Department of Aerospace Engineering

Criterion 1.1.3

Average percentage of courses having focus on employability/entrepreneurship/ skill development offered by the University

2019-2020 to 2021-2022

YEAR	**:**	**VII / IV**
COURSE CODE	**:**	**16AS401**
TITLE OF THE COURSE	**:**	**Avionics**
L: T: P: S/P: C	**:**	**03:00: 00:02: 04**

COURSE OBJECTIVES:

This course will enable students to:

1. To understand analyze Avionics System Requirements
2. To understand evolution of Flight Deck Design
3. To understand Federated and Integrated Avionics System Architectures involving MAU, LRMs and various digital Data bus networks.
4. To understand system assessment methods

COURSE OUTCOMES:

Upon successful completion of this course, the students:

1. To apply System requirement analysis methods for decomposition of functions among systems and sub systems
2. To build message structures using data bus concepts and to evolve conceptual avionics system architectures
3. To evolve avionics test bench architecture
4. To appreciate importance of HFE in Flight Deck Design and automation

Module 1 8 Hours

Power Distribution System: Bus Bar, split bus bar system, special purpose cables. Electrical diagram and identification scheme. Circuit controlling devices. Power utilization-typical application to avionics. Need for Avionics in civil and military aircraft.

Module 2 **8 Hours**

Inertial Navigation System: Gyroscopic versus Inertial platform. Structure of stable platform. Inertial Navigation units. Inertial alignment. Inertial interface system. Importance of Compass swing. Electronic Flight Control System: Fly-by-wire system:-basic concept and features. Pitch and Roll rate:-command and response. Control Laws. Frequency response of a typical FBW actuator. Cooper Harper scale. Redundancy and failure survival. Common mode of failures and effects analysis.

Module 3 **8 Hours**

Electronic Flight Instrument Systems: Display -units, presentation, failure, and annunciation. Display of air data. Introduction to Avionics Sub Systems and Electronic Circuits: Typical avionics subsystems. Amplifier, oscillator, aircraft communication system, transmitter, receiver, antenna.

Module 4 **8 Hours**

Principles of Digital Systems: Digital Computers, Microprocessors, Memories. Flight Deck and Cockpits: Control and display technologies CRT, LED, LCD, EL and plasma panel, Touch screen, Direct voice input (DVI)-Civil cockpit and military cockpit : MFDS, HUD, MFK, and HOTAS

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Module 5 **8 Hours**

Avionics Systems Integration: Avionics equipment fit. Electrical data bus system. Communication Systems, Navigation systems, Flight control systems, Radar, Electronic Warfare, and fire control system. Avionics system architecture, Data buses, MIL-STD1553B.

Text Books:

1. Introduction to Avionics Systems R.P.G. Collinson Springer 3rd edition, 2011
2. Aircraft Systems: Mechanics, Electrical and Avionics Subsystems Integration Ian Moir, Allan Seabridge Wiley 3rd Edition, 2012

Reference Books:

1. Middleton, D.H., Ed., "Avionics Systems, Longman Scientific and Technical", Longman Group UK Ltd., England, 1989, ISBN-13: 978-0582018815.
2. Spitzer, C.R., "Digital Avionic Systems", McGraw-Hill Inc., US, 2nd edition, 1992, ISBN-13: 978-0070603332.
3. Mike Tooley and David Wyatt, Aircraft Communications and Navigation Systems, Butterworth Heinemann, 2007.
4. D.R. Cundy and R.S. Brown, Introduction to Avionics, Pearson, 2010.

SEMESTER/YEAR	**:**	**VII / I V COURSE**
CODE	**:**	**16AS404**
TITLE OF THE COURSE	**:**	**Aircraft Design**
L: T: P: S/P : C	**:**	**03 :00 : 00 :00 : 03**

COURSE OBJECTIVES

This course will enable students to

1. This course deals with Conceptual designs of aerospace vehicles, components, missions, or systems that incorporate realistic constraints/applicable engineering standards.
2. Students who successfully complete the course will demonstrate the outcomes by accomplishing the conceptual design of an aircraft

COURSE OUTCOMES

Upon successful completion of this course, the students:

1. Develop the ability to synthesize basic engineering science to accomplish a mission-driven design of an aircraft, including:
2. Perform conceptual airplane and propulsion sizing estimates to meet specified operational and performance requirements
3. Develop proficiency in and an appreciation for performing trade studies to optimize aircraft conceptual design.

Module 1 **8 Hours**

Overview of Design Process:

Introduction, Typical requirements for a civil transport and a military fighter aircraft, Phases of design, Aircraft conceptual design process, Take-off weight build up, Empty weight estimation, Fuel fraction estimation, Take- off weight calculation, Trade studies.

Airfoil Selection: Airfoil geometry, Airfoil lift and drag, Airfoil families, Airfoil design, Airfoil lift coefficient, Airfoil thickness, Camber, Stall, Reynolds number effects

Module 2 **9 Hours**

Geometry: Wing geometry, Aspect ratio, Sweep, Taper ratio, Twist, Incidence, Dihedral, Wing vertical location of wings, Wing tips, Biplane wings, Tail geometry and arrangement

Thrust to Weight Ratio & Wing Loading Thrust to weight definitions, Power loading, Statistical

estimate of T/W. Thrust matching, Wing Loading and its effect on Stall speed, Take-off Distance, Catapult take-off, and Landing Distance. Wing Loading for Cruise, Loiter, Endurance.

Module 3 **8 Hours**

Initial Sizing: Rubber engine sizing, Fixed engine sizing, Geometry sizing – Fuselage, Wing, Tail volume coefficient and Control surface sizing,

Configuration Layout & loft: Conic lofting, Conic fuselage development, Conic shape parameter, Wing-tail layout & Loft. Aerofoil linear interpolation. Aerofoil flat-wrap interpolation. Wing aerofoil layout-flap wrap. Wetted area determination. Special considerations in configuration layout: Aerodynamic, Structural, Detectability. Crew station, Passenger, and Payload arrangements

Module 4 **8 Hours**

Aerodynamics & Propulsion: A brief overview of aerodynamic coefficients and forces, Types of propulsion systems, Jet engine thrust considerations, Thrust-drag book keeping, Installed thrust methodology, Piston engine performance – propeller performance and piston-prop thrust correction, Turboprop performance

MODULE 5 **7 Hours**

Sizing calculation using spread sheet, Design using CAD software. Software available for aircraft design (OpenVSP)

Text Books:

1. Daniel P. Raymer, Aircraft Design - A Conceptual Approach- AIAA Education Series, IV Edition © 2006.
2. Thomas C Corke, Design of Aircraft- Pearson Edition. Inc. © 2003.

Reference Books:

1. J Roskam, Aeroplane Design –Vol: 1 to 9
2. John Fielding, Introduction to Aircraft Design - Cambridge University Press, 2009
3. Standard Handbook for Aeronautical & Astronautical Engineers, Editor Mark Davies , Tata

McGraw Hill, 2010

SEMESTER/YEAR : VII / IV

COURSE CODE :16AS406

TITLE OF THE COURSE : Unmanned Aircraft Systems & E- Mobility

L: T: P: S/P: C : 03:00: 00:00: 03

COURSE OBJECTIVES:

This course will enable students to

1. To understand roles and responsibilities for UAVs.
2. To identify and define aircraft systems and navigation
3. To understand the basics of electric vehicles, their architecture and modeling.

