Fillippone, Aerospace Engineering Reference, Butterworth – Heinmann, 2012.
4. Micheal .J. Kroes, James .R. Rardon, Aircraft : Basic Science with Student Study Guide, McGraw Hill, 2011.
5. Delp. Bent and Mckinely "Aircraft Maintenance Repair", McGraw Hill, New York, 1987.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB3003	AIRPORT ENGINEERING	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To expose the students to Airport planning and design principles of Airports.

UNIT 1 AIRPORT PLANNING **9 Hrs.**

Air transport characteristics-airport classification-air port planning: objectives, components, layout characteristics, socio- economic characteristics of the Catchment area, criteria for airport site selection and ICAO stipulations, Typical airport layouts, Case studies, Parking and circulation area.

UNIT 2 AIRPORT DESIGN **9 Hrs.**

Runway Design: Orientation, Wind Rose Diagram – Runway length – Problems on basic and Actual Length, Geometric design of runways, Elements of Taxiway Design – Airport Zones – Passenger Facilities and Services.

UNIT 3 DESIGN OF AERODROME PAVEMENT **9 Hrs.**

Procedure for pavement design (Aircraft Classification Number (ACN) - Pavement Classification Number (PCN) method), Elements of pavement Evaluation, USA practices: design of flexible and rigid pavements, design examples (FAA method, FAAR FIELD method).

UNIT 4 DESIGN OF VISUAL AIDS **9 Hrs.**

Operational factors, operating approach slope marking, visual indicators system (T- VASIS, PAPI), runway and taxiway lighting, surface movement guidance and control requirements, additional marking of pavement shoulders, apron marking, taxiway edge system, Signs, Frangibility.

UNIT 5 SAFETY MANAGEMENT SYSTEM **9 Hrs.**

Introduction to State Safety Program - Introduction to Safety Management System. Airport drainage: Purpose, determination run-off (FAA method), typical drainage layout, sub-surface drainage.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - procedure of Airport planning.
CO2 - Airport design procedures.
CO3 - Design of aerodrome pavement procedures
CO4 - Design of visual aids procedures.
CO5 - Safety Management System.
CO6 - Precaution and Warning Systems.

TEXTS / REFERENCE BOOKS

1. Rangwala, “Airport Engineering”, Charotar Publishing House, 2013.
2. Ashford N. and Wright P.H., Airport Engineering, John Wiley and Sons Inc., New York.
3. Horonjeff R and Mackelvey F.X., Planning and Design of Airports, 4th Intl. Edition, McGraw Hill Book Co., New Delhi.
4. Dr. S. K. Khanna, M.G.Arora and S.S. Jain, Airport Planning & Design, Nem Chand & Bros., Roorkee, 2010.
5. G.V. Rao Airport Engineering, Tata McGraw Hill Pub. Co., New Delhi 2008.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB3004	HELICOPTER MAINTENANCE	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To make the students to understand the Helicopter components and the tools used to maintain the components.
- To know the Defect investigation and to learn the methods to carry out investigation.
- To carry out the detailed maintenance and practice procedures.

UNIT 1 HELICOPTER FUNDAMENTALS 9 Hrs.

Basic fundamentals of Helicopter working and the directions, Basics of Ground handling of helicopters, Working principles and Applications of bearings and Gears, The construction of fuselage and tail boom used in helicopter.

UNIT 2 MAIN ROTOR SYSTEM 9 Hrs.

Head maintenance, blade alignment, rotor balance, Vibration, Tracking, Blade sweeping, Dampener maintenance, Counter weight adjustment & Auto rotation adjustments, Flight-Control Rotor– Stabilizer, dampeners – Swash plate flight control systems, Collective –– Bell cranks – Mixer box – Gradient unit control boosts – Maintenance & Inspection control rigging.

UNIT 3 MAIN ROTOR TRANSMISSIONS 9 Hrs.

Engine transmission coupling – Drive shaft – Maintenance clutch – Freewheeling units –Spray clutch – Roller unit – Torque meter – Rotor brake – Maintenance of components – vibrations and monitoring systems- Mounting systems – Transmissions.

UNIT 4 POWER PLANTS AND TAIL ROTORS 9 Hrs.

Fixed wing power plant modifications – Installation – Different type of power plant maintenance. Tail rotor system – Servicing tail rotor track – System rigging.

UNIT 5 AIRFRAMES AND RELATED SYSTEMS 9 Hrs.

Fuselage maintenance – Airframe Systems – Special equipment, types of under carriages and their operations.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - the basic concepts of Helicopter components.
CO2 - Recognize various the tools used to maintain the components.
CO3 - Understanding the methods to carry out various Defect investigations.
CO4 - Carry out the detailed maintenance.
CO5 - Understanding the power plant and tail rotors.
CO6 - Understanding the airframe systems and the special equipment.

TEXTS / REFERENCE BOOKS

1. Serope Kalpakjian, Steven R. Schmid, Manufacturing Engineering and Technology, Pearson Education, 2014.
2. P.C. Sharma, “A Text Book of Production Technology”, S.Chand and Co. Ltd., New Delhi,2010.
3. B.H.Amstead, Phillip F.Ostwald, L.Begemon, “Manufacturing Processes”, John Wiley 36 and Sons, 8th Edition, 1998.
4. De Garmo, “Materials and Processes in Manufacturing”, Prentice Hall of India, 8th Edition, 2008.
5. P.N.Rao, “Manufacturing Technology – I and II”, Tata McGraw Hill Publishing Co., New Delhi – 2013.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB3005	AIRCRAFT ENGINE MAINTENANCE AND REPAIR	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To make the students to understand the Airframe components and the tools used to maintain the components. Defect investigation, methods to carry out investigation and the detailed maintenance and practice procedures.
- To make the students to familiarize with the Aircraft engine maintenance procedure and practice.
- To acquire knowledge of basics of Aeronautics and engine components.
- To learn the concepts of Piston engines

UNIT 1 PISTON ENGINES 9 Hrs.

Carburation and Fuel injection systems for small and large engines - Ignition system components - spark plug detail - Engine operating conditions at various altitudes – Engine power measurements – Classification of engine lubricants and fuels – Induction, Exhaust and cooling system - Maintenance and inspection check to be carried out. Inspection and maintenance and troubleshooting - Inspection of all engine components - Daily and routine checks - Overhaul procedures - Compression testing of cylinders- Special inspection schedules - Engine fuel, control and exhaust systems - Engine mount and super charger - Checks and inspection procedures.

UNIT 2 PROPELLERS 9 Hrs.

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

UNIT 3 JET ENGINES 9 Hrs.

Types of jet engines – Fundamental principles – Bearings and seals - Inlets – compressors turbines- exhaust section – classification and types of lubrication and fuels- Materials used – Details of control, starting around running and operating procedures – Inspection and Maintenance-permissible limits of damage and repair criteria of engine components- internal inspection of engines- compressor washing- field balancing of compressor fans- Component maintenance procedures - Systems maintenance procedures - use of instruments for online maintenance - Special inspection procedures-Foreign Object Damage - Blade damage.

UNIT 4 TESTING AND INSPECTION 9 Hrs.

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

UNIT 5 OVERHAULING 9 Hrs.

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

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Apply maintenance procedure to Aircraft Engines
CO2 - Identify the engine components and faults
CO3 - Apply non-destructive testing procedures to identify the defects
CO4 - Apply overhauling procedure to new engines
CO5 - Apply the compression testing of cylinders
CO6 - Apply the procedures on aircraft jet engines and repair

TEXTS / REFERENCE BOOKS

1. Kroes & Wild, "Aircraft Power plants ", 7th Edition - McGraw Hill, New York, 1994.
2. Turbomeca, “Gas Turbine Engines ", The English Book Store ", New Delhi, 1993.
3. United Technologies’ Pratt & Whitney, "The Aircraft Gas Turbine Engine and its Operation”, The English Book Store, New Delhi.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 marks**

SAEB3006	FATIGUE TESTING OF AIRCRAFT STRUCTURES	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To learn about mathematical and principles of facture mechanics
- To impart the knowledge about the fundamental source of failure of mechanical components.
- To make students understand the fatigue design curve approaches and limitations
- To make the students learn the characterization of variables in cyclic loads.
- To expand student's knowledge on testing of the material for the fatigue failure

UNIT 1 FATIGUE OF STRUCTURES 9 Hrs.

S.N. curves - Endurance limits - Effect of mean stress, Goodman, Gerber and Soderberg relations and diagrams - Notches and stress concentrations - Neuber's stress concentration factors - Plastic stress concentration factors - Notched S.N. curves – Fatigue of composite materials.

UNIT 2 STATISTICAL ASPECTS OF FATIGUE BEHAVIOUR 9 Hrs.

Low cycle and high cycle fatigue - Coffin - Manson's relation - Transition life - cyclic strain hardening and softening - Analysis of load histories - Cycle counting techniques -Cumulative damage - Miner's theory - Other theories.

UNIT 3 PHYSICAL ASPECTS OF FATIGUE 9 Hrs.

Phase in fatigue life - Crack initiation - Crack growth - Final Fracture - Dislocations - fatigue fracture surfaces.

UNIT 4 FRACTURE MECHANICS 9 Hrs.

Strength of cracked bodies - Potential energy and surface energy - Griffith's theory - Irwin - Orwin extension of Griffith's theory to ductile materials - stress analysis of "cracked bodies - Effect of thickness on fracture toughness" - stress intensity factors for typical 'geometries.

UNIT 5 FATIGUE DESIGN AND TESTING 9 Hrs.

Safe life and Fail-safe design philosophies - Importance of Fracture Mechanics in aerospace structures - Application to composite materials and structures.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Apply the mathematical knowledge to define fatigue behaviors of the materials
CO2 - Identify the causes for the fatigue failure of the materials.
CO3 - Ability to analyse the fracture due to fatigue
CO4 - Select the testing method for the fatigue failure prediction of the materials.
CO5 - Solve the causes of the crack initiation & its growth.
CO6 - Select the materials with ability to with damage tolerant structures

TEXTS / REFERENCE BOOKS

1. Barrois W, Ripely, E.L., “Fatigue of aircraft structure," Pergamon press. Oxford, 1983.
2. Prasanth Kumar, "Elements of fracture mechanics", Wheeter publication, 1999.
3. Kare Hellan ,’Introduction to Fracture Mechanics’, McGraw Hill, Singapore,1985
4. Knott, J.F., “Fundamentals of Fracture Mechanics,” - Buterworth & Co., Ltd., London, 1983.
5. Sih C.G., “Mechanics of fracture.” Vol - I, Sijthoff and w Noordhoff International Publishing Co., Netherlands, 1989.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB3007	ORBITAL MECHANICS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To understand the concepts of satellite injection.
- To evaluate the satellite perturbations, trajectory computation.
- To know the basic functions of travel and flight of ballistic missiles.
- To discuss the stages of separation.

UNIT 1 BASIC CONCEPTS 9 Hrs.

The solar system -Reference frames and coordinate systems –The celestial sphere -The ecliptic - Motion of vernal equinox – Sidereal time-Solar time-Standard time-The earth's atmosphere. Types of orbit.

UNIT 2 THE GENERAL N-BODY PROBLEM 9 Hrs.

The Many body problem - Lagrange - Jacobi identity - The circular restricted three body problem – Libration points-Relative Motion in the N-body problem-The two-body problem-Satellite orbits - Relations between position and time-Orbital elements.

UNIT 3 SATELLITE INJECTION AND SATELLITE ORBIT PERTURBATIONS 9 Hrs.

General aspects of satellite injections-Satellite orbit transfer-Various cases-Orbit deviations due to injection errors-Special and general perturbations-Cowell's Method - Encke's method – Method of variations of orbital elements General perturbations approach.

UNIT 4 INTERPLANETARY TRAJECTORIES BALLISTIC MISSILE -TRAJECTORIES 9 Hrs.

Two-dimensional inter planetary trajectories –Fast interplanetary trajectories –Three dimensional interplanetary trajectories- Launch of interplanetary spacecraft –Trajectory about the target planet. The boost phase-The ballistic phase -Trajectory geometry -Optimal flights -Time of flight-Re-entry phase – The position of the impact point Influence coefficients.

UNIT 5 MATERIALS FOR SPACE CRAFT 9 Hrs.

Space environment-Peculiarities -Effect of space environment on the selection of materials of spacecraft.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Study the basic concepts of orbits and its types.
CO2 - Understand the satellite perturbations, trajectory computation.
CO3 - Understand the importance of missile performance.
CO4 - Understand the properties control system.
CO5 - Analyze the trajectory calculations and materials.
CO6 - Distinguish the basics of fluid statics and fluid dynamics for propulsion.