COURSE OUTCOMES:

Upon successful completion of this course, the students:

1. Describe different phases of design of UAVs.
2. Describe the basic principles of UAS operation requirements and develop concept operation
3. Describe various E-Vehicle management systems and its simulations.

Module 1 **10 Hours**

Introduction to Unmanned Aircraft Systems (UAS). The Beginning The Need for Effective Control The First Modern Unmanned Aircraft; The Target Drone Some Applications of UAS, The Systemic Basis of UAS System Composition Basic Technology Control Methods. Classification of UAS Long-endurance, Long-range Role Aircraft Medium-range, Tactical Aircraft Close-range/Battlefield Aircraft; MUAV Types MAV and NAV Types, UCAV Novel Hybrid Aircraft, Configurations Research UAV

Module 2 **10 Hours**

Introduction to Design and Selection of the System Conceptual Phase Preliminary Design Detail Design Selection of the System Aerodynamics and Airframe Configurations Lift-induced Drag Parasitic Drag Rotary-wing Aerodynamics Response to Air Turbulence Airframe Configurations

Transportation: Micro-UAV VTOL Close-range Systems HTOL Close-range Systems Medium-range Systems MALE and HALE Systems

Module 3 **10 Hours**

THE DEVELOPMENT OF UAV SYSTEMS

Introduction to System Development and Certification System Development Certification Establishing Reliability System Ground Testing UAV Component Testing UAV Sub-assembly and Sub-system

Testing Complete UAV Control Station Testing Catapult Launch System Tests Documentation System In-flight Testing Test Sites Preparation for In-flight Testing In-flight Testing System Certification

Module 4 **10 Hours**

Electro mobility and the Environment

A Brief History of the Electric Powertrain, Energy Sources for Propulsion and Emissions, The Advent of Regulations, Drive Cycles, BEV Fuel Consumption, Range, and mpge, Carbon Emissions for Conventional and Electric Powertrains, An Overview of Conventional, Battery, Hybrid, and Fuel Cell Electric Systems, A Comparison of Automotive and Other Transportation Technologies.

Vehicle Dynamics: Vehicle Load Forces, Vehicle Acceleration, Simple Drive Cycle for Vehicle Comparisons

Module 5 **10 Hours**

Battery Management & EV Simulation

Batteries Types and Battery Pack, Lifetime and Sizing Considerations, Basic Requirements for Charging System, Charging Standards and Technologies, BMS Definition, Li-Ion Cells, Li-Ion BMSs, Li-Ion Batteries,BMS Functions: Measurement: Voltage, Temperature, Current.

EV Simulations: system level simulation, EV simulator, simulator modules, performance evaluation, system optimization.

Text books:

1.Reg Austin, Unmanned Aircraft systems UAVs Design, Development and Deployment, A John Wiley & Sons,Ltd.,2010.

2. Douglas M.Marshall et al., Introduction to unmanned Aircraft systems, second edition Taylor & Francis, 2016.

3. Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles, John G. Hayes, G. Abas Goodarzi, 1st Edition, 2018, Wiley, ISBN 9781119063667.

Reference Books:

1. Jay Gundlach, Civil and commercial Unmanned Aircraft Systems, AIAA Education Services, 2016

2. Battery Management system for large Lithium Battery Packs, Davide Andrea, 1st Edition, 2010, ARTECH HOUSE, ISBN-13 978-1-60807-104-3

3. Hybrid Vehicles from Components to System, F. BADIN, Ed, 1st Edition, 2013, Editions Technip, Paris, ISBN 978-2-7108-0994-4.

4. Modern Electric Vehicle Technology C.C. Chan and K.T. Chau, 1st Edition, 2001, Oxford university press, ISBN 0 19 8504160.

SEMESTER/YEAR	**:**	**VII / IV**
COURSE CODE	**:**	**16AS408**
TITLE OF THE COURSE	**:**	**Satellite Technologies**
L: T: P: S/P: C	**:**	**03:00: 00:00: 03**

COURSE OBJECTIVES:

This course will enable students to

1. Understand the function of spacecraft subsystems.
2. Apply orbital mechanics formula and tools to spacecraft mission design.
3. Select appropriate launch systems and understand their affect on satellite and payload design and performance

COURSE OUTCOMES:

Upon successful completion of this course, the students

1. Evaluate spacecraft subsystem performance and trades
2. Estimate space system costs
3. Trade subsystem performance requirements to optimize higher-level system performance, cost, or weight

Module 1: Mission planning analysis and design **8 hours**

The space era, Nano satellite, Nano satellite-Evolution, Disruptions, global economics, future scenario. Orbital elements, types of orbits-LEO, SSO, MEO, GEO, Mission definition, Mission objectives, Mission analysis, mission operations .Mission control software Basic concepts of flight dynamics.

Module 2: Payload options for Nano satellite **8 hours**

Types of payload for a nanosatellite, design considerations for payloads, Earth observation payloads-optical camera, infra-red camera, spectrometers. Communication payloads in a Nanosatellite-Store and forward system, Ionospheric effects, AIS, laser communications, scientific payloads.

Module 3: Nanosatellite structure & Thermal Control systems **8 Hours**

Types of structure design, Building structure, CubeSat Structure, Material for structure, structure analysis, testing of structure.

Thermal systems: Satellite working environment, design and analysis, implementation of TCS, types of thermal control-Active and passive thermal controls, testing of nanosatellite for verification of TCS.

Module 4: Communication systems and Digital electronics 8 Hours

OBC hardware and software, telemetry-TM data acquisition, on board time, on board data storage, tele command- Code selection command format, Attitude control electronics Space segment RF communication, ground segment-Earth station, optical and laser communication.

Module 5: Product Assurance 8 Hours

Environment conditions a satellite undergo Product assurance and quality assurance, Reliability analysis, Reliability standards and specifications, Reliability prediction, Product assurance for a nanosatellite, software quality assurance.

Software's

CubeSat Simulation Library, Introduction to STK software

Text Books

1. "Quintessence of Nano-Satellite technology", Planet Aerospace India, Notion Press, ISBN: 978-1-64951-662-6, 2020.

Reference Books

1. Nithin Sivadas,Akshay Gulati, "A Nanosatellite Mission to study charged particle precipitation from van Allen Radiation Belts caused due to Sesimo-Electromagnetic Emissions", Indian Institute of technology Madras.
2. NASA Ames Launching Nanosatellites, Science Experiments on SpaceX Rocket, April 10, 2014.
3. Communications"-Dennis Roddy Publisher: Tata McGraw Hill Education Pvt Ltd, Delhi.

SEMESTER/YEAR : VII SEM / IV COURSE
CODE :16AS410
TITLE OF THE COURSE : Aircraft Maintenance, Overhaul and Repair
L: T: P: S/P: C : 03:00: 00:00: 03

COURSE OBJECTIVES:

This course will enable students to

1. Comprehend the fundamentals of maintenance and certification.
2. Acquire the knowledge of documentation for maintenance.
3. Understand the Aircraft Maintenance, safety and trouble shooting.

COURSE OUTCOMES:

Upon successful completion of this course, the students

1. Maintain the aircraft maintenance manual and logbook.
2. Do the quality control and calibration.
3. Incorporate the safety regulations and rules.

Module -1 **8 Hours**

Fundamentals of Maintenance & Certification

Types of maintenance, Redesign, Failure rate pattern, other maintenance considerations. Aviation industry certification requirements, Type certificate (FAA form 8110.9), Airworthiness certificate (FAA form 8100-2), Aviation maintenance certifications, General, Airframe, Powerplant, Avionics courses.

Module -2 **8 Hours**

Documentation for Maintenance Manufacturers documentation, Airplane maintenance manual, Fault insulation manual, illustrated parts catalogue, structural repair manual, wiring diagram manual, Master minimum equipment, Federal Aviation regulation (FAR), Advisory circulars, Airworthiness direction ATA document standards, Technical policies and procedure manuals(TPPM), calibration manual, Directorate General of Civil Aviation (DGCA)

Module -3 **8 Hours**

Aircraft Management Maintenance

Structure, Role of aviation management, Line supervisory management, Management areas of concern in airlines, Manager of overhaul shops, Line maintenance control center flight line (preflight & post flight), Aircraft Logbook, daily check on major components of aircraft depending on airframe (flying) hours or calendar life, Maintenance crew skill requirements. First Flight Servicing (FFS), Turn Round Servicing (TRS), Last Flight Servicing (LFS), Types of maintenance bases

Module -4 **9 Hours**

Hangar Maintenance (on Aircraft) & Material Support

Introduction, organization of hanger maintenance, Non- routine item, parts availability, cannibalization, Types of shops- sheet metal shop, Aircraft interior shop, Engine shop, Avionics shop, ground support equipment and ground handling equipment, outsourcing of shop maintenance work, operation of overhaul shops, Material support, Material management inventory control, Support functions of material, Parts ordering, Storage, Issue, control and handling, Parts receiving quality control, calibration program, stock level adjustments, shelf life, exchanges, warranty & modifications of parts, spares management, approved bonded stores for airborne items.

Module -5 **7 Hours**

Maintenance Safety &Trouble shooting

FOD, Safety regulations, Role of ATC. Tarmac discipline and management, occupational safety and health standards maintenance safety program, Airlines safety management, General safety rules, Accident & injury reporting, Hazardous materials storage and handling aircraft furnishing practices trouble shooting, repeated snags, rectifications, modifications on aircraft and release of mod leaflets, Knowledge of malfunctions.

Text Books:

1. Harry A Kinnison, Tariq Siddiqui, Aviation Maintenance Management, Mc Graw Hill education (India) Private Ltd 2013.
2. Kroes, Watkins, Delp, ‘Aircraft maintenance and repair’, Mc Graw Hill, 2013.

Reference Books:

1. Larry Reithmaier “Aircraft Repair Manual" Palmar Books, Marquette, 1992.
2. Brimm. DJ, Bogges, HE, Aircraft Maintenance, Pitman publishing corp, London, 1952.

SEMESTER/YEAR : VIII / IV
COURSE CODE : 16AS412
TITLE OF THE COURSE : Aerospace Technical Publications
L: T: P: S/P: C : 03:00: 00:00: 03

COURSE OBJECTIVES:
1) To understand the fundamentals of aircraft and its systems and subsystems.
2) To understand the fundamentals and role of Aerospace Technical Publications in Aerospace Industry.
3) To understand Importance of Airworthiness, various Airworthiness standards, Type certificate & Production under Type Certificate.
4) To understand function, types, and controls of Aircraft propulsion systems.
5) To understand the avionics and communication system of Aircraft
6) To understand the various aviation quality standards which are required for Aerospace Technical Publications.

COURSE OUTCOMES:
• After completion of the course, the graduates will be able to:
• Understand the certification, aircraft registration procedures
• Explain the Airworthiness requirements for different categories of aircrafts
• Apply knowledge of engineering mechanics, controls, electronics, electrical and communication engineering to identify different systems instruments used in an aircraft
• Examine the different systems present in an aircraft.
• Apply the knowledge of aircraft standards and selecting the methods / methodology to carry out any process in aircraft.
• Evaluate and interpret the Aerospace technical manuals.

Module 1: 8 hours

AEROSPACE TECHPUBS, AEROSPACE INDUSTRY LANDSCAPE AND MAJOR PLAYERS:

Aerospace Techpups-Role, Life Cycle; Airworthiness Standards and Regulations, Aerospace Industry Landscape & Key Competitors, Key Sectors of Aerospace and Defense Industry, Maintenance, Repair & Overhaul (MRO), Aircraft decommissioning, Relevance to Technical publications.
LIFE SPAN OF AIRCRAFT
Design Process - Problem definition, Conceptual Design, Preliminary Design, Detail Design. Flight Test-Certification, Aircraft Manufacturing, Construction, Assembly, Testing, Aircraft sales, Aircraft Handover, Aircraft Leasing, Aircraft After Market, Aircraft Decommissioning, Technical publication development
AIRWORTHINESS, TYPE CERTIFICATION AND REGULATORY BODIES
Importance of Airworthiness, standards, regulatory bodies, certificate, categories, Validity Type certificate & Production under Type Certificate, Aviation Authorities, Airworthiness Directories, Impact of AD on technical publications.

Module 2: **8 hours**

KNOW YOUR AIRCRAFT

Basic terminology used in aerospace techpubs. Basics of Flight - forces acting on aircraft, Lift, Weight, Thrust, Drag, Angle of attack, L/D ratio, Air foil Design, Construction. Types of Aircraft - types of aircrafts and its classification. Different Aircraft Families - Boeing Aircraft family, Bombardier Aircraft family, Aircraft Dimensions, Sections and Station Numbers.

KNOW YOUR AIRCRAFT ELECTRICAL AND LIGHTING SYSTEMS

Electrical System - AC and DC Generation, AC and DC Electrical Load Distribution, Primary and Secondary Power Distribution, Electrical Structure Network. Lighting System- purpose, exterior lights including anticollision, landing, taxi, logo, wing inspection lights. Internal Lights, Emergency lightning, Maintenance, and inspection lightning.

KNOW AIRCRAFT AVIONICS, COMMUNICATION, NAVIGATION AND INFLIGHT ENTERTAINMENT SYSTEM

Communication System - Purpose, External Transmission, Audio Integrating and Voice Command Systems, Static Discharger. Navigation System - Air Data/Inertial Reference Systems, Standby navigation systems, Radio Altimeter (RA), Distance Measuring Equipment, Aircraft Environment Surveillance System. Inflight Entertainment System - overview on inflight entertainment system.

Module 3: **9 hours**

AIRCRAFT DIFFERENT SYSTEM FAMILIARIZATION

Aircraft General Presentation: Introduction, Fuselage-types, Truss, monocoque, Semi-monocoque. Wings, Stabilizers, Engine, Landing Gear. Airframe - Airframe classification, Aircraft Structure- Fixed Wing, Structural stress on Aircraft, Fuselage, types, Aircraft Wing, Classification, Structure, Sub-assemblies, Ribs, stringer, Skin, Empennage, Tail, Fins and Unusual fin Configuration. Aircraft Flight controls – Primary and secondary controls.

Air conditioning system - purpose, Distribution System, Pressurization Control System, Air Cooling system, Temperature Control, Moisture/Air Contaminant Control. Equipment and Furnishing - Cockpit, Passenger Compartment, Galleys, Lavatories, Additional Compartments,

Emergency Equipment. Fire Protection System – Functions, Methods, Fire extinguishing methods. Flight Control System - Primary Flight Control System, Aileron, Spoiler, Elevator, Trimmable Horizontal Stabilizer, Rudder, Lift Augmenting, Flaps. Fuel system - Purpose, Storage, Distribution, Dump/Jettison, Fuel Quantity and Management System, Control and Indicating. Hydraulic System - working principle and purpose, Basic Hydraulic Systems, and its components, Open and Closed Center Hydraulic Systems, power jack, Hydraulic Systems components, Hydraulic Systems in a large Aircraft, Advantages of Hydraulics.