TEXTS / REFERENCES BOOKS

1. George .P.Sutton , Oscar Biblarz “Rocket Propulsion Elements”, Wiley Publishers 8th Edition, 2010.
2. J.ohn H. Blakelock, “Automatic control of aircraft and missiles”, 2nd Edition, Wiley Publishers, 2011.
3. George.M.Siouris “Missile guidance and control systems", Springer 2nd Edition, 2004.
4. Tactical and Strategic Missile Guidance, 5th Edition, Paul Zarchan, Progress in Astronautics and Aeronautics, AIAA, 2007, ISBN-10: 1-56347-874-9.
5. Missile Guidance and Control Systems, George M. Siouris, Springer-Verlag, 2004, ISBN: 0-387-00726.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB3008	MISSILE GUIDANCE NAVIGATION AND CONTROL	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To understand the advanced concepts of missile systems, missile airframes, autopilots, guidance laws.
- To find the key drivers in the missile guidance design and system engineering process.
- To explain the critical trade-offs, methods, and technologies in missile guidance sizing.

UNIT 1 INTRODUCTION TO MISSILE SYSTEMS 9 Hrs.

History of guided missile for defence applications- Classification of missiles– Generalized Missile Equations of Motion- Coordinate Systems- Lagrange's Equations for Rotating Coordinate Systems- Rigid-Body Equations of Motion-missile system elements, missile ground systems.

UNIT 2 MISSILE AIRFRAMES, AUTOPILOTS AND CONTROL 9 Hrs.

Missile aerodynamics- Force Equations, Moment Equations, Phases of missile flight. Missile control configurations. Missile Mathematical Model. Autopilots — Definitions, Types of Autopilots, Example Applications. Open-loop autopilots. Inertial instruments and feedback. Autopilot response, stability, and agility- Pitch Autopilot Design, Pitch-Yaw-Roll Autopilot Design.

UNIT 3 MISSILE GUIDANCE LAWS 9 Hrs.

Tactical Guidance Intercept Techniques, Derivation of the Fundamental Guidance Equations, explicit, Proportional Navigation, Augmented Proportional Navigation, beam riding, bank to turn missile guidance, Three-Dimensional Proportional Navigation, comparison of guidance system performance, Application of Optimal Control of Linear Feedback Systems.

UNIT 4 STRATEGIC MISSILES 9 Hrs.

Introduction, Two-Body Problem, Lambert's Theorem, First-Order Motion of a Ballistic Missile, Correlated Velocity and Velocity-to-Be-Gained Concepts, Derivation of the Force Equation for Ballistic Missiles, Atmospheric Re-entry, Ballistic Missile Intercept, Missile Tracking Equations of Motion, Introduction to Cruise Missiles, Terrain-Contour Matching (TERCOM) Concept.

UNIT 5 WEAPON DELIVERY SYSTEMS 9 Hrs.

Weapon Delivery Requirements, Factors Influencing Weapon Delivery Accuracy, Unguided Weapons, Bombing Problem, Guided Weapons, Integrated Flight Control in Weapon Delivery, Missile Launch Envelope, Mathematical Considerations Pertaining to the Accuracy of Weapon Delivery Computations.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the advanced concepts of missile guidance and control to the engineers.

CO2 - Provide the necessary mathematical knowledge that are needed in understanding the physical processes.

CO3 - Have an exposure on various topics such as missile systems, missile airframes, autopilots, guidance laws and will be able to deploy these skills effectively in the understanding of missile guidance and control

CO4 - Develop linear guidance, control, and navigation laws.

CO5 - Analyse performance of the integrated guidance and navigation controller.

CO6 - Illustrate the targeting system, launch platform, and-missile guidance integration.

TEXTS / REFERENCESBOOKS

1. Blakelock, J. H., “Automatic Control of Aircraft and Missiles”, 2nd Ed., John Wiley & Sons, 1990.
2. Fleeman, Eugene L., “Tactical Missile Design”, First Ed., AIAA Education series, 2001.
3. Siouris, G.M., "Missile Guidance and control systems", Springer, 2003.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB3009	COMPUTATIONAL FLUID DYNAMICS FOR AEROSPACE APPLICATION	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To understand the concepts of fluid dynamics computationally.
- To evaluate the characteristics of flows.
- To know the basic methods of various computational methods.
- To discuss the structural grid generation and turbulence models.

UNIT 1 INTRODUCTION 9 Hrs.

Historical Background-of Computations - Classification of Partial Differential Equations- Introduction to Navier-Stokes System of Equations. Comparison of numerical, analytical and experimental.

UNIT 2 FINITE DIFFERENCE METHODS AND SOLUTIONS 9 Hrs.

Finite Difference Methods-Finite Element Methods - Finite Volume Methods, Neumann Boundary Conditions, Dirichlet Boundary Conditions Burgers' Equation- Coordinate Transformation for Arbitrary Geometries.

UNIT 3 INCOMPRESSIBLE VISCOUS FLOWS AND COMPRESSIBLE FLOWS 9 Hrs.

Pressure Correction Methods -Semi-Implicit Method for Pressure-Linked Equations -Pressure Implicit with Splitting of Operators -Marker-and-Cell (MAC) Method.

UNIT 4 STRUCTURED AND UNSTRUCTURED GRID GENERATION 9 Hrs.

Grid Generation: Introduction, Types of grid, Factors affecting the grid, Grid transformation, Prandtl-Mayer expansion waves, Stretched grids. : Numerical grid generation; basic ideas; transformation and mapping.

UNIT 5 COMPUTING TECHNIQUES AND APPLICATION 9 Hrs.

Domain Decomposition Methods- Multigrid Methods- Parallel Processing- Turbulence Models- Zero-Equation Models- One- Equation Models -Two-Equation Models -Second Order Closure Models (Reynolds Stress Models) - Algebraic Reynolds Stress Models -Compressibility Effects- Direct Numerical Simulation- RANS- LES.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Apply Partial Differential equation, Navier stokes system of equation for Aerospace applications

CO2 - Apply the Finite Difference Methods, Finite Element Methods, Finite Volume Methods, Neumann Boundary Conditions, Dirichlet Boundary Conditions Burgers' Equation, Coordinate Transformation for Arbitrary Geometries.

CO3 - Derive the Incompressible Viscous flows and Compressible flows for aerospace applications

CO4 - Analyse the Structured and Unstructured Grid generation, transformation and Mapping

CO5 - Apply the Domain Decomposition Methods and Multigrid Methods for Turbulence Models, Zero-Equation Models, One-Equation Models and Two-Equation Models

CO6 - Apply the Domain Decomposition Methods and Multigrid Methods for Second Order Closure Models, Algebraic Reynolds Stress.

TEXTS / REFERENCE BOOKS

1. Chung T.J Computational fluid dynamics, second edition –Cambridge University press USA, 2016.
2. Suhas V Patankar,"Numerical Heat Transfer and Fluid Flow", Taylor and Francis, 2016.
3. Principles of Computational Fluid Dynamics by P. Wesseling., 2016.
4. Shaw C T, "Using Computational Fluid Dynamics" Prentice Hall, 2016.
5. Anderson.J.D.Jr. "Computational Fluid Dynamics: An Introduction", 3rd Edition, 2016.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB3010	AEROSPACE VEHICLE DESIGN	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To compute and analyse the various forces and moments acting on a rocket.
- To formulate the equations of motions for flight and separation phases.
- To understand the combustion and propulsion systems in rocket.
- To select suitable materials for the rockets and launch vehicles.

UNIT 1 ROCKET DYNAMICS 9 Hrs.

Classification of launch vehicles and missiles – Rocket systems – Airframe components – Forces and moments acting on a rocket – Propulsion, aerodynamics, gravity – inertial and non-inertial frames – coordinate transformation – Equations of motion for three-dimensional motion through atmosphere and vacuum – numerical problems.

UNIT 2 SOLID PROPULSION AND PYROTECHNICS 9 Hrs.

Solid propellant rockets – classification – components and their design considerations – propellant grain design – grain mechanical properties – ballistics and burn rate design issues – igniter design – pyrotechnic devices and systems – classification – mechanisms and application of pyrotechnic devices in rockets and launch vehicles – Design problems in rocket systems.

UNIT 3 LIQUID PROPULSION AND CONTROL SYSTEMS 9 Hrs.

Liquid propellant rockets – classification and components – thrust chamber, feed systems, propellant tanks, turbo-pumps, types of valves and applications – their design considerations – Different bipropellant systems like cryogenics and their characteristics – pogo and slosh engine gimbal systems and thrusters for control – Thrust control systems – Design problems.

UNIT 4 MULTI-STAGING OF ROCKET AND SEPARATION DYNAMICS 9 Hrs.

Navigation and guidance systems in rockets and launch vehicles – aerodynamic control systems of launch vehicles – multi-staging of rockets – vehicle optimization techniques – stage separation system – dynamics, separation techniques – rocket flight dispersion, numerical problems.

UNIT 5 DESIGN, MATERIALS AND TESTING OF ROCKETS 9 Hrs.

Design requirements and selection – performance evaluation and assessment – space environment on the selection of materials for rockets and spacecraft – material selection for specific requirements – advance materials-super alloys and composite materials – Qualification of rocket and missile systems – types of testing and evaluation of design and function.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Learn about the different systems of rockets and launch vehicles, formulation of the equation of motion and about the advanced rockets for future missions.

CO2 - Understand the function of the solid propellant propulsion and pyrotechnic systems and the design principles.

CO3 - Understand the function of the liquid propellant propulsion and control systems and the design principles.

CO4 - Formulate the equation of motions for a mission and spent stage separation dynamics, understanding the principles of navigation, guidance and control of rockets and launch vehicles, and design of a multistage rocket.

CO5 - Understand the system design, construction, function, performance and testing aspects. and to familiarize with the selection of suitable materials for different rocket systems.

CO6 - Understand the design, performance and testing aspects.

TEXTS / REFERENCE BOOKS

1. Cornelisse, J. W., “Rocket Propulsion and Spaceflight Dynamics”, Pitman, London, 1982.
2. Ramamurthi K., “Rocket Propulsion”, Macmillan Publishers India first Ed., 2010.
3. Sutton, G.P., “Rocket Propulsion Elements”, Wiley, New York, 9th Ed., 2017.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB3011	AEROSPACE INSTRUMENTATION AND SENSORS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To provide an overview of the different types of sensors and instruments flown on spacecraft.
- To provide students with an appreciation and understanding of the development of the design processes involved for different instruments.

UNIT 1 INTRODUCTION 9 Hrs.

Scientific Background – Parameters to be observed – Sensing platforms (rocket engine, satellites) – introduction to various sensors and instrumentation needed for satellite mission function

UNIT 2 MEASUREMENTS OF CHARGED AND NEUTRAL PARTICLES 9 Hrs.

Pulse and Current modes – Pulse height spectra and analysis – Counting curves and plateaus – Energy resolution - Detector efficiency – Dead time – Analysers: Electrostatic, Magnetic-field, Time-of-flight – Detectors: Solid state, Scintillation counters, Electron multipliers – Actual instruments – Analog or pulse height spectroscopy electronics – Digital techniques – Impact of microprocessors on inflight data processing units – Power supplies – Neutral particle imagers.

UNIT 3 MEASUREMENT OF MAGNETIC AND ELECTRIC FIELDS 9 Hrs.

Fluxgate magnetometer – Search coil magnetometer – Optical absorption magnetometer. Electric Fields: Double probe technique – Beam experiments – Observation of electric fields parallel to the magnetic field.

UNIT 4 PHOTON COUNTING SENSORS AND IMAGERS 9 Hrs.

Auroral imagers: Optical, UV, X-ray – X-ray sensors and imagers - Detection techniques, Grazingincidence optics – Charged Coupled Devices – Other imaging techniques – tomography.

UNIT 5 SPACECRAFT SYSTEMS AND SATELLITE ORBITS 9 Hrs.

Subsystems – Testing and Qualifications – Trade-offs – Role of orbit to investigation – Unusual orbital techniques: L1 orbit, double lunar swing-by.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Explains how mathematics, physics, and engineering-based concepts are used to develop and design a sensor which complies with a set of specific requirements.

CO2 - Discusses essential topics such as cost estimation, signal processing, noise reduction, filters, phased arrays, radars, optics, and radiometers used in space operation.

CO3 - Covers a range of typical sensors used in the spacecraft industry such as infrared,

CO4 - Interpret the passive microwave, radars and space-based GPS sensors.

CO5 - Spacecraft Sensors is an invaluable resource for engineers, technical consultants, those in the business division, and research scientists associated with spacecraft projects.

CO6 - Explain, how the sensors and instruments interface with the spacecraft platform.