Landing Gear - Landing Gear types and operation, Alignment, Support, and Retraction systems, Safety Devices, Maintenance, Rigging and Adjustment, Steering Systems Aircraft wheels- construction and inspection, Brakes, Brake Actuating Systems, Aircraft Tires and Tubes, classification, construction, inspection.

Module 4: **9 hours**

AIRCRAFT DIFFERENT SYSTEM FAMILIARIZATION

Aircraft Oxygen System - Oxygen system, requirements, Cockpit Oxygen system, Passenger Oxygen system, Portable Oxygen System. Aircraft Pneumatic Systems - Components, bleed sources, sub systems, Distribution, Indicating, Sources of the Pneumatic systems.
Water and Waste Management System - purpose, Potable water system, Toilet system, Wastewater drain. Master Warning System, List of Warnings – description, controls and indications, CAS message Window, mode and Types, master indicator lights, warning, and caution lights. Aircraft ground handling and ground equipment: Refuelling - Safety Precautions, procedure, Bonding, and grounding, refuelling vehicles, Towing, Parking, Mooring, Storage, Jacking of aircraft, Ground Support Equipment - Technical publication.
AIRCRAFT POWER PLANT SYSTEMS, DISPLAYS AND CONTROLS
Types of Turbine Engines - Turbojet, Turboprop, Turbofan, Turboshaft Engines. Engine Systems and Controls- Cowling, Mounts, Engine, Propulsion Control System (PCS), Fuel distribution, Power Control, Air System, Ignition System, Starting, Oil System, Thrust Reverser. Control and Indicating - Engine controls.

Module 5: **7 hours**

STANDARDS USED IN AERO TECH-PUBS

S1000D: S1000D and Commercial Aviation, Benefits, Book-Based Structures vs. S1000D Data Module. Structures, Data Module Types, From Data Modules to Publications iSpec 2200: Introduction, History, Description, Difference between ATA 100 and iSpec 2200, Deliverables of iSpec 2200, ATA SGML concept.
Introduction to ATA systems: ATA overview, Usage of ATA spec, ATA system codes, Difference between ATA 100, iSpec 2100 and iSpec 2200, ATA chapters, ATA numbers and its ATA Chapter name.
Introduction to ASD STE-100, Why ASD STE-100, Advantages of ASD STE 100, Writing rules, Difference between normal English and STE, Descriptive writing, Examples in STE.

TEXT BOOKS:

1) Airworthiness: An Introduction to Aircraft Certification, 2nd Edition, ASIN: B00519EPVU, Butterworth-Heinemann, 2010.
2) John D. Anderson, “Introduction to Flight”, McGraw-Hill Education, 2011. ISBN: 9780071108059.

3) Ianmoir, Allan Seabridge, “Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration”, John Wiley & Sons, 2011, ISBN 978111965008.
4) Lalit Gupta And O P Sharma, Aircraft Systems (Fundamentals of Flight Vol. IV), Himalayan.

REFERENCE BOOKS:

1) Pallet, E.H.J., Aircraft Instruments and Integrated Systems, Longman Scientific And Technical, Indian Reprint 1996.
2) A.C Kermode, “Flight Without Formulae”, Pearson Education India, 1989. ISBN – 9788131713891.
3) S R Majumdar, Pneumatic Systems, Tata Mcgraw Hill Publishing Co.; 1995.
4) Irwin E. Treager, Gas Turbine Engine Technology_, GLENCOE Aviation Technology Series, 7th Edition, Tata McGraw Hill Publishing Co. Ltd. Print 2003.

SEMESTER /YEAR : VII/IV
COURSE CODE : 16AS471
TITLE OF THE COURSE : AI & ML Lab
L: T/A:P: C : 0 : 0 : 3 : 1

COURSE OBJECTIVES:

This course will enable students to

1. This course aims to provide a foundation in artificial intelligence techniques for planning, with an overview of the wide spectrum of aerospace problems

COURSE OUTCOMES:

At the end of this course, student is able to

1. Write program in Python for general purpose
2. Appreciate the need for data cleaning, data visualization
3. Familiar with Machine learning algorithms available in Python.
4. Familiar with data sets related to aero and space applications

LIST OF EXPERIMENTS:

1. Applications of AI&ML in Aerospace Engineering
2. Introduction to data science, machine learning and Python
3. Introduction to case studies (Engine Health Monitoring, satellite data, etc.) and get the datasets from the open literature
4. Work on data cleaning, data visualization and data analysis (statistical quantities)
5. Introduction to machine learning methods (Supervised/Un-supervised and Reinforcement Learning)
6. Very quick introduction to machine learning algorithms (Linear Regression. Logistic Regression. Decision Tree. SVM, Naive Bayes. kNN, K-Means, Random Forest.)
7. Dividing the available data into training and testing data
8. Discussion on trend analysis and applying various machine learning algorithms available in python
9. Discussion on openly available data sets for aerospace and other industries

SEMESTER /YEAR : VII/IV
COURSE CODE : 16AS472
TITLE OF THE COURSE : Major Project Stage I
L: T/A:P: C : 0 : 0 : 10 : 5

Projects in Aerospace engineering are to strengthen the understanding of the student's fundamentals through the effective application of theoretical concepts. They develop the skill which helps them to deliver a solution to a problem or business need that meets some defined requirements within a budgeted cost and schedule. Stage I of the Major Project covers problem formulation, under the guidance of faculty in the department. The students are expected to work on a topic in the field of Aerospace Engineering. They will be evaluated based on the presentations made during the course of the project and the report submitted at the end of the semester. The evaluation is done by a committee of examiners appointed by the Chair of the Department.

Course Outcomes

1. To identify research topic in their area of interest in Aerospace Engineering
2. To conduct a thorough literature review, identify gaps and define objectives and scope of work
3. To develop a methodology for prototype/model/experimental setup necessary for the project
4. To present, articulate and defend the findings

SEMESTER /YEAR : VII/IV
COURSE CODE : 16AS481
TITLE OF THE COURSE : Major Project Stage II
L: T/A:P: C : 0 : 0 : 18 : 9

Projects in Aerospace engineering are to strengthen the understanding of the student's fundamentals through the effective application of theoretical concepts. They develop the skill which helps them to deliver a solution to a problem or business need that meets some defined requirements within a budgeted cost and schedule. The project should be focused on the synthesis of knowledge gained over the previous semesters and Stage-I of the project. The project should be relevant to Aerospace Engineering which could involve theoretical and/or computational and/or fabrication and/ or experimental work. Students are required to submit a report at the end of the semester. Evaluation will be done during the course of the project as well as at the end of the semester by a committee of examiners appointed by the Chair of the Department.

Course Outcomes

1. To identify a research topic and conduct a thorough literature survey and define the objective and scope of work
2. To develop a methodology (design) for conducting a theoretical/experimental study
3. To implement, analyze the findings of the proposed problem.
4. To organize, analyze results and draw conclusions through group discussion.
5. To document and present the findings

SEMESTER/YEAR : V / III

COURSE CODE : 19AS3501

TITLE OF THE COURSE : AERODYNAMICS – II

L: T: P: S/P: C : 03:00: 00:00: 03

COURSE OBJECTIVES

This course will enable students to:

1. To provide students with an overview of effects of Compressible flows.
2. Analyze how the aerodynamics affects the aircraft design and operation
3. To make students understand the characteristics of normal and oblique shock waves.
4. To make students learn about the effects of high-speed flows.