TEXTS / REFERENCES BOOKS

1. Abid, Mohamed M., “Spacecraft Sensors”, Chichester, England; Hoboken, NJ: J. Wiley, 2005.
2. Kohichiro Oyama, Chio-Zong Cheng, “An introduction to space instrumentation”, Tokyo, Japan: Terrapub, 2013.
3. Yuri Surkov, “Exploration of Terrestrial Planets from Spacecraft: Instrumentation, Investigation, Interpretation”, Wiley-Praxis Series in Astronomy & Astrophysics, Ellis Horwood Ltd, 2nd Ed., 1990.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB3012	SMART MATERIALS FOR AEROSPACE STRUCTURES	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To familiarize with the fundamentals of structural health monitoring.
- To impart knowledge in the areas of Vibration based techniques in structural health monitoring, fibre optics and Piezo electric sensors.
- To familiarize with the fundamentals of fabrication, modelling, analysis, and design of smart materials and structures.

UNIT 1 OVERVIEW AND INTRODUCTION 9 Hrs.

Piezoelectric Material Crystal Structure – Fundamentals of Piezoelectricity – Shape Memory Alloys – Fundamentals of Shape Memory Alloy (SMA) Behavior – Phase Transformation – Lattice Structure and Deformation Mechanism – Electrostrictive Material Systems – ER and MR Fluids – Current Application – Aerospace Field – Machine Tools – Automotive Systems – Medical Systems – Electronics Equipment – Robots – Energy Harvesting Using Smart Materials.

UNIT 2 PIEZOELECTRIC THEORY 9 Hrs.

Electromechanical Constitutive Equations – Piezo ceramic Actuator & Sensor Equations – Piezoelectric Coupling Coefficients – Actuator Performance and Load Line Analysis – Hysteresis and Nonlinearities in Piezoelectric Materials – Piezo ceramic Actuators – Behavior under Static & Dynamic Excitation Fields – Depoling Behavior and Dielectric Breakdown – Curie Temperature – Power Consumption – Equivalent Circuits to Model Piezo ceramic Actuators – The Bimorph Sensor.

UNIT 3 BEAM MODELLING WITH PIEZOELECTRIC MATERIAL 9 Hrs.

Basic Definitions of Stress, Strains and Displacements in Beams – Transverse Deflection of Uniform Isotropic Beams – Simple Blocked Force Beam Model (Pin Force Model) – Single Actuator Characteristics – Dual Actuators – Symmetric & Asymmetric Actuation with Differential Voltages – Uniform Strain Model – Euler-Bernoulli Beam Model – Dissimilar Actuators – Embedded Actuators – Testing of a Beam with Surface Mounted Piezoactuators.

UNIT 4 UNDERSTANDING SHAPE MEMORY ALLOYS (SMA) 9 Hrs.

Low Temperature Stress-Strain Curve – Origin of the One-Way Shape Memory Effect – Stress Induced Martensite and Pseudoelasticity – Two-Way Shape Memory Effect – All-Round Shape Memory Effect – R-Phase Transformation – Porous SMA – Constrained Behavior of SMA – Free Recovery – Constrained Recovery – Effective Load-Lines of an SMA Wire Actuator – Sample Preparation – Transformation Temperatures under Zero Stress.

UNIT 5 CONSTITUTIVE MODELLING AND SMA BEHAVIOUR 9 Hrs.

Tanaka Model – Liang and Rogers Model – Brinson Model – Testing of SMA Wires –Variation of Transformation Temperatures with Stress – Stress-Strain Behavior at Constant Temperature – Stress-Temperature Behavior at Constant Strain – Heat Absorbed by the SMA Wire – Thermomechanical Energy Equilibrium Power Requirements for SMA Activation – Resistance Behavior of SMA Wires – Heat Dissipation – SMA Wire Damping Capacity.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Classify the various forms of functional materials.
CO2 - Investigate the Piezoelectric material behavior.
CO3 - Investigate the behavior of SMA material.
CO4 - Model a beam with Piezoelectric patch.
CO5 - Impart knowledge on modelling of SMA material.
CO6 - Familiarize with artificial neural networks and image processing

TEXTS / REFERENCE BOOKS

1. Inderjit Chopra and Jayant Sirohi,' Smart Structures Theory', Cambridge University Press, 2014.
2. Martin, J.W., Engineering Materials, Their properties and Applications, Wykedham Publications (London) Ltd., 1987.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB3013	INDUSTRIAL AERODYNAMICS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To understand the concepts of industrial aerodynamics.
- To evaluate the performance of industrial aerodynamics in International standard atmosphere.
- To familiarize the learner with non-aeronautical uses of aerodynamics such as road vehicle building aerodynamics and problems of flow induced vibrations.
- To know the basic functions of vehicle aerodynamics.

UNIT 1 ATMOSPHERE 9 Hrs.

Types of winds, Causes of variation of winds, Atmospheric boundary layer, Effect of terrain on gradient height, Structure of turbulent flows. Roughness parameters, simulation techniques in wind tunnels.

UNIT 2 WIND ENERGY COLLECTORS 9 Hrs.

Horizontal and vertical axis machines, energy density of different rotors, Power Coefficient, Betz coefficient by momentum theory.

UNIT 3 VEHICLE AERODYNAMICS 9 Hrs.

Boundary layers and separation, two dimensional wake and vortex formation Strouhal and Reynolds numbers, Separation and reattachments, Power requirements and drag coefficients of automobiles, Effects of cut back angle, aerodynamics of trains and Hovercraft.

UNIT 4 BUILDING AERODYNAMICS 9 Hrs.

Pressure distribution on low rise buildings, wind forces on buildings, Environmental winds in city blocks, special problems of tall buildings, building codes, ventilation and architectural aerodynamics.

UNIT 5 FLOW INDUCED VIBRATIONS 9 Hrs.

Vortex shedding, lock & effects of Reynolds number on wake formation in turbulent flows across wind Galloping Wake galloping-along wind galloping of circular cables-oscillation of tall structures and launch vehicles under Wind loads-stall flutter.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Recall history and evolution of industrial and vehicle aerodynamics.
CO2 - Compare the industrial aerodynamics with variations of earth atmospheric properties.
CO3 - Understand the working of principle of vehicle aerodynamics.
CO4 - Recognize the functions of industrial aerodynamics elements.
CO5 - Analyze the application of vehicle aerodynamics problems.
CO6 - Distinguish the basics of methods to solve building aerodynamics.

TEXT / REFERENCE BOOKS

1. Rose Mccallen, Fred Browand, James Rose, “The aerodynamics of heavy vehicle- Trucks, buses and trains” Springer Berlin Heidelperg , Newyork, 2010.
2. Sovran, M(ed), “Aerodynamic drag mechanism of bluff bodies and road vehicles”, Plenum Press, N.Y, 2011.
3. Calvert N.G, “Wind Power Principles”, Charles Griffin & Co London, 2010.
4. M.Sovran (Ed), “Aerodynamics and drag mechanisms of bluff bodies and Road vehicles”, Plenum press, New York, 1978.
5. Sachs. P., “Winds forces in Engineering”, Pergamon Press, 1978.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB3014	HYPERSONIC AERODYNAMICS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To learn basics of hypersonic flow, shock wave, boundary layer interaction and aerodynamic heating.
- To extend the surface inclination methods for hypersonic inviscid flows.
- To explain the approximate methods for inviscid hypersonic flows.

UNIT 1 BASICS OF HYPERSONIC AERODYNAMICS 9 Hrs.

Thin shock layers – entropy layers – low density and high-density flows – hypersonic flight paths – hypersonic flight similarity parameters – shock wave and expansion wave relations of inviscid hypersonic flows.

UNIT 2 SURFACE INCLINATION METHODS FOR HYPERSONIC INVISCID FLOWS 9 Hrs.

Local surface inclination methods – modified Newtonian Law – Newtonian theory – tangent wedge or tangent cone and shock expansion methods – Calculation of surface flow properties.

UNIT 3 APPROXIMATE METHODS FOR INVISCID HYPERSONIC FLOWS 9 Hrs.

Approximate methods – hypersonic small disturbance equation and theory – thin shock layer theory – blast wave theory – entropy effects – rotational method of characteristics – hypersonic shock wave, shapes and correlations.

UNIT 4 VISCOUS HYPERSONIC FLOW THEORY 9 Hrs.

Navier-Stokes equations – boundary layer equations for hypersonic flow – hypersonic boundary layer – hypersonic boundary layer theory and non-similar hypersonic boundary layers – hypersonic aerodynamic heating and entropy layers effects on aerodynamic heating – heat flux estimation.

UNIT 5 VISCOUS INTERACTIONS IN HYPERSONIC FLOWS 9 Hrs.

Strong and weak viscous interactions – hypersonic shockwaves and boundary layer interactions – Estimation of hypersonic boundary layer transition – Role of similarity parameter for laminar viscous interactions in hypersonic viscous flow

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Explain shock wave and expansion wave relations of inviscid hypersonic flows
CO2 - Explain the solution methods for hypersonic inviscid flows
CO3 - Analyze the hypersonic boundary layers
CO4 - Explain the viscous interaction in hypersonic flows
CO5 - Analyze chemical and temperature effects in hypersonic flow.
CO6 - Understand the viscous interactions in hypersonic viscous flow

TEXT / REFERENCE BOOKS

1. AndersonJ. D., “Hypersonic and High Temperature Gas Dynamics”, AIAA Education Series, 2nd Ed., 2006.
2. AndersonJ. D., “Modern Compressible Flow with Historical Perspective”, TMH, 3rd Ed., 2012.
3. Heiser, W. H. and Pratt, D. T., “Hypersonic Air Breathing Propulsion”, AIAA, 1994.
4. John T. Bertin, “Hypersonic Aerothermodynamics”, AIAA Inc., Washington DC, 1994

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB3015	EXPERIMENTAL AERODYNAMICS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To learn the basic measurement technique in Fluid mechanics.
- To provide extensive treatment of the operating principles and limitations of pressure and temperature measurements.
- To cover both operating and application procedures of hot wire anemometer.
- To describe flow visualization techniques and to highlight in depth discussion of analog methods.
- To understand the importance of special flows and error analysis.

UNIT 1 BASIC MEASUREMENTS IN FLUID MECHANICS 9 Hrs.

Objective of experimental studies – Fluid mechanics measurements – Properties of fluids – Measuring instruments – Performance terms associated with measurement systems – Direct measurements - Analogue methods – Flow visualization – Components of measuring systems – Importance of model studies.

UNIT 2 WIND TUNNEL MEASUREMENTS 9 Hrs.

Characteristic features, operation and performance of low speed, transonic, supersonic and special tunnels - Power losses in a wind tunnel – Instrumentation and calibration of wind tunnels – Turbulence- Wind tunnel balance – Wire balance – Strut-type – Platform-type – Yoke-type – Pyramid type – Strain gauge balance – Balance calibration.

UNIT 3 FLOW VISUALIZATION AND ANALOGUE METHODS 9 Hrs.

Visualization techniques – Smoke tunnel – Hele-Shaw apparatus - Interferometer – Fringe-Displacement method – Schlieren system – Shadowgraph - Hydraulic analogy – Hydraulic jumps – Electrolytic tank.

UNIT 4 PRESSURE, VELOCITY AND TEMPERATURE MEASUREMENTS 9 Hrs.

Pitot - static tube characteristics - Velocity measurements - Hot-wire anemometry – Constant current and Constant temperature Hot-Wire anemometer – Pressure measurement techniques - Pressure transducers – Temperature measurements.

UNIT 5 SPECIAL FLOWS AND UNCERTAINTY ANALYSIS 9 Hrs.

Experiments on Taylor-Proudman theorem and Ekman layer – Measurements in boundary layers - Data acquisition and processing – Signal conditioning – Uncertainty analysis – Estimation of measurement errors – External estimate of the error – Internal estimate of the error – Uncertainty calculation - Uses of uncertainty analysis.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Explain the knowledge on measurement techniques in aerodynamic flow.
CO2 - Analysis the Lift and drag measurements through various techniques in wind tunnel
CO3 - Apply the flow visualization technique to study flow pattern of aerodynamic model.
CO4 - Illustrate the Specific instruments for flow parameter measurement like pressure, velocity
CO5 - Apply the Wind tunnel boundary corrections and Scale effects
CO6 - Perform uncertainty calculation of drones.

TEXT / REFERENCE BOOKS

1. Rathakrishnan, E., “Instrumentation, Measurements, and Experiments in Fluids,” CRC Press – Taylor & Francis, 2007.
2. Robert B Northrop, “Introduction to Instrumentation and Measurements”, Second Edition, CRC Press, Taylor & Francis, 2006.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB3016	HELICOPTER AERODYNAMICS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- The principals involved in helicopters
- The performance and stability aspects of Helicopter under different operating conditions.
- Dynamic stability of helicopters
- Considerations of helicopter design

UNIT 1 INTRODUCTION **9 Hrs.**

Helicopter as an aircraft, Basic features, Layout, Generation of lift, Main rotor, Gearbox, tail rotor, power plant, considerations on blade, flapping and feathering, Rotor controls and various types of rotor, Blade loading, Effect of solidity, profile drag, compressibility etc., Blade area required, number of Blades, Blade form, Power losses, Rotor efficiency.