COURSE OUTCOMES

Upon successful completion of this course, the students:

1. Apply the essential facts, concepts and principles of compressible flows
2. Utilize the concepts of normal shock phenomenon
3. Analyze the concepts of oblique shock and expansion waves
4. Acquire the knowledge of differential equations of motion, governing Compressible flows.
5. Measure the parameters of high-speed flows.

Module -1 **8Hours**

One Dimensional Compressible Flow:

Mass, Momentum, Energy equations, velocity of sound, adiabatic steady state flow equations, Flow through convergent-divergent nozzle, Performance under various back pressures.

Module -2 **8 Hours**

Normal Shock:

Prandtl Meyer equation and Rankine – Huguenot relation, Normal shock equations: Property ratios in terms of upstream Mach number, Moving Normal Shock wave, Numerical problems

Module -3 **8 Hours**

Oblique shocks and Expansion waves:

Oblique shocks and corresponding equations, Hodograph and pressure turning angle, shock polars, flow

past wedges and concave corners, strong, weak and detached shocks, Flow past convex corners, Prandtl –Meyer expansion function, Reflection and interaction of shocks and expansion waves, Pitot static tube, corrections for subsonic and supersonic flows.

Module -4 **8 Hours**

Steady State Compressible Flows:

Basic potential equations for compressible flow. Linearization of potential equation-small perturbation theory. Boundary conditions, Pressure coefficient expression, small perturbation equation for compressible flow -Ackert's supersonic airfoil theory, Lift, drag pitching moment and center of pressure of supersonic profiles.

Module -5 **8Hours**

Measurements in High speed Flow:

Types of subsonic wind tunnels - Balances and measurements - Interference effects- transonic, Supersonic and hypersonic wind tunnels and characteristic features, their operation and performance - Shock tubes and shock tunnels - Free flight testing - Measurements of pressure, velocity and Mach number –Flow visualization methods of subsonic and supersonic flows

Text Books:

1.John D Anderson, "Modern Compressible Flow", Mc Graw Hill,3rd edition, 2012, ISBN-13:978-1259027420.

2. Radhakrishnan, E., "Gas Dynamics", Prentice Hall of India, 5th edition, 2014, ISBN-13: 978-8120348394

Reference Books:

1Ascher. H. Saphiro, "Dynamics and Thermodynamics of Compressible fluid flow", John Wiley& Sons, 1st edition, 1977, ISBN-13: 978-0471066910.

2. Yahya, S.M., "Fundamentals of Compressible flow", NEW AGE, 2009, ISBN-13: 978-8122426687.

3. H.W. Liepmann and A. Roshko, "Elements of Gas Dynamics", Dover Publications Inc, 2003, ISBN-13: 978-0486419633.

4.Hodge B. K, Koenig K, Compressible Fluid Dynamics with Computer Application, 1st edition, Prentice Hall, New York (1995).

SEMESTER/YEAR : V / III
COURSE CODE : 19AS3502
TITLE OF THE COURSE : INTRODUCTION TO SPACE TECHNOLOGY
L: T/A: P: C : 03:00:00:00:03

COURSE OBJECTIVES

This course will enable students to:

1. Understand the harsh environment of space
2. Learn the governing laws of planetary motion
3. Know various launch systems and launching stages
4. Understand the function of spacecraft subsystems

COURSE OUTCOMES

Upon successful completion of this course, the students:

1. Apply orbital mechanics formula and tools to spacecraft mission design
2. Select appropriate launch systems and understand their effect on satellite and payload design and performance.
3. Select suitable payloads and sensors for various space missions

MODULE 1 8Hours

Space Environment

Earth's Atmosphere, Neutral atmosphere, Plasma, Solar Cycle, Solar Radiation, Radiation Belts, Earth's Magnetic field, Space Debris, Electro static charging, meteoroid impact, Effect of environment on Space craft, Aerodynamic drag

MODULE 2

Orbital Mechanics 8 Hours

Orbital velocity, escape velocity, Keplar's law of planetary motion, two body motion, linear and angular momentum, Keplar's second law, Equation of trajectory

MODULE 3

Space Propulsion 9 Hours

Space Missions, Principle of rocket launching, Rocket Propulsion, Staging, Solid propellant, liquid

propellant and cryogenic Propulsion, Electric Propulsion, Electro Thermal Thrusters, Sounding rockets, PSLV, GSLV, Launch window

MODULE 4

Satellite & Subsystems **9Hours**

Power Systems, Attitude Determination and Control, Guidance and Navigation, Avionics, Telemetry, tracking and command, Communication, Structure and Mechanisms, Thermal System

MODULE 5

Introduction to Test facility and Testing for space components and system **8 Hours**

Types of Tests; Test Facilities and Safeguards; Safety and Environmental Concerns; Monitoring and Control of Toxic Materials and Exhaust Gases; Instrumentation and Data Management; Reliability and Quality Control; Flight Testing. Assembly integration test, comprehensive test & test vacuum chamber and comprehensive test & test vibration facilities.

Text Books:

1. Wertz, J.R. and W.J. Larson, eds. Space Mission Analysis and Design (SMAD). 3rd ed. Microcosm Press, 1999. ISBN: 1881883108.
2. Pisacane, V.L. and R.C. Moore. Fundamentals of Space Systems. Oxford, 1994. ISBN: 0195074971.
3. Fortesque, P.W. and J.P.W. Stark. Space Systems Engineering. John Wiley and Sons, 1995.

Reference Books:

1. Griffin, M.D. and J.R. French. Space Vehicle Design. AIAA, 1991. ISBN: 0930403908.
2. Morgan, W.L. and G.D. Gordon. Communications Satellite Handbook. 1989. ISBN: 0471316032.

Other Sources:

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

SEMESTER/YEAR : V / III
COURSE CODE : 19AS3503
TITLE OF THE COURSE: AIRCRAFT PERFORMANCE
L: T/A: P: C : 03: 00: 00: 00:03

COURSE OBJECTIVES:

This course will enable students to:

1. Understand the aircraft performance in steady unaccelerated and accelerated flight.
2. Understand the airplane performance parameters.
3. Acquire the knowledge on aircraft maneuver performance

COURSE OUTCOMES:

Upon successful completion of this course, the students:

1. Understand Equations of motion for unaccelerated steady flight.
2. Develop the equation for the steady performance of level, climb and glide flight
3. Calculate the Range and Endurance of propeller driven and jet driven airplanes
4. Enumurate aircraft performance like takeoff, and landing of accelerated Flight
5. Understand the V-n diagram and calculate the Maneuver performance of the accelerated Flight
6. Understand the different phases of weight estimations required for designing of aircrafts

Module: 1 **7 Hours**

The Equations of Motion Steady Un accelerated Flight

Introduction, four forces of flight, General equation of motion, Power available and power-required curves. Thrust available and thrust required curves. Conditions for power required and thrust required minimum. Thrust available and maximum velocity, Power available and maximum velocity, Altitude effects on power available and power required; thrust available and thrust required.

Module: 2 **9 Hours**

Steady Performance – Level Flight, Climb & Glide

Performance: Equation of motion for Rate of climb- graphical and analytical approach -Absolute ceiling, Service ceiling, Time to climb – graphical and analytical approach , climb performance graph (hodograph diagram), Gliding flight, Range during glide, minimum rate of sink and shallowest angle of glide.

Fundamental Airplane Performance Parameters

The fundamental Parameters: Thrust – to – weight ratio, Wing loading, Drag polar, and lift-to – drag ratio. Minimum velocity. Aerodynamic relations associated with lift-to-drag ratio.

Module: 3 **9 Hours**

Range and Endurance:

Propeller driven Airplane: Physical consideration, Quantitative formulation, Breguet equation for Range and Endurance, Conditions for maximum range and endurance.

Jet Airplane: Physical consideration, Quantitative formulation, Equation for Range and Endurance, Conditions for maximum range and endurance, Effect of head wind tail wind.

Module: 4 **9 Hours**

Aircraft Performance in Accelerated Flight

Take-off Performance: Calculation of Ground roll, Calculation of distance while airborne to clear obstacle, Balanced field length

Landing Performance and Accelerated Climb: Calculation of approach distance, Calculation of flare distance, Calculation of ground roll, ground effects. Acceleration in climb.

Module: 5 **8 Hours**

Maneuver Performance

Turning performance: Level turn, load factor, Constraints on load factor, Minimum turn radius, Maximum turn rate. Pull-up and Pull-down maneuvers: (Turning rate, turn radius). Limiting case for large load factor. The V-n diagram.

Text Books:

1. John D. Anderson, Jr. “Aircraft Performance and Design”, McGraw-Hill International Editions, Aerospace Science/ Technology Editions, 1999.
2. John D. Anderson, Jr., “Introduction to flight” McGraw-Hill International Editions, Aerospace Science/ Technology Editions, 2000.

Reference Books:

1. Perkins, C.D., and Hage, R.E., “Airplane Performance stability and Control”, John Wiley Son Inc, New York, 1988.

COURSE CODE : 19AS3504
TITLE OF THE COURSE: PRINCIPLES OF MANAGEMENT & ECONOMICS FOR ENGINEERS
L: T/A: P: C : 03:00:00:00:03

COURSE OBJECTIVES:

This course will enable students to:

1. To help the students to understand the fundamental concepts and principles of management; the basic roles, skills, functions of management, various organizational structures and basic knowledge of marketing.
2. To impart knowledge, with respect to concepts, principles and practical applications of Economics, which govern the functioning of a firm/organization under different market conditions

COURSE OUTCOMES:

Upon successful completion of this course, the students:

1. Understand needs, functions, roles, scope and evolution of management
2. Understand importance, purpose of planning and hierarchy of planning and also analyze its types
3. Discuss decision making, organizing, staffing, directing and controlling.
4. Select the best economic model from various available alternatives.
5. Understand various interest rate methods and implement the suitable one.
6. Estimate various depreciation values of commodities.
7. Prepare the project reports effectively.

Module-1 **8 Hours**

Management:

Introduction - Meaning - nature and characteristics of Management, Scope and Functional areas of management - Management as a science, art of profession - Management & Administration -Roles

of Management, Levels of Management, and Development of Management Thought- early management approaches – Modern management approaches. Planning: Nature, importance and purpose of planning process Objectives - Types of plans (Meaning Only) - Decision making Importance of planning - steps in planning & planning premises - Hierarchy of plans.

Module-2 **9 Hours**

Organizing and Staffing:

Nature and purpose of organization Principles of organization - Types of organization -Departmentation Committees Centralization Vs. Decentralization of authority and responsibility -Span of control - MBO and MBE (Meaning Only) Nature and importance of staffing--Process of Selection & Recruitment (in brief). Directing & Controlling: Meaning and nature of directing Leadership styles, Motivation Theories, Communication - Meaning and importance - coordination, meaning and importance and Techniques of Co Ordination. Meaning and steps in controlling - Essentials of a sound control system - Methods of establishing control (in brief).

Module-3 **8 Hours**

Introduction: Engineering and Economics

Problem solving and decision making, Laws of demand and supply, Difference between Microeconomics Macroeconomics, equilibrium between demand & amp; supply, elasticity of demand, price elasticity, income elasticity. Law of Returns, Interest and interest factors, simple and compound interest, Cash flow diagrams, personal loans and EMI payment calculation with flexible interest rates, Discussion and problems.

Module-4 **9 Hours**

Present, future and annual worth and rate of returns

Basic present worth comparisons, Present worth equivalence, Assets with unequal lives and infinites lives, future worth comparisons, payback comparisons, Equivalent annual worth comparisons, situations for annual worth comparisons. Asset life, Rate of return, minimum acceptable rate of return, IRR anomalies and misconceptions, Cost of capital, comparisons of all present future and annual worth with IRR, product costing, Balance sheet, Discussions and problems.

Module-5 **8 Hours**

Costing and depreciation

Components of costs, estimation of selling price, marginal cost, first cost, all kinds of overheads, indirect cost estimation with depreciation, mensuration and estimation of material cost, cost estimation

of mechanical process, idling time. Product costing (approaches to product costing), causes of depreciation, methods of computing depreciation charges, straight line method, declining balance method, sum of years method, sinking fund method, service output methods, taxation concepts, personal income taxes and corporate taxes, Discussions and problems.

Text Books:

1. Principles of Management by Tripathy and Reddy
2. Mechanical estimation and costing, T.R. Banga & S.C. Sharma, 17th edition 2015
3. Engineering Economy, Riggs J.L. McGraw Hill, 2002
4. Engineering Economy, Thuesen H.G. PHI , 2002

Reference Books:

1. Management Fundamentals - Concepts, Application, Skill Development - Robers Lusier - Thomson
2. Basics of Engineering Economy, Leland Blank & Anthony Tarquin, McGraw Hill Publication (India) Private Limited
3. Engineering Economics, R.Paneerselvam, PHI publication
4. Management and Engineering Economics, Ravi Kumar R, Sunstar Publications
5. Fundamentals of Management: Essential Concepts and Applications, Pearson Education, Robbins S.P. and Decenzo David A.

Economics: principles of economics, and gregory mankiw, cengage learning.

SEMESTER/YEAR : V / III
COURSE CODE : 19AS3505
TITLE OF THE COURSE: AEROSPACE PROPULSION LAB
L: T/A: P: C : 0: 0: 3: 1

COURSE OBJECTIVES:

This course will enable students to:

1. Conduct experiments on using devices including bomb calorimeter, viscometers and gas turbine engines.
2. Conduct experiments to viscosity and efficiency of engines.
3. Basic understanding of performance of engines.

COURSE OUTCOMES:

Upon successful completion of this course, the students:

1. Understand propellers and there performance.
2. Determine Performance characteristics of Gas turbine engines.

LIST OF EXPERIMENTS:

1. Flash and Fire point of fuel
2. Redwood viscometer
3. Saybolt Viscometer
4. Bomb Calorimeter
5. Performance of Two stroke engine
6. Performance of Four stroke engine
7. Performance of propeller
8. Description of Gas Turbine Engine

SEMESTER/YEAR : V / III
COURSE CODE : 19AS3506
TITLE OF THE COURSE: FLIGHT PHYSICS LAB
L: T/A: P: C : 0: 0: 3: 1

COURSE OBJECTIVES:

This course will enable students to:

1. Conduct experiments on aerofoil, water flow channel.
2. Conduct experiments on pitot and static tubes.
3. Basic understanding of flow visualization.