UNIT 2 AERODYNAMICS OF ROTOR BLADE **9 Hrs.**

Aerofoil characteristics in forward flight, Hovering and Vortex ring state, Blade stall, maximum lift of the helicopter calculation of Induced Power, High speed limitations; parasite drag, power loading, ground effect.

UNIT 3 POWER PLANTS AND FLIGHT PERFORMANCE **9 Hrs.**

Piston engines, Gas turbines, Ramjet principle, Comparative performance, Horsepower required, Range and Endurance, Rate of Climb, Best Climbing speed, Ceiling in vertical climb, Autorotation.

UNIT 4 STABILITY AND CONTROL **9 Hrs.**

Physical description of effects of disturbances, Stick fixed Longitudinal and lateral dynamic stability, lateral stability characteristics, control response. Differences between stability and control of airplane and helicopter.

UNIT 5 ROTOR VIBRATIONS **9 Hrs.**

Dynamic model of the rotor, Motion of the rigid blades, flapping motion, lagging motion, feathering motion, Properties of vibrating system, phenomenon of vibration, fuselage response, vibration absorbers, Measurement of vibration in flight. Rotor Blade Design: General considerations, Airfoil selection, Blade construction, Materials, Factors affecting weight and cost, Design conditions, Stress analysis.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Make use of Aerodynamics calculation of Rotor blade
CO2 - Apply stability and control characteristics of Helicopter
CO3 - Experiment with control Rotor vibration
CO4 - Apply Momentum and simple blade element theories to helicopter's rotor blades.
CO5 - Analyse the power requirements in forward flight and associated stability problems of helicopter.
CO6 - Understand aerodynamics of rotor blades

TEXT / REFERENCE BOOKS

1. John Fay, "The Helicopter and How It Flies", Himalayan Books 1995
2. Lalit Gupta, "Helicopter Engineering", Himalayan Books New Delhi 1996
3. Joseph Schafer, "Basic Helicopter Maintenance", Jeppesen 1980
4. R W Prouty, Helicopter Aerodynamics, Phillips Pub Co, 1993.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB3017	WIND TURBINE DESIGN THEORY	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To understand the fundamentals of wind energy and its conversion system
- To impart knowledge on air foil design and braking system
- To learn gear coupled generator wind turbine components

UNIT 1 WIND ENERGY FUNDAMENTALS & WIND MEASUREMENTS 9 Hrs.

Wind Energy Basics, Wind Speeds and scales, Terrain, Roughness, Wind Mechanics, Power Content, Class of wind turbines, Atmospheric Boundary Layers, Turbulence. Instrumentation for wind measurements, Wind data analysis, tabulation, Wind resource estimation, Betz's Limit, Turbulence Analysis.

UNIT 2 AERODYNAMICS THEORY & WIND TURBINE TYPES 9 Hrs.

Airfoil terminology, Blade design, Rotor performance and dynamics, Balancing technique (Rotor &Blade), Types of loads; Sources of loads Vertical Axis Type, Horizontal Axis, Constant Speed Constant Frequency, Variable speed Variable Frequency, Up Wind, Down Wind, Stall Control ,Pitch Control, Gear Coupled Generator type, Direct Generator Drive /PMG/Rotor Excited Sync Generator.

UNIT 3 GEAR COUPLED GENERATOR WIND TURBINE COMPONENTS AND THEIR CONSTRUCTION 9 Hrs.

Electronics Sensors /Encoder /Resolvers, Wind Measurement : Anemometer & Wind Vane, Grid Synchronisation System, Soft Starter, Switchgear [ACB/VCB], Transformer, Cables and assembly, Compensation Panel, Programmable Logic Control, UPS, Yaw & Pitch System : AC Drives, Safety Chain Circuits, Generator Rotor Resistor controller (Flexi Slip), Differential Protection Relay for Generator, Battery/Super Capacitor Charger & Batteries/Super Capacitor for Pitch System, Transient Suppressor/Lightning Arrestors, Oscillation & Vibration sensing.

UNIT 4 DIRECT ROTOR COUPLED GENERATOR (MULTI POLE) [VARIABLE SPEED VARIABLE FREQ.] 9 Hrs.

Excited Rotor Synch. Generator/PMG Generator, Control Rectifier, Capacitor Banks, Step Up/Boost Converter (DC-DC Step Up), Grid Tied Inverter, Power Management, Grid Monitoring Unit(Voltage and Current),Transformer, Safety Chain Circuits.

UNIT 5 MODERN WINDTURBINE CONTROL & MONITORING SYSTEM 9 Hrs.

Details of Pitch System & Control Algorithms, Protections used & Safety Consideration in Wind turbines, Wind Turbine Monitoring with Error codes, SCADA& Databases: Remote Monitoring and Generation Reports, Operation & Maintenance for Product Life Cycle, FACTS control & LVRT & New trends for new Grid Codes.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Determine energy available in wind and limitations in wind turbine design
CO2 - Analyze the wind turbine aerodynamics and breaking system
CO3 - Explain about various components of wind turbine and its working
CO4 - Explain about different types of generators and power condition used in wind systems
CO5 - Assess modern wind turbine control, monitoring and maintenance and report generation.
CO6 - impart knowledge on modern wind turbine control & monitoring

TEXT / REFERENCE BOOKS

1. C-WET: Wind Energy Resources Survey in India.
2. John D Sorensen and Jens N Sorensen, Wind Energy Systems, Wood head Publishing Ltd, 2011
3. Kaldellis. J.K, Stand–alone and Hybrid Wind Energy Systems, CRC Press, 2010
4. Mario Garcia–Sanz, Constantine H. Houpis, Wind Energy Systems, CRC Press, 2012
5. Spera, D.A., Wind Turbine Technology: Fundamental concepts of Wind Turbine Engineering, ASME Press,1994.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB3018	BOUNDARY LAYER THEORY	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To understand the importance of boundary layer in Aerodynamics.
- To understand various types of boundary layers and their applications.

UNIT 1 VISCOUS FLOW EQUATIONS 9 Hrs.

Navier-Stokes Equations, Creeping motion, Couette flow, Poiseuille flow through ducts, Ekman drift.

UNIT 2 LAMINAR BOUNDARY LAYER 9 Hrs.

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.

UNIT 3 TURBULENT BOUNDARY LAYER 9 Hrs.

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, mixing length hypothesis.

UNIT 4 APPROXIMATE SOLUTION TO BOUNDARY LAYER EQUATIONS 9 Hrs.

Approximate integral methods, digital computer solutions – Von Karman – Polhausen method.

UNIT 5 THERMAL BOUNDARY LAYER 9 Hrs.

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.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Apply the basic fundamentals of Different types of Boundary layer thickness.
CO2 - Analyze the behavior of the fluid flow under static condition.
CO3 - Understand the basics of Different types of flow such as Laminar, turbulent and compressible flow, Incompressible flow, Viscid and Inviscid flow.
CO4 - Basics of Boundary layer Control.
CO5 - Flow through pipe of different types of flow.
CO6 - Importance of non-dimensional numbers.

TEXT / REFERENCE BOOKS

1. Schlichting H., “Boundary Layer Theory”, McGraw Hill, New York, 2010.
2. Frank White, Viscous Fluid flow, McGraw Hill, 2011.
3. Reynolds A.J., “Turbulent flows in Engineering”, John Wiley & Sons, 2013.
4. Ronald L., Panton, “Incompressible fluid flow”, John Wiley & Sons, 1984.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB3019	ADVANCE FLIGHT DYNAMICS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To familiarize the student's ability to analyze the concepts of advance flight dynamics.

UNIT 1 INTRODUCTION TO ATMOSPHERIC AND SPACE FLIGHT 9 Hrs.

Modelling and simulation of Atmosphere and Space flight -attitude and kinematics of Cordinate frames – basic definitions of vector-coordinate systems and rotation matrix-Euler axis and principal angle-Euler angles-Euler symmetric parameters (quaternion)-Rodrigues parameters – Gibbs vectors-attitude kinematics.

UNIT 2 CELESTIALFRAME AND ELEMENTS 9 Hrs.

Newton's law of gravitation –gravitational anomalies – two body problem – Celestial frame and orbital elements –planet fixed frame –lamberts problem- perturbation acceleration-effects of Planetary oblations – effects of atmospheric drag –three body problem-equations of motion langrage solution-restricted three body problem.

UNIT 3 ATMOSPHERIC AND SPACE FLIGHT TRAJECTORIES 9 Hrs.

Atmospheric and Space trajectories – equations of motion –airplane flight paths- long range cruising flight -steady wind on airplane-take off maneuver-rocket ascent trajectories.

UNIT 4 ROTATIONAL MOTION AND CONTROL SYSTEMS 9 Hrs.

Euler equation for a rotational motion-rotational kinematic energy-principal body frame –torque free rotation of spacecraft – implementation of control systems elements-single axis closed loop attitude control-multi axis closed loop attitude control- Six-degrees of freedom simulation.

UNIT 5 FLIGHT SIMULATOR AS A TRAINING DEVICE AND RESEARCH TOOL 9 Hrs.

Introduction, advantage of simulator, the effectiveness of Simulator - wing rock motion of aircraft simulation. The Data sources, Validation, in- flight simulators.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the working principles of flight motion and celestial bodies in space.
CO2 - Comprehend the sound foundation in the design principles of celestial frame and elements.
CO3 - Learn the operation of trajectories.
CO4 - Should be able to understand the concept of control systems.
CO5 - Understand the principle and performance of flight simulator.
CO6 - Applying the importance of Advance flight dynamics to Aerospace.

TEXT / REFERENCE BOOKS

1. Ashishtewari, Atmospheric and space flight dynamics: modeling and simulation with Matlab and Simulink, Birkhauser, spinger international edition, 2011.
2. Automatic Control of Atmospheric and Space Flight Vehicles: Design and Analysis with MATLAB® and Simulink® (Control Engineering) 2011 Edition.
3. Pamadi, B. "Performance, stability, Dynamics and Control of Airplanes", AIAA 2004.
4. Etkin, B. and Reid L.D. "Dynamics of Flight-Stability and Control" 3rd edition, John Wiley, 1996.
5. Stengel, R.F. "Flight dynamics" Princeton University Press, Princeton, N.J., USA, 2004.
6. Kaplan, Marshall H., Modern Spacecraft Dynamics and Control, John Wiely & Sons, New York. 1976.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB3020	LAUNCH VEHICLES AND SPACECRAFT PROPULSION	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To understand the concepts of launch vehicles and spacecraft.
- To evaluate the performance of fluids and fluid flows in International standard atmosphere.
- To know the basic functions of fluids and fluid flows and heat transfer.
- To discuss fluid properties in the basis of the structural, aerodynamics.

UNIT 1 INTRODUCTION 9 Hrs.

Introduction - Historical Note / Basic Propulsion Devices - Architectural description of Launch Vehicles and Satellites - Rocket Equation / Staging / Payload - Launch weight relation - Propulsion Requirements / Thrust and time requirements - Types of rockets / propellants / choices.

UNIT 2 NOZZLE FLOWS AND AEROTHERMO CHEMISTRY 9 Hrs.

Nozzle flows / Introduction - Performance parameters - Review of aero thermo chemistry - Propellant and burning - Internal Ballistics - Grains / Ignition etc.

UNIT 3 PROPELLANTS AND HEAT TRANSFER 9 Hrs.

System Description / Propellants - Combustion / Heat Transfer / Cooling - Feed Systems - R-4 Auxiliary Components - Monopropellants / Catalytic systems -Ignition / Restart / Environmental problems.

UNIT 4 SATELLITE INTEGRATION 9 Hrs.

Cold gas systems - Thruster satellite integration - Propellant management in spacecraft - Propellant access in microgravity.

UNIT 5 PROPULSION OPTIONS 9 Hrs.

Air breathing options in launch vehicles - Non chemical propulsion options - Nuclear Rockets. Electrostatic and Electromagnetic propulsion. Special thermal and integration problems.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Study the applications of the conservation laws to flow.
CO2 - Understand the importance of dimensional analysis.
CO3 - Understand the importance of various types.
CO4 - Understand the properties of basic flows.
CO5 - Familiarize the satellite integration.
CO6 - Distinguish the basics of fluid statics and fluid dynamics for propulsion.

TEXT / REFERENCE BOOKS

1. G.P. Sutton : Rocket Propulsion Elements, Wiley, New York, 2012.
2. C.D. Brown: Spacecraft Propulsion, AIAA Education Series, AIAA Inc., Washington DC, 2011.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 Exam Duration : 3 Hrs.

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB3021	MISSILE TECHNOLOGY	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To understand the concepts of missiles.
- To evaluate the performance of fluids and fluid flows in International standard atmosphere.
- To know the basic functions of missile control systems.
- To discuss the stages of separation.