COURSE OUTCOMES:

Upon successful completion of this course, the students:

1. Understand tubes and there flow performance.
2. Determine Performance and force measurement, pressure distribution in ae foil and blunt body.

LIST OF EXPERIMENTS

1. Measurement of pressure distribution over an aero foil
2. Measurement of pressure distribution over a blunt body
3. Flow visualization in water flow channel
4. Force measurement
5. Flow over flat plate
6. Understanding pitot and static tubes

SEMESTER/YEAR : V / III
COURSE CODE : 19AS3507
TITLE OF THE COURSE: Mini Project III
L: T/A: P: C : 00 :00 : 02 :00: 1

Mini project is Project-based learning involving students in designing, developing, and constructing hands-on solutions to a problem. It aims to build students' creative capacity to work through difficult problems, in teams of 2-4 members. This creates an opportunity for students to apply conceptual knowledge gained in classrooms to real-time projects. The students learn and have more hands-on various computer-aided design and simulation tools. They are encouraged to build the prototype of the designed models in mini-project- III.

SEMESTER/YEAR : V / III
COURSE CODE : 19AS3508
TITLE OF THE COURSE: WIND TUNNEL MODEL TESTING
L: T/A: P: C : 03: 00: 00:00:03

COURSE OBJECTIVES:

This course will enable students to:

1. To understand the need for experimental aerodynamics, types of wind tunnels and their application areas
2. To understand the design of wind tunnels, test section & drive system
3. To understand various types of test techniques & types of measurements and uncertainties
4. Acquire knowledge on design on models for wind tunnel testing
5. To carry out simple experiments in the DSU wind tunnel

COURSE OUTCOMES:

Upon successful completion of this course, the students:

1. Design models for wind tunnel testing both for low speed and high speed wind tunnels
2. Having hands-on training on carrying out wind tunnel tests and analyze results
3. Ability to select proper measuring instruments based on need
4. Ability to analyze and present tested results

Module -1 **9 Hours**

Introduction to Wind Tunnels

Aerodynamics, Properties of Air and Water, Similarity Parameters, Incompressible Flow, Types of Wind Tunnels and their applications

Module -2 **9 Hours**

Components of Wind Tunnel Systems

Overall Objectives, Power Considerations, Energy Ratio of typical Wind Tunnels, Cooling, Test

Section Flow Quality, Drive Systems, Wind Tunnel Construction, Test Section Inserts, Safety

Module -3 **9 Hours**

Measurement Techniques & Calibration of Test Section

Flow Visualization Techniques, Pressure, Force and Moment measurements, Boundary Layer measurements, External and Internal Balances, Balance requirements and Specifications, Installation in models, Calibration and use of transonic & supersonic wind tunnels, Design of models (Force models, pressure models and spin models) and instrumentation systems

Module -4 **9 Hours**

Special Test Techniques & Data Reduction

Data Reduction from Wind Tunnel Tests, Scale Effects, Corrections to Wind Tunnel Data, Measurement Uncertainties

Module -5 **4 Hours**

Experiments in DSU Wind Tunnel

Design and manufacturing of simple models for testing in DSU low speed wind tunnel, analyses of experimental findings and documentation

Text Books:

1. Jewel B. BARLOW, William H. RAE Jr., Alan POPE, "Low-Speed Wind Tunnel Testing", John Wiley & Sons, New York, Toronto, 1999, 3rd Edition, ISBN 978-0-471-55774-9
2. Alan Pope and Kennith L Goin, "High-Speed Wind Tunnel Testing", John Wiley and Sons, New York, 1965

Reference Books:

1. Liepmann, H W and Roshko A, Elements of Gas Dynamics", Dover Publications, 2013. ISBN 9780486316857
2. John D Anderson Jr., "Fundamentals of Aerodynamics", 5th Edition, McGraw Hill Education (India) Pvt. Ltd., 2010

SEMESTER/YEAR : V / III
COURSE CODE : 19AS3509
TITLE OF THE COURSE: FINITE ELEMENTAL METHODS
L: T/A: P: C : 03: 00: 00: 00: 03

COURSE OBJECTIVES

This course will enable students to:

1. To enable the students to appreciate the use of finite element methods to analyze structural and dynamic problems.
2. To enable the students to understand and perform finite element analysis of 1D and 2D structures.
3. To teach the procedure to perform finite element based steady-state and transient response analysis.

COURSE OUTCOMES

Upon successful completion of this course, the students:

1. Calculate element energy functions for 1-D and 2D finite elements.
2. Understand and apply Raleigh Ritz method and develop mathematical expressions for bars and beams.
3. Understand and appreciate the finite element method in solving simple problems of engineering significance.
4. Understand and appreciate the finite element method in solving steady state heat transfer problems.

Module 1 **8 Hours**

Introduction: Equilibrium equations in elasticity subjected to body force, traction forces, and stress-strain relations for plane stress and plane strains. General description of finite element method, application and limitations, types of elements based on geometry. Node numbering, half band width.

Module 2 **8 Hours**

Basic Methods in FEM Euler - Lagrange equation for bar, beam (cantilever / simply supported fixed). Principle of virtual work, principle of minimum potential energy, Raleigh's Ritz method. Direct approach or stiffness matrix formulation of bar element and Galerkin's method.

Module 3 **8 Hours**

Interpolation Models: Interpolation polynomials- linear, quadratic and cubic. Simplex complex and multiplex elements, 2D PASCAL's triangle, CST elements-shape functions and nodal load vector, strain displacement matrix and Jacobian for triangular and rectangular element. Higher Order Elements: Langrange's interpolation, one dimensional elements-quadratic element and their shape functions. Shape function of 2-D quadrilateral element-linear, quadric element Isoparametric, sub parametric and super parametric elements.

Module 4 **9 Hours**

1-D Bars &Trusses: Solution of 1-D Bars: Solutions of bars and stepped bars for displacements, reactions and stresses by sing penalty approach and elimination approach.Guass-elimination technique. Trusses: Stiffness matrix of truss element. Numerical problems

Module 5 **8 Hours**

Beams & Heat Transfer Beams: Hermite shape functions for beam element, derivation of stiffness matrix. Numerical problems of beams carrying concentrated, UDL and linearly varying loads. Heat transfer: Steady state heat transfer, 1D heat conduction governing equations. Functional approach for heat conduction, Galerkin's approach for heat conduction, 1D heat transfer in thin fins.
Softwares used in FEM Analysis: Simulia and Ansys Structures

Text Books:

1. T.R. Chandrupatla and A.D Belegunde , Finite Elements in Engineering, 3rd Ed PHI.
2. S.S. Rao, Finite Element Method in Engineering,4th Edition, Elsevier, 2006.

Reference Books:

1. R.D. Cook D.S Maltus, M.E Plesha and R.J.Witt, Concepts and applications of Finite Element Analysis, Wiley 4th Ed, 2009
2. J.N.Reddy, Finite Element Method, McGraw -Hill International Edition, 2009.