UNIT 1 MISSILE SYSTEMS 9 Hrs.

Introduction - history - classification - missile system elements - missile ground systems -radars – launchers - coordinate frames - basics of trajectory dynamics - Missile equations of motion- coordinate systems – Rigid body equations of motion - D - Alembert principle.

UNIT 2 MISSILE CONTROL SYSTEMS 9 Hrs.

Introduction - Roll stabilization – Root locus for roll stabilization system - Transfer function - control of aerodynamic missiles – Missile auto pilot – boost autopilot - Transfer function for a ballistic type missile - Van guard control system – block diagram – root locus - Alternate control system.

UNIT 3 PROPULSION 9 Hrs.

Principles of jet propulsion and rocketry - nozzle theory and characteristic parameters - rockets solid and liquid propellant - Ramjet and Turbo jet engines – evaluation of flight performance – forces acting on vehicle - basic relations of motion - multi stage vehicles.

UNIT 4 NAVIGATION, GUIDANCE AND CONTROL 9 Hrs.

Navigation - types - INS - GPS - radar based terrain mapping, guidance - explicit – Proportional Navigation guidance – Augmented Proportional Navigation guidance –Comparison of guidance system performance - Autopilot – control surfaces and actuators – Back to turn missile guidance.

UNIT 5 MISSILE TRAJECTORY CALCULATIONS 9 Hrs.

Vertical, inclined and gravity turn trajectories – determination of range and altitude ballistic missile intercept – missile tracking equations of motion – numerical computation of ballistic trajectories – Dynamics of stage separation.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Study the applications of the conservation laws to flow
CO2 - Understand the importance of missile coordinate system
CO3 - Understand the importance of missile performance
CO4 - Understand the properties control system
CO5 - Analyze the trajectory calculations
CO6 - Distinguish the basics of fluid statics and fluid dynamics for propulsion

TEXT / REFERENCE BOOKS

1. George .P.Sutton ,Oscar Biblarz “Rocket Propulsion Elements”, Wiley publishers 8th Edition, 2010
2. John H. Blakelock, “Automatic control of aircraft and missiles”, 2nd Edition, Wiley publishers 2011.
3. George M.Siouris, “Missile guidance and control systems“, Springer 2nd Edition, 2004.
4. Tactical and Strategic Missile Guidance, 5th Edition, Paul Zarchan, Progress in Astronautics and Aeronautics, AIAA, 2007, ISBN-10: 1-56347-874-9.
5. Missile Guidance and Control Systems, George M. Siouris, Springer-Verlag, 2004, ISBN: 0-387-00726.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB3022	FLIGHT VEHICLES' GUIDANCE AND CONTROL	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To understand the concepts of guidance and control of flight vehicles.
- To evaluate the performance of flight vehicle's transformation.
- To know the basic functions of navigation.
- To discuss the methodology of modeling of aerospace vehicles.

UNIT 1 GUIDANCE 9 Hrs.

Introduction - history - classification - missile system elements - missile ground systems -radars – launchers - coordinate frames - basics of trajectory dynamics - Missile equations of motion- coordinate systems – Rigid body equations of motion - D - Alembert principle.

UNIT 2 FLIGHT VECHICE'S TRANSFORMATION 9 Hrs.

Introduction - Roll stabilization – Root locus for roll stabilization system - Transfer function - control of aerodynamic missiles – Missile auto pilot – boost autopilot - Transfer function for a ballistic type missile - Van guard control system – block diagram – root locus - Alternate control system.

UNIT 3 NAVIGATION 9 Hrs.

Principles of jet propulsion and rocketry - nozzle theory and characteristic parameters - rockets solid and liquid propellant - Ramjet and Turbo jet engines – evaluation of flight performance – forces acting on vehicle - basic relations of motion - multi stage vehicles.

UNIT 4 PERFORMANCE 9 Hrs.

Navigation - types - INS - GPS - radar based terrain mapping, guidance - explicit – Proportional Navigation guidance – Augmented Proportional Navigation guidance –Comparison of guidance system performance - Autopilot – control surfaces and actuators – Back to turn missile guidance.

UNIT 5 MODELLING 9 Hrs.

Vertical, inclined and gravity turn trajectories – determination of range and altitude ballistic missile intercept – missile tracking equations of motion – numerical computation of ballistic trajectories – Dynamics of stage separation.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Recall basics of flight mechanics.
CO2 - Understand the basic working principle of guidance and control of flight vehicles.
CO3 - Understand the working of flight transformation in various planes.
CO4 - Recognize the functions guidance algorithm.
CO5 - Understand the missile control system.
CO6 - Recall the basics of functions of radar and launch vehicle flight control system.

TEXT / REFERENCE BOOKS

1. Flight without Formulae by A.C Kermode, Pearson Education, 10th Edition, 2011.
2. Mechanics of Flight by A.C Kermode, Pearson Education, 5th Edition, 2012.
3. Fundamentals of Flight, Shevell, Pearson Education, 2nd Edition, 2013.
4. 'Modern Navigation, Guidance and Control Processing, Ching-Fang Lin, Prentice Hall Inc., Englewood Cliffs, New Jersey, 2011.
5. 'Guided Weapon Control Systems', Garnele P, Pergamon, 1980.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB3023	MANNED SPACE MISSIONS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- Know the advanced concepts of manned space missions to the engineers.
- Understand the space and environment and its conditions.
- Apply the concept of life supporting devices.

UNIT 1 FUNDAMENTALS OF SPACE MISSIONS 9 Hrs.

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

UNIT 2 SPACE VS EARTH ENVIRONMENT 9 Hrs.

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

UNIT 3 LIFE SUPPORT SYSTEMS AND COUNTERMEASURES 9 Hrs.

Life Support Systems and Space Survival Overview, Environment Controlled Life Support Systems (ECLSS), Human / Machine Interaction, Human Factors in Control Design, Crew Accommodations.

UNIT 4 MISSION LOGISTICS AND PLANNING 9 Hrs.

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

UNIT 5 SUBSYSTEMS 9 Hrs.

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

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the working principles of basic control system.
CO2 - Comprehend the sound foundation in the various subsystems.
CO3 - Learn the advanced concepts of manned space missions to the engineers.
CO4 - Understand the space and environment and its conditions.
CO5 - Understand the the principle and performance of various subsystems.
CO6 - Applying the importance of the mission logistics and planning.

TEXT / REFERENCE BOOKS

1. Larson, W. J. and Pranke, L. K., Human Spaceflight: Mission Analysis and Design, McGraw-Hill Higher Education, Washington, DC , 1999 2. McNamara, Bernard. 2010.
2. Into the Final Frontier: The Human Exploration of Space, 2012.
3. Connors, M.M., Harrison, A.A., and Akins, F.R. 2005. Living Aloft: Human Requirements for Extended Spaceflight, University Press of the Pacific, Honolulu, Hawaii: ISBN: 1-4102-1983-6 4 Eckart, P. 1996.
4. Jones, T., Sky Walking – An Astronaut's Memoir, Harper Collins, New York, NY, 2006
5. Mullane, M., Riding Rockets – The Outrageous Tales of a Space Shuttle Astronaut, Scribner, New York, NY, 2006

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB3024	CRYOGENIC ENGINEERING	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To enrich the students in the field of Cryogenic Engineering and its Applications.
- To learn the various Refrigeration processes, Equipment, Instruments, gas separation and Purification processes.

UNIT 1 CRYOGENIC FLUIDS AND MATERIAL PROPERTIES 9 Hrs.

Cryogenic Engineering – Properties of cryogenic fluids – Oxygen, Nitrogen, Argon, Neon, Flourine, Helium. Hydrogen, Properties of Solids – Mechanical, Thermal, and Electrical-Super conductivity, Cryogenic applications.

UNIT 2 CRYOGENIC REFRIGERATION AND GAS LIQUEFACTION 9 Hrs.

Principle – Joule Thomson Expansion, Cascade processes, Ortho para hydrogen conversion, cold gas refrigerators, Linde- Hampson cycles, Claude and cascaded systems, magnetic cooling, Stirling Cycle, Pulse Tube refrigeration.

UNIT 3 CRYOGENIC EQUIPMENTS AND REQUIREMENTS 9 Hrs.

Cryogenics- Heat Exchangers, Compressors, Expanders, Effect of various parameters in performance and system optimization. Insulation and Storage equipment for cryogenic fluids, industrial storage and transfer of cryogenic fluids.

UNIT 4 GAS SEPARATION AND PURIFICATION 9 Hrs.

Ideal gas, Mixture characteristics – composition diagrams – gas separation – Principle of Rectification process– principle and working of air separation, principle and working of gas purification.

UNIT 5 CRYOGENIC INSTRUMENTATION 9 Hrs.

Grinding process; cylindrical grinding, surface grinding, center less grinding – honing, lapping, super finishing, polishing, buffing and hobbing. Metallic Coatings; electro plating, galvanizing, tin coating, anodizing. Organic Finishes; primers, oil paint, brushing, spraying and rubber base coatings.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Describe the basic concepts of various cryogenic fluids and materials.
CO2 - Understand the cryogenic refrigeration and gas liquefaction.
CO3 - Understanding the working principles of cryogenic equipment.
CO4 - Understanding the working of gas separation and purification.
CO5 - Understanding the instrumentation of cryogenic technology
CO6 - To design the cryogenic system based on the application.

TEXT / REFERENCE BOOKS

1. Randal F. Barron, Cryogenic Systems, McGraw Hill, 2010.
2. Cryogenic Engineering, Van Nostrand Co. Inc. 2011.
3. Klaus D. Timmerhaus, Richard Palmer Reed, Cryogenic Engineering: 50 years of progress, Springer, 2011.
4. Hastlden, C., “Cryogenic Fundamentals”, Academic Press, 2001.
5. Walker, “Cryocoolers”, Plenum Press, 2000.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB3025	3D PRINTING TECHNOLOGIES	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- Exploit technology used in additive manufacturing.
- Understand importance of additive manufacturing in advance manufacturing process.
- Acquire knowledge, techniques and skills to select relevant additive manufacturing process.
- Eplore the potential of additive manufacturing in different industrial sectors.
- Apply 3D printing technology for additive manufacturing.

UNIT 1 INTRODUCTION 9 Hrs.

Overview, Basic principle need and advantages of additive manufacturing, Procedure of product development in additive manufacturing, Classification of additive manufacturing processes, Materials used in additive manufacturing, Challenges in Additive Manufacturing.

UNIT 2 ADDITIVEMANUFACTURING PROCESSES 9 Hrs.

Z-Corporation 3D-printing, STereoLithography apparatus (SLA), Fused deposition modeling (FDM), Laminated Object Manufacturing (LOM), Selective deposition lamination (SDL), Ultrasonic consolidation, Selective laser sintering (SLS), Laser engineered net shaping (LENS), Electron beam free form fabrication (EBFFF), Electron beam melting (EBM), Plasma transferred arc additive manufacturing (PTAAM), Tungsten inert gas additive manufacturing (TIGAM), Metal inert gas additive manufacturing (MIGAM).

UNIT 3 ADDITIVE MANUFACTURING MACHINES AND SYSTEMS 9 Hrs.

Axes, Linear motion guide ways, Ball screws, Motors, Bearings, Encoders/ Glass scales, Process Chamber, Safety interlocks, Sensors. Introduction to NC/CNC/DNC machine tools, CNC programming and introduction, Hardware Interpolators, Software Interpolators, Recent developments of CNC systems for additive manufacturing.

UNIT 4 POST-PROCESSINGINADDITIVEMANUFACTURING 9 Hrs.

Preparation of 3D-CAD model, Reverse engineering, Reconstruction of 3D-CAD model using reverse engineering, Part orientation and support generation, STL Conversion, STL error diagnostics, Slicing and Generation of codes for tool path, Surface preparation of materials.

UNIT 5 MATERIALS FOR SPACE CRAFT 9 Hrs.

Support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non-thermal and thermal techniques, Brief information on characterization techniques used in additive manufacturing, Applications of additive manufacturing in rapid prototyping, rapid manufacturing, rapid tooling, repairing and coating.

Max. 45 Hours

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Able to define the various process used in Additive Manufacturing.
CO2 - Able to analyse and select suitable process and materials used in Additive Manufacturing.
CO3 - Able to identify, analyse and solve problems related to Additive Manufacturing.
CO4 - Able to apply knowledge of additive manufacturing for various real-life applications.
CO5 - Able to apply technique of CAD and reverse engineering for geometry transformation in Additive Manufacturing.
CO6 - Understand the basic concept of additive manufacturing application.