SEMESTER/YEAR : VI / III
COURSE CODE : 19AS3601
TITLE OF THE COURSE : CONTROL THEORY
L: T: P: S/P: C : 03:00: 00:00: 03

COURSE OBJECTIVES:

This course will enable students to:

1. Understand the concepts of open loop, closed loop systems and types of controllers.

2. Construct signal flow diagram from the Blocks and signal flow graphs.

3. Know about the Bode plot, Nyquist plot, polar plot and Root locus method.

COURSE OUTCOMES:

Upon successful completion of this course, the students:

1. Apply the concepts of open loop, closed loop systems and types of controllers.

2. Develop signal flow diagram from the Blocks and signal flow graphs.

3. Interpret the Bode plot, Nyquist plot, polar plot and Root locus method

Module -1 **8 Hours**

Introduction: Concept of automatic controls, Open loop and closed loop systems, Concepts of feedback, requirements of an ideal control system, Types of controllers- Proportional, Integral Proportional Integral, Proportional Integral Differential controllers.
Mathematical Models: Transfer function models, models of mechanical systems, models of electrical circuits, DC and AC motors in control systems, Analogous systems: Force voltage, Force current

Module -2 **8 Hours**

Block Diagrams and Signal Flow Graphs: Transfer Functions definition, function, block representation of systems elements, reduction of block diagrams, Signal flow graphs: Mason'sgain formula

Module -3 **8 Hours**

Transient and Steady State Response Analysis: Introduction, first order and second order system response to step, ramp and impulse inputs, concepts of time constant and its importance in speed of response. System stability: Routh's- Hurwitz Criterion

Module -4 **8 Hours**

Root Locus Plots: Definition of root loci, General rules for constructing root loci, Analysis usingroot locus plots. Frequency Response Analysis: Polar plots, Nyquist stability criterion, Stabilityanalysis, Gain margin and phase margin.

Frequency Response Analysis Using Bode Plots: Bode attenuation diagrams, Stability analysisusing Bode plots, Simplified Bode Diagrams.

Module -5 **8 Hours**

System Compensation and State Variable Characteristics of Linear Systems: Series and feedback compensation, Introduction to state concepts, state equation of linear continuous data system. Matrix representation of state equations, controllability and Observability, Kalman and Gilberts test

Text Books:

1. Katsuhiko Ogatta, Modern Control Engineering, Pear son Education, 5th edition, 2015, ISBN13: 978-9332550162.
2. M.Gopal, Control Systems Principles and Design, TMH, 4th edition, 2012, ISBN-13: 978-0071333269.

Reference Books:

1. Richard.C.Dorf and Robert.H.Bishop, Modern Control Systems, Pearson Education India, 12th edition, 2013, ISBN-13: 978-9332518629
2. Eronini-Umez, System dynamics & control, Thomson Asia pvt Ltd. Singapore, 2002.
3. Schaum's series, Feedback Control System, 2001.

SEMESTER/YEAR : VI SEM / III YEAR
COURSE CODE : 19AS3602
TITLE OF THE COURSE : AIRCRAFT SYSTEMS & INSTRUMENTATION
L: T: P: S/P: C : 03:00: 00:00: 03

COURSE OBJECTIVES:

This course will enable students to:

1. To provide the knowledge regarding basic concepts of flight instruments, their significanceand operation.
2. To impart the concepts of measurements using air data sensor, Gyroscope and engine data.
3. To impart the basic concepts regarding Avionics systems and also the necessary knowledgeon working of avionics system in aircraft.

COURSE OUTCOMES:

Upon successful completion of this course, the students:

1. Understand the basics of measurements and different parameters
2. Appreciate the need for general measurements in aviation industry
3. Identify the fundamental cockpit instruments and their working principles
4. Select proper instrumentation requirements for aerospace vehicles
5. Differentiate various sensors and transducers used in aerospace vehicles
6. Apprehend the principles behind temperature, pressure, fuel flow and engine

Module 1 8 Hours

Airplane Control Systems: Conventional Systems, fully powered flight controls, Power actuated systems, Modern control systems, Digital fly by wire systems, Auto pilot system active control Technology.

Module -2 8 Hours

Aircraft Systems: Hydraulic systems, Study of typical workable system, components, Pneumatic systems, Advantages, Working principles, Typical Air pressure system, Brake system, Typical Pneumatic power system, Components, Landing Gear systems, classification.

Module -3 **8 Hours**

Engine Systems: Fuel systems for Piston and jet engines, Components of multi engines.Lubricating systems for piston and jet engines. Starting and Ignition systems, typical examples for piston and jet engines.

Module -4 **8 Hours**

Auxiliary System: Basic Air cycle systems, Vapor Cycle systems, Evaporative vapour cycle systems, Evaporative air cycle systems, Fire protection systems, Deicing and anti-icing systems.

Module -5 **8 Hours**

Aircraft Instruments: Flight Instruments and Navigation Instruments, Gyroscope, Accelerometers, Air speed Indicators, TAS, EAS, Mach Meters, Altimeters, Principles and operation, Study of various types of engine instruments, Tachometers, Temperature gauges, Pressure gauges, Operation and Principles.

Text Books:

1. Ian Moir and Allan Sea bridge, Aircraft Systems: Mechanical, Electrical and Avionics Sub system Integration‘, Wiley India Pvt Ltd, 3rd edition, 2012, ISBN-13: 978-8126535217.

2. Pallet, E.H.J., “Aircraft Instruments and Integrated Systems”, Longman Scientific and Technical, Indian reprint 1996.

Reference Books:

1. Lalit Gupta and OP Sharma, ‘Aircraft Systems (Fundamentals of Flight Vol.IV), Himalayan Books, 2006.

2. Treager,S., “Gas Turbine Technology”, McGraw-Hill, 3rd edition,2013,ISBN-13: 978-1259064876.

3. R.W.Sloley and W.H.Coulthard, ‘The aircraft Engineers Handbook, No4, INSTRUMENTS’, Shroff, 6thEdition, 2005, ISBN-13: 978-8175980518

4.SR Majumdar, ‘Pneumatic Systems‘, Tata McGraw Hill Publishing Co,1st edition,2001,ISBN 13: 978-0074602317.

5. William A Neese, ‘Aircraft Hydraulic Systems‘, Himalayan Books; 2007

SEMESTER/YEAR : VI / III
COURSE CODE : 19AS3603
TITLE OF THE COURSE : AIRCRAFT STABILITY & CONTROL
L: T: P: S/P: C : 03:00: 00:00: 03

COURSE OBJECTIVES:

This course will enable students to:

1. Understand the basics of aircraft stability and control.
2. Understand the static longitudinal and static directional stability.
3. Acquire the knowledge on dynamic lateral and directional stability.

COURSE OUTCOMES:

Upon successful completion of this course, the students:

1. Understand the contribution of various airframe components on longitudinal static stability in stick fixed condition and responses required from control surfaces to overcome sudden aerodynamic unbalancing.
2. Evaluate stick force required at stick free condition and understand the basic concepts of static directional stability.
3. Predict aileron control forces and flying modes such as Dutch roll, spiral roll, phugoid, longperiod oscillation with the help of Routh's criterion, for a given stability equation.
4. Estimate the dynamic derivatives for forward speed, pitching velocity, time rate of changeof angle of attack, rolling rate and yawing rate.
5. Develop various inter-coupling effects with the motion of aircraft and Examine the response of an aircraft

Module -1: Static Longitudinal Stability and Control-Stick Fixed 8Hours.

Historical perspective, Aerodynamic Nomenclature, Equilibrium conditions, Definition of static stability, Definition of longitudinal static stability, stability criteria, Contribution of airframe components: Wing contribution, Tail contribution, Fuselage contribution, Power effects Introduction, Trim condition. Static margin, Stick