TEXT / REFERENCE BOOKS

1. Gibson, I, Rosen, D W. and Stucker ,B., Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, 2010.
2. Chua C.K., Leong K.F., and Lim C.S., “Rapid prototyping: Principles and applications”, Third Edition, World Scientific Publishers, 2010.
3. Chee Kai Chua, Kah Fai Leong, 3D Printing and Additive Manufacturing: Principles and Applications: Fourth Edition of Rapid Prototyping, World Scientific Publishers, 2014.
4. Gebhardt A., “Rapid prototyping”, Hanser Gardener Publications, 2003.Kenneth G. Budinski & Michael K. Budinski, "Engineering Materials: Properties and Selection", 9th Edition, Pearson, 2009, 792 pages.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB3026	AIRCRAFT DESIGN	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To understand the concepts of air vehicle design.
- To estimate aerodynamic, propulsive and gravitational forces for design.
- To select airframe components and power plant.
- To analyze the performance, stability and control of the airplane.

UNIT 1 INTRODUCTION 9 Hrs.

Introduction, Aircraft Design Requirements, specifications, role of users, Aerodynamic and Structural consideration, Airworthiness requirements and standards-classifications of airplanes, relative merits and demerits. Special features of modern airplane, Weight-estimation based on mission requirements.

UNIT 2 AERODYNAMIC DESIGN AND PERFORMANCE 9 Hrs.

Basics of Wing Design, Selection of airfoil selection, influencing factors. Span wise load distribution and Planform shapes of airplane wing. Wing drag estimation. High lift devices, Air Loads in Flight, Symmetrical measuring loads in flight, Basic flight loading conditions, Load factor, Velocity - Load factor diagram, gust load and its estimation.

UNIT 3 STRUCTURAL DESIGN 9 Hrs.

Structural aspects of design of airplane, Bending moment and shear force diagram. Design principles of all metal stressed skin wings for civil and military application, features of light airplanes using advanced composite materials.

UNIT 4 INTEGRATION OF WING, FUSELAGE, EMPENNAGE AND POWER PLANT 9 Hrs.

Estimation of Horizontal and Vertical tail volume ratios. Choice of power plant and various options of locations, considerations of appropriate air -intakes. Integration of wing, fuselage, empennage and power plant. Estimation of center of gravity.

UNIT 5 ADVANCED DESIGN CONCEPTS 9 Hrs.

Supercritical Wings, relaxed static Stability, controlled configured vehicles, V/STOL aircraft and, rotary wing vehicles. Layout peculiarities of supersonic aircraft – optimization of wing loading to achieve desired performance – loads on undercarriages and design requirements.

Max. 45 Hrs.

COURSE OUTCOMES

After completing this course, students will understand the following concepts thoroughly and will be able to apply it in academic problems and industrial real life problems.

CO1 - Understand the concepts of design through preliminary design.
CO2 - Estimate the gross weight of the aircraft using statistical data.
CO3 - Evaluate aerodynamic and performance parameters for design.
CO4 - Understand the Structural aspects of airplane design.
CO5 - Analyze the stability and performance by CG calculation and engine characteristics.
CO6 - Understand the advanced design concepts.

TEXT / REFERENCE BOOKS

1. D.P. Raymer, “Aircraft Conceptual design”, AIAA Series, 2012.
2. G. Corning, “Supersonic & Subsonic Airplane Design”, II Edition, Edwards Brothers Inc., Michigan 2010.
3. E.F. Bruhn, “Analysis and Design of Flight Vehicle Structures”, Tristate Offset Co., U.S.A., 2011.
4. E. Torenbeek, “Synthesis of Subsonic Airplane Design”, Delft University Press, London, 1976.
5. A.A. Lebedenski, “Notes on airplane design”, Part-I, I.I.Sc., Bangalore.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB3027	SPACE PROPULSION	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To learn the principles of operation and design of spacecraft power plants.
- To explain the basics of hypersonic propulsion.
- To compare the solid and liquid rocket propulsion.

UNIT 1 BASICS OF HYPERSONIC PROPULSION 9 Hrs.

Introduction – Thermodynamic Closed Cycle Analysis – First Law Analysis – Stream Thrust. Analysis – Compression Components – Burner Entry Pressure – Fuel-Air Mixing – Combined Mixing and Chemical Kinetics – Supersonic combustion and Scramjet Propulsion.

UNIT 2 SOLID ROCKET PROPULSION 9 Hrs.

Propulsion Elements for Solid Rocket Motors – Solid Propellant Grain Design – Prediction and Measurement of Specific Impulse – Solid Propellant Combustion and Internal Ballistics of Motors – Plume, Signal Interference and Plume Signature – Structural Analysis of Propellant Grains – Safety Characteristics of Solid Propellants and Hazards of Solid Rocket Motors.

UNIT 3 LIQUID ROCKET PROPULSION 9 Hrs.

Types of Propellants – Propellant Tanks – Propellant Feed Systems – Gas Pressure Feed. Systems – Tank Pressurization – Turbo pump Feed Systems and Engine Cycles – Rocket Engines for Manoeuvring, Orbit Adjustments, Attitude Control – Engine Families – Valves and Pipelines – Engine Support Structure.

UNIT 4 HYBRID ROCKET PROPULSION 9 Hrs.

Conventional bi-propellant systems – high regression rate fuels – O/F shift – Scale-up tests - Regression rate analysis – Review of Solid-Fuel Regression Rate Behavior in Classical and Nonclassical Hybrid Rocket Motors – Mechanisms and Measurement Techniques of Solid-Fuel Pyrolysis Phenomena and Regression Rate – Analytical Models - Vortex Injection – High-Speed Flow Effects – Combustion Instability and Transient Behaviour – Similarity and Scaling Effects.

UNIT 5 ELECTRICAL ROCKET PROPULSION 9 Hrs.

Introduction – Electrostatic Propellant Acceleration – Bombardment Ionization – Plane Diode – Electrostatic Thruster Performance – Arcjet – Pulsed-Magnetoplasma Accelerators – Laser Propulsion-Different Types, Advantages and Applications.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Explain hypersonic propulsion systems and their application to aerospace vehicles.
CO2 - Understand the traditional propulsion concepts, including liquid, solid, hybrid, ion, and thermal rockets.
CO3 - Know the applications and principles of solid, liquid, and hybrid rocket propulsion systems.
CO4 - Understand the performances of various rocket propulsion systems.
CO5 - Apply the concepts of electrical propulsion in rocket.
CO6 - Understand the advantages and applications of electrical rocket propulsion.

TEXT / REFERENCE BOOKS

1. John T. Bertin, “Hypersonic Aerothermodynamics”, AIAA Inc., Washington DC, 1994.
2. Sutton, G.P., “Rocket Propulsion Elements”, Wiley, New York, 9th Ed., 2017.
3. Heiser, W. H. and Pratt, D. T., “Hypersonic Air Breathing Propulsion”, AIAA, 1994.
4. Hill P. G., and Peterson C. R., “Mechanics and Thermodynamics of Propulsion”, Pearson Education, 2nd Ed., 2009.
5. Oates G. C., “Aerothermodynamics of Aircraft Engine Components”, AIAA Education Series, 1985.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB3028	AIRCRAFT STABILITY AND CONTROL	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To stability of aircraft at various flight conditions.
- To stability, control, and dynamic characteristics of aircraft.
- To evaluate the flight and handling qualities.
- To know the advances in flight dynamics and controls.

UNIT 1 BASIC CONCEPTS 9 Hrs.

Aircraft Axis System, Coordinate Transformation, Aircraft Force and moment Equations, Basic Concept of Stability and Control, Types of stability.

UNIT 2 LONGITUDINAL DYNAMIC STABILITY AND CONTROL 9 Hrs.

Longitudinal stability, Contribution of wing and Tail, Total contribution, Stick fixed and stick free stability, control effectiveness, hinge moment, tabs. Determination Of Neutral Points And Maneuver Points In Flight Tests. Aerodynamic balancing.

UNIT 3 MANEUVERABILITY 9 Hrs.

Effects of freeing the stick. Control forces and force gradients. Critical conditions for stability and control. Effect of maneuvers. Longitudinal dynamic stability, stability derivatives, characteristic equation for stick fixed case, modes and stability criterion, effect of freeing the stick.

UNIT 4 DYNAMIC STABILITY 9 Hrs.

Brief description of lateral and directional dynamic stability- spiral, divergence and Dutch roll. Response, automatic control, autorotation and spin.

UNIT 5 MODERN CONTROL THEORY 9 Hrs.

Classical vs modern control theory, introduction – state-space modelling, canonical transformation, controllability and observability, state-feedback design, application of modern control theory to aircraft autopilot design- stability augmentation, autopilot design, state observer, optimal control, problems. Introduction to aircraft autopilot design using classic control theory.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Illustrate the aircraft axis system and measurement of stability and control of aircraft through fundamental equations.

CO2 - Apply the longitudinal dynamic stability and control of stick-fixed and stick-free control surfaces.

CO3 - Interpret the concept of stability criterion in manoeuvrability of aircraft operated in stick-fixed and stick-free control surfaces.

CO4 - Perform the dynamic stability criterion for different manoeuvre points in flight tests.

CO5 - Analyse the state-space modelling, canonical transformation, controllability and observability, state- feedback design.

CO6 - Applying the modern control theory to aircraft autopilot design- stability augmentation, autopilot design, state observer, optimal control,

TEXT / REFERENCE BOOKS

1. Thomas R. Yechout, 'An introduction to Aircraft Flight Mechanics', AIAA educational Series, 2016.
2. Bernard Etkin, Lloyd Duff Reid, Dynamics of Flight, Stability & Control, 3rd Edition, John Wiley & Sons, 2016.
3. Malcom J. Abzug, E.E. Larrabee, Airplane Stability & Control , 2nd Edition, Cambridge University Press, 2016.
4. Nelson. R.C., Flight Stability and Automatic Control, McGraw Hill, 2017.
5. Perkins C.D. and Hage R.E., Airplane Performance, Stability and Control, Wiley Toppan, 2016.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB3029	NON-DESTRUCTIVE TESTING IN AEROSPACE STRUCTURES	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To acquaint the students with the overview of NDT
- To elaborate the concept and procedure for liquid and magnetic penetrant testing and evaluate through practical study
- To introduce the concept and procedure for radiograph testing methods and evaluate through practical study

UNIT 1 INTRODUCTION 9 Hrs.

NDT Versus Mechanical testing - Overview of the Non Destructive Testing Methods for the detection of manufacturing defects as well as material characterization. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT- Visual inspection – Unaided and aided.

UNIT 2 SURFACE NDT METHODS 9 Hrs.

Liquid Penetrant Testing - Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results. Magnetic Particle Testing- Theory of magnetism, inspection materials Magnetisation methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism.

UNIT 3 THERMOGRAPHY AND EDDY CURRENT TESTING (TET) 9 Hrs.

Thermography- Principles, Contact and noncontact inspection methods, Techniques for applying liquid crystals, Advantages and limitation - infrared radiation and infrared detectors, Instrumentations and methods, applications. Eddy Current Testing-Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Types of arrangement, Applications, advantages, Limitations, Interpretation/Evaluation.

UNIT 4 ULTRASONIC TESTING (UT) AND ACOUSTIC EMISSION (AE) 9 Hrs.

Ultrasonic Testing-Principle, Transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A/Scan, B-scan, C-scan. Phased Array Ultrasound, Time of Flight Diffraction. Acoustic Emission Technique – Principle, AE parameters, Applications.

UNIT 5 RADIOGRAPHY (RT) 9 Hrs.

Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, Inverse square, law, characteristics of films - graininess, density, speed, contrast, characteristic curves, Penetrameters, Exposure charts, Radiographic equivalence. Fluoroscopy- Xero-Radiography, Computed Radiography, Computed Tomography

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Discuss the basics of NDT and its industrial standards
CO2 - Acquire knowledge on the concept and procedure for liquid and magnetic penetrant testing.
CO3 - Interpret the given mechanical components to inspect using radiograph testing methods techniques
CO4 - Apply ultrasonic techniques based on materials and its application.
CO5 - Describe the applications of electrical and other NDT methods.
CO6 - Impart knowledge in other methods of NDT and electrical method with case study.

TEXT / REFERENCE BOOKS

1. "Non destructive Testing Handbook", Vol. 1-10, 3rd Edition, American Society for NonDestructive Testing., 2010. ISBN: 978-1-57117-186-3.
2. Hellier C., "Handbook of Non destructive Evaluation", 1st edition, McGraw-Hill Professional., United States, 2001. ISBN: 0070281211, 978-0070281219.
3. Paipetis A.S, Matikas T. E., and Aggelis D. G., "Emerging Technologies in Non- Destructive Testing",1st edition, CRC Press., United States, 2012. ISBN :9780415621311.
4. Ravi Prakash, "Non destructive Testing Techniques", 1st Edition, New Age Science., India, 2009. ISBN: 1906574065, 978-1906574062.
5. Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol. 7, Ultrasonic Testing
6. Charles, J. Hellier," Handbook of Nondestructive evaluation", McGraw Hill, New York 2001.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB3030	PROPELLER BLADE THEORY	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To study the propeller parts and types used for various aircraft engines
- To analyze the propeller design and performance
- To check the damage and repair criteria for different propeller.

UNIT 1 INTRODUCTION **9 Hrs.**

Propeller theory - operation, construction assembly and installation - Pitch change mechanism- Propeller axially system.

UNIT 2 PROPELLER TYPES **9 Hrs.**

Propeller and its types – fixed propeller, control pitch propeller, kort nozzle, ducted propeller, voith schneider. Propeller dimension.

UNIT 3 PROPELLER PARTS **9 Hrs.**

Parts of propeller, 3 blade - 5 blade - 6 blade propellers and its advantages, propeller boss hub, crown nut, propeller skew, pitch of propeller.

UNIT 4 PERFROMANCE OF PROPELLER **9 Hrs.**

Thrust creation by propeller. Propeller Material – Propeller balancing- static and dynamic.

UNIT 5 DAMAGE AND REPAIR CRITERIA **9 Hrs.**

General Inspection procedures - Checks on constant speed propellers - Pitch setting, Propeller Balancing, Blade cuffs, Governor/Propeller operating conditions – Damage and repair criteria.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Discuss the basics of propeller blades
CO2 - Understand the different types of propeller.
CO3 - Understand the different parts of propeller blades.
CO4 - Analyse the thrust created by propeller blades
CO5 - Describe the checks on constant speed propellers
CO6 - Understand the damage and repair criteria for propeller blades.

TEXT / REFERENCE BOOKS

1. GP. Ghose, “Basic Ship propulsion”,2015
2. E.A. Stokoe “Reeds Ship construction for marine engineers”, Vol. 5,2010
3. E.A. Stokoe, “Reeds Naval architecture for the marine engineers”,4th Edition,2009

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB3031	VIBRATION AND AEROELASTICITY	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To understand the concepts of vibration and aero elasticity.
- To evaluate the characteristics of structural members.
- To know the basic methods to solve the solid mechanics problems.
- To discuss the structural mechanics and its applications.

UNIT 1 BASIC NOTIONS 9 Hrs.

Simple harmonic motion – Terminologies – Newton's Law – D' Alembert's principle – Energy Methods.

UNIT 2 SINGLE DEGREE OF FREEDOM SYSTEMS 9 Hrs.

Propeller and its types – fixed propeller, control pitch propeller, kort nozzle, ducted propeller, voith schneider. Propeller dimension.

Free vibrations – Damped vibrations – Forced Vibrations, with and without damping – support excitation – Vibration measuring instruments, Undamped vibration absorbers, Vibration isolation, Lagrangian's and Hamilton Equations.

UNIT 3 MULTI DEGREES OF FREEDOM SYSTEMS 9 Hrs.

Two degrees of freedom systems – Static and Dynamic couplings vibration absorber Principal co-ordinates, Principal modes and orthogonal condition – Eigen value problems. Hamilton's principle-Lagrangean equation and application – Vibration of elastic bodies Vibration of strings- Longitudinal, Lateral and Torsional vibrations.

UNIT 4 APPROXIMATE METHODS 9 Hrs.

Rayleigh's and Holzer Methods to find natural frequencies. Timoshenko beam, vibration of plates, collocation method, Myklested - prohl method.

UNIT 5 ELEMENTS OF AEROELASTICITY 9 Hrs.

Concepts – Coupling – Aero elastic instabilities and their prevention – Basic ideas on wing. divergence, loss and reversal of aileron control – Flutter and its prevention.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Comprehend the simple harmonic motion and energy methods
CO2 - Analyse the equations of motion for free, damped and forced vibration of single degree of freedom system
CO3 - Analyse the Two degrees of freedom mass coupled systems and Forced vibration of an undamped two degrees of freedom system
CO4 - Solve the following problems Transverse, flexural, torsional vibration of beams, Timoshenko beam
CO5 - Evaluate the Coupling and Aero elastic Instabilities.
CO6 - Examine wing. divergence, loss and reversal of aileron control

TEXT / REFERENCE BOOKS

1. Bisplinghoff R.L., Ashley H and Hoffman R.L., "Aeroelasticity" – Addision Wesley Publication, New York, 2010.
2. Tse. F.S., Morse, I.F., Hinkle, R.T., "Mechanical Vibrations", – Prentice Hall, New York, 2011.
3. Scanlan R.H. & Rosenbaum R., "Introduction to the study of Aircraft Vibration and Flutter", John Wiley and Sons. New York, 1982.
4. Tongue. B. H., "Principles of Vibration", Oxford University Press, 2000.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB3033	INDUSTRIAL TECHNIQUES	L	T	P	EL	Credits	Total Marks
		3	1	0	0	3	100

COURSE OBJECTIVES

- Outline Fundamental concepts in UI & UX
- Introduce the principles of Design and Building an mobile app
- Illustrate the use of CAD in product design

UNIT 1 UI/UX 9 Hrs.

Fundamental concepts in UI & UX - Tools - Fundamentals of design principles - Psychology and Human Factors for User Interface Design - Layout and composition for Web, Mobile and Devices - Typography - Information architecture - Color theory - Design process flow, wireframes, best practices in the industry
-User engagement ethics - Design alternatives

UNIT 2 APP DEVELOPMENT 9 Hrs.

SDLC - Introduction to App Development - Types of Apps - web Development - understanding Stack - Frontend - backend - Working with Databases - Introduction to API - Introduction to Cloud services - Cloud environment Setup- Reading and writing data to cloud - Embedding ML models to Apps - Deploying application.

UNIT 3 INDUSTRIAL DESIGN 9 Hrs.

Introduction to Industrial Design - Points, lines, and planes - Sketching and concept generation - Sketch to CAD - Introduction to CAD tools - Types of 3D modeling - Basic 3D Modeling Tools - Part creation – Assembly - Product design and rendering basics - Dimensioning & Tolerancing

UNIT 4 MECHANICAL RAPID PROTOTYPING 9 Hrs.

Need for prototyping - Domains in prototyping - Difference between actual manufacturing and prototyping - Rapid prototyping methods - Tools used in different domains - Mechanical Prototyping; 3D Printing and classification - Laser Cutting and engraving - RD Works - Additive manufacturing

UNIT 5 ELECTRONIC RAPID PROTOTYPING 9 Hrs.

Basics of electronic circuit design - lumped circuits - Electronic Prototyping - Working with simulation tool - simple PCB design with EDA

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the fundamentals of design principles and design alternatives
CO2 - Synthesize the apk models and create new app.
CO3 - Understand the CAD tools for 3D modeling.
CO4 - Express the knowledge in the area of rapid prototyping.
CO5 - Enhance the knowledge in basics of electronic circuit design for rapid prototyping.
CO6 - Elaborate the simple PCB design with EDA.

TEXT / REFERENCE BOOKS

1. Peter Fiell, Charlotte Fiell, Industrial Design A-Z, TASCHEN America Llc(2003)
2. Samar Malik, Autodesk Fusion 360 - The Master Guide.
3. Steve Krug, Don't Make Me Think, Revisited: A Common Sense Approach to Web Usability, Pearson,3rd edition(2014)

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SAEB3034	ARTIFICIAL INTELLIGENCE IN AEROSPACE INDUSTRIES	L	T	P	EL	Credits	Total Marks
		3	1	0	0	3	100

COURSE OBJECTIVES

- Understand the importance, principles, and search methods of AI
- Provide knowledge on predicate logic and Prolog.
- Introduce machine learning fundamentals

UNIT 1 INTELLIGENT AGENT AND UNINFORMED SEARCH 9 Hrs.

Introduction - Foundations of AI - History of AI - The state of the art - Risks and Benefits of AI - Intelligent Agents - Nature of Environment - Structure of Agent - Problem Solving Agents - Formulating Problems - Uninformed Search - Breadth First Search - Dijkstra's algorithm or uniform-cost search - Depth First Search - Depth Limited Search.

UNIT 2 PROBLEM SOLVING WITH SEARCH TECHNIQUES 9 Hrs.

Informed Search - Greedy Best First - A* algorithm - Adversarial Game and Search - Game theory - Optimal decisions in game - Min Max Search algorithm - Alpha-beta pruning - Constraint Satisfaction Problems (CSP) - Examples - Map Coloring - Job Scheduling - Backtracking Search for CSP

UNIT 3 LEARNING 9 Hrs.

Machine Learning: Definitions – Classification - Regression - approaches of machine learning models - Types of learning - Probability - Basics - Linear Algebra – Hypothesis space and inductive bias, Evaluation. Training and test sets, cross validation, Concept of over fitting, under fitting, Bias and Variance - Regression: Linear Regression - Logistic Regression.

UNIT 4 SUPERVISED LEARNING 9 Hrs.

Neural Network: Introduction, Perceptron Networks – Adaline - Back propagation networks - Decision Tree: Entropy – Information gain - Gini Impurity - classification algorithm - Rule based Classification - Naïve Bayesian classification - Support Vector Machines (SVM).

UNIT 5 UNSUPERVISED LEARNING 9 Hrs.

Unsupervised Learning – Principle Component Analysis - Neural Network: Fixed Weight Competitive Nets - Kohonen Self-Organizing Feature Maps – Clustering: Definition - Types of Clustering – Hierarchical clustering algorithms – k-means algorithm.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the foundations of AI and the structure of Intelligent Agents
CO2 - Use appropriate search algorithms for any AI problem
CO3 - Study of learning methods
CO4 - Solving problem using Supervised learning
CO5 - Solving problem using Unsupervised learning
CO6 - Solving problem using clustering algorithms.

TEXT / REFERENCE BOOKS

1. S. Russell and P. Norvig, “Artificial Intelligence: A Modern Approach”, Prentice Hall, Fourth Edition, 2021.
2. S.N.Sivanandam and S.N.Deepa, Principles of soft computing-Wiley India.3 rd ed,
3. Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997.
4. I. Bratko, “Prolog: Programming for Artificial Intelligencell, Fourth edition, Addison-Wesley Educational Publishers Inc., 2011.
5. C. Muller & Sarah Alpaydin, Ethem. Introduction to machine learning. MIT press, 2020.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SMEB3033	INDUSTRY 4.0 , 5.0 TECHNOLOGIES AND APPLICATIONS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVES

- To understand different contributing technologies that enable industry 4.0 and 5.0.
- To make aware of how the industry 4.0 and 5.0 technologies can be applied to diverse applications.

UNIT 1 INTRODUCTION TO INDUSTRY 4.0 AND 5.0 9 Hrs.

History of industrial revolutions, Industry 4.0: Definition, core values, contributing technologies, and challenges. Industry 5.0: Definition, core values, contributing technologies, and challenges.

UNIT 2 CONTRIBUTING TECHNOLOGIES TO INDUSTRY 4.0 9 Hrs.

Industrial internet of things, 5G, Smart sensors, Digital twins and simulations, Augmented reality, Virtual Reality, Computer vision systems, Robotics and automation, 3D Printing, Cloud computing, Cyber security, and Big data analytics.

UNIT 3 INDUSTRY 4.0 FOR DESIGN, MANUFACTURING & FACTORY OPERATIONS 9 Hrs.

Cyber-physical systems, Product development: AR/VR enabled CAD, Customized CAD, Cloud based CAD, Digital twin and live simulation, and Additive manufacturing. Smart Manufacturing: Digital manufacturing, Cloud based manufacturing, IoT based manufacturing, Advanced CNC machines and programming, and Micro electro mechanical systems.

UNIT 4 ADDITIONAL CONTRIBUTING TECHNOLOGIES TO INDUSTRY 5.0 9 Hrs.

Extended reality, Cobots and exoskeletons, Smart sensors and bio-based technologies, Artificial intelligence and machine learning, Enhanced additive manufacturing (4D printing), Cloud, cognitive and edge computing, 6G and beyond, Internet of everything, Industrial block chain, Network slicing, Private mobile networks, and Individualized human-machine interaction technologies, Autonomous Vehicles like self-propelled vehicles, drones, and unmanned vehicles.

UNIT 5 INDUSTRY 5.0 FOR MASS PERSONALIZATION, SOCIETY 5.0 AND SDGs 9 Hrs.

Realization of sustainable development goals (SDGs), Society 5.0, and Mass personalization with industry 5.0 technologies, Focus on customer experiences, Hyper-customization, Responsive and distributed supply chain management, Interactive products, Human cyber-physical systems, Collaborative production, Smart and sustainable logistics, Automated accounting, Preventive and predictive maintenance, End-to-end engineering, Mobile and autonomous transportation.

Case Studies: Case studies on the diverse applications of Industry 4.0 and Industry 5.0 like transportation, energy, infrastructure, factory operations, logistics, autonomous mobility, product design, smart cities, smart nation, clean environment, etc.

Max. 45 Hrs.

COURSE OUTCOMES

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

CO1: Explain the core values, contributing technologies, and challenges of industry 4.0 and 5.0.

CO2: Justify how different technologies contribute to industry 4.0.

CO3: Recommend the industry 4.0 technologies to product design, manufacturing, and factory operations.

CO4: Justify how different technologies contribute to industry 5.0.

CO5: Recommend industry 5.0 contributing technologies to realize SDGs, Society 5.0 and mass personalization.

CO6: Prepare a report with the current trends, what industry 4.0 and/or 5.0 technologies can help make these operations smarter, and the benefits and challenges of their implementation for the given case study/ application.

TEXT / REFERENCE BOOKS

1. Uthayan Elangovan, “Industry 5.0: The Future of the Industrial Economy”, CRC Press, 2021.
2. Mahmoud Numan Bakkar and Elspeth McKay, "Advanced Research and Real-World Applications of Industry 5.0", IGI Global Publisher, 2023.
3. Klaus Schwab, “Fourth Industrial Revolution”, Random House USA Inc, New York, USA,2017.
4. Jean-Claude André, “Industry 4.0: Paradoxes and Conflicts”, Wiley Publications, 2019.
5. Oliver Grunow,“Smart Factory and Industry 4.0. The current state of Application Technologies”, Studylab Publications,2016
6. Sang C. Suh, U. John Tanik, John N Carbone, and Abdullah Eroglu, “Applied Cyber-Physical Systems”, Springer Publications, New York,2013.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SBAB4001	PRINCIPLES AND PRACTICES OF MANAGEMENT	L	T	P	EL	C	Total Marks
		3	0	0	0	3	100

COURSE OBJECTIVE

- To analyse how the field of Management has evolved and its significant contributions
- To analyse and apply the critical role of managers in modern organizational settings.
- To illustrate and evaluate the importance of planning, organizing, directing and controlling in decision making.

UNIT 1 INTRODUCTION **9 Hrs.**

Definition, Functions, Process, Scope and Significance of Management. Nature of Management, Managerial Roles, Managerial Skills and Activities, Difference between Management and Administration. Significance of Values and Ethics in Management.

UNIT 2 SCHOOLS OF MANAGEMENT **9 Hrs.**

Evolution of Management Thought - Contributions of F.W. Taylor, Henry Fayol, Elton Mayo, Approaches of Management Thought (including MBO & MBE) Functions of Management. Concept of Leadership- Theories and Styles.

UNIT 3 PLANNING AND ORGANIZING **9 Hrs.**

Nature, Scope, Objective and Significance of Planning, Elements and Steps of Planning, Decision Making Organizing Principles, Span of Control, Line and Staff Relationship, Authority, Delegation and Decentralization. Effective Organizing, Organizational Structures, Formal and Informal Organizations, Staffing.

UNIT 4 DIRECTING **9 Hrs.**

Effective Directing, Supervision, Motivation: Different Theories of Motivation - Maslow, Herzberg, Mc Clelland, Vroom, Porter and Lawler, Job Satisfaction. Communication Process, Channels and Barriers, Effective Communication.

UNIT 5 CONTROLLING AND COORDINATING **9 Hrs.**

Elements of Managerial Control, Control Systems, Management Control Techniques, Effective Control Systems. Coordination Concept, Importance, Principles and Techniques of Coordination, Concept of Managerial Effectiveness.

Max. 45 Hrs.

COURSE OUTCOMES

CO1 - To provide an understanding of basic management concepts, principles, and practices.
CO2 - To develop planning and decision-making strategies in an organization.
CO3 - To summarize the concept and complete the process of organizing.
CO4 - To develop an understanding of staffing, leadership, directing and motivation in an organization.
CO5 - To predict the dynamics of controlling and its emerging issues in management.
CO6 - Assess managerial practices and choices relative to ethical principles and standards

TEXT / REFERENCE BOOKS

1. Stephen P. Robbins, David A. Decenzo, Fundamentals of Management, Pearson Education, 9th Edition
2. Harold Koontz, O'Donnell and Heinz Weihrich, Essentials of Management. New Delhi, 9th edition, Tata McGraw Hill
3. Management Fundamentals: Concepts, Applications, & Skill Development, 6th edition, Sage.
4. Richard L. Daft, Principles Of Management, Cengage Learning.
5. Prasad, L.M. Principles and Practice of Management, Sultan Chand
6. Jhunjhunwala J Mohanty, Management Principles and Applications, Himalaya Publishing House

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

S41BPB41	VENTURE CREATION	L	T	P	EL	C	Total Marks
		2	0	0	3	3	100

COURSE OBJECTIVES

- To develop an entrepreneurial mindset, understand the concept of entrepreneurship and identify personal strengths and weaknesses
- To understand the design thinking process and apply design thinking to real-world problems
- To identify problems and opportunities and develop ideas for new ventures by assessing market potential
- To develop a value proposition, business model canvas, build MVP to create sustainable differentiation for the venture with a well-structured business plan, unit economics, go-to-market strategies and funding plan for managing business growth
- To build an idea pitch and deliver it with confidence to potential stakeholders

UNIT 1 INTRODUCTION TO ENTREPRENEURSHIP 9 Hrs.

Defining Entrepreneurship, evolution the concept & Emerging Trends in Entrepreneurship (Domain specific), understanding the unique opportunities; Why be an Entrepreneur? Entrepreneurship in Indian Scenario & Its role in economic development; Success stories of Entrepreneur (Domain specific);Entrepreneurial style assessment tool; Developing the Entrepreneurial mindset- Attributes & skills, recognizing your sweet spot for starting up; Principles of Effectuation; Myths about Entrepreneurship; Types of Entrepreneurs; Entrepreneur vs Intrapreneur; Role of Entrepreneurial Teams.

UNIT 2 DESIGN THINKING &OPPORTUNITY DISCOVERY 9 Hrs.

Introduction to Design Thinking for startups; Design Thinking principles & process; Define the problem using Design thinking principles and validate Problem; Generation of ideas, Idea generation techniques and evaluating creative ideas; Identify problem worth solving; Sharpen your Problem Pitch.

UNIT 3 CUSTOMER, MARKETS AND CREATING A SUSTAINABLE DIFFERENTIATION 9 Hrs.

Differentiate between a customer and a consumer; Who is your customer and what is your segment; Customer Job, Pains, and Gains using Value proposition Canvas; Build solution using Value Proposition Canvas; Market Estimation-TAM,SAM,SOM; Competitive analysis; Minimum viable product – what is MVP: Build - Measure - Learn, differentiate between solution Demo & MVP; How to validate MVP- Achieve a Product – Market fit.

UNIT 4 BUSINESS MODEL, BUSINESS PLANNING AND GO TO MARKET STRATEGIES 9 Hrs.

Introduction to Business model, Business plan ; Lean approach 9 block lean canvas model; Financial feasibility: Costs, revenue streams, Pricing, Financial Projections, Key Financial Metrics using financial template, Managing growth & targeting scale, Unit economics; Selecting the Right Channel; Introduction to Digital Marketing and tools; Branding strategy.

UNIT 5 FUNDING STRATEGY **9 Hrs.**

Sources of funds: Debt & Equity ; Map the Start-up Lifecycle to Funding Options; Build an Investor ready pitch deck

Max. 45 Hrs.

COURSE OUTCOMES

CO1 - To define entrepreneurship and explain emerging trends in entrepreneurship.
CO2 - To identify and evaluate business opportunities and assess market potential
CO3 - To conduct customer discovery, market research, build a lean canvas, develop a business plan and marketing strategies
CO4 - To identify sources of funding and develop a funding strategy, understand basic legal requirement for starting and running a business
CO5 - To build an idea pitch and deliver it with confidence to various stakeholders To develop planning and decision-making strategies in an organization.

TEXT / REFERENCE BOOKS

1. Hisrich, R. D., Peters, M. P., & Shepherd, D. A. (2017). Entrepreneurship (10th ed.). McGraw-Hill Education.
2. Ries, E. (2011). The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. Crown Business.
3. Blank, S. G., &Dorf, B. (2012). The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company. K&S Ranch.
4. Roy, R. (2017). Indian Entrepreneurship: Theory and Practice. New Delhi: Oxford University Press.
5. Chandan, J. S., & Rana, S. S. (2019). Entrepreneurship Development and Management. New Delhi: McGraw Hill Education.
6. Sinek, S. (2011). Start with Why: How Great Leaders Inspire Everyone to Take Action. Portfolio.
7. Choudhary, R., & Mehta, N. (2019). From Zero to One: How to Build a Successful Startup in India. Notion Press.
8. Osterwalder, A., &Pigneur, Y. (2010). Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. John Wiley & Sons.
9. Mitra, P., & Banerjee, A. (2019). Startup Minds: The Entrepreneur's Journey from Idea to Success. SAGE Publications India.
10. Thiel, P. (2014). Zero to One: Notes on Startups, or How to Build the Future. Crown Business.
11. Zappos, T. (2010). Delivering Happiness: A Path to Profits, Passion, and Purpose. Business Plus.

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
ESE	**University Assessment Exam**	**50 Marks**

SMEB3037	ENTREPRENEURSHIP DEVELOPMENT	L	T	P	C	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

- To Empower the students with knowledge of entrepreneurship skills.
- To develop and strengthen entrepreneurial quality and motivation in students and to impart basic entrepreneurial skills and understanding to run a business efficiently and effectively.
- To develop and strengthen entrepreneurial quality and motivation in students and to impart basic entrepreneurial skills and understanding to run a business efficiently and effectively.

UNIT 1 INTRODUCTION TO ENTREPRENEURSHIP 9 Hrs.

Meaning and concept of entrepreneurship, the history of entrepreneurship development, role of entrepreneurship in economic development, Myths about entrepreneurs, agencies in entrepreneurship management and future of entrepreneurship types of entrepreneurs. Pros and Cons of being an entrepreneur, Women entrepreneurs- problems and promotion, Types of Entrepreneurs, Characteristics of a successful entrepreneur, Competency requirement for entrepreneurs - Awareness of self-competency and its development**.**

UNIT 2 MOTIVATION AND PRODUCT 9 Hrs.

Major Motives Influencing an Entrepreneur – Achievement Motivation Training, Self-Rating, Business Games, Thematic Apperception Test – Stress Management, Entrepreneurship Development Programs – Need, Objectives. Product - Definition, types, criteria in the selection of a product. Market research-definition, techniques. SWOT Analysis- definition, scope, importance

UNIT 3 BUSINESS CONCEPT 9 Hrs

Business enterprise – definition, steps involved in starting a business venture –formalities, licensing and registration procedures-Small Enterprises – Definition, Classification – Characteristics, Ownership Structures – Project Formulation – Steps involved in setting up a Business – identifying, selecting a Good Business opport MODULE, Market Survey and Research, Techno Economic Feasibility Assessment – Preparation of Preliminary Project Reports – Project Appraisal – Sources of Information – Classification of Needs and Agencies. Industrial estates – role and types

UNIT 4 BUSINESS PLAN 9 Hrs

Business Plan- Definition, importance- Preparing Business Plan - Financial aspects of the Business Plan -Marketing aspects of the Business Plan - Human Resource aspects of the Business Plan - Technical aspects of the Business Plan - Social aspects of the Business Plan - Problems and prospects of Business Plan.

UNIT 5 SUPPORT TO ENTREPRENEURS 9 Hrs.

Sickness in small Business – Concept, Magnitude, Causes and Consequences, Corrective Measures – Business Incubators – Government Policy for Small Scale Enterprises – Growth Strategies in small industry – Expansion, Diversification, Joint Venture, Merger and Sub Contracting.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 –Identify your entrepreneurship traits.

CO2 - Develop awareness about entrepreneurship and successful entrepreneurs.

CO3 –Identify the business opportunity

CO4 – Apply the prospects of business plan.

CO5 - Develop an entrepreneurial mind-set by learning key skills such as design, personal selling, and communication.

CO6 – Understand the DNA of an entrepreneur and assess their strengths and weaknesses from an entrepreneurial perspective

TEXT / REFERENCE BOOKS

1. S.S.Khanka, “Entrepreneurial Development” S.Chand & Co. Ltd. Ram Nagar New Delhi,1999.
2. Kurahko & Hodgetts, ” Entrepreneurship – Theory, process and practices”, Thomson learning 6th edition, 2018.
3. Donald F Kuratko, “Entrepreneurship – Theory, Process and Practice”, 9th Edition, Cengage Learning, 2018.
4. Rajeev Roy, "Entrepreneurship" 2nd Edition, Oxford University Press, 2017.
5. Hisrich R D, Peters M P, “Entrepreneurship” 8th Edition, Tata McGraw-Hill, 2018

END SEMESTER EXAM QUESTION PAPER PATTERN

Max. Marks : 100 **Exam Duration : 3 Hrs.**

CAE	**Continuous Assessment Exam**	**50 Marks**
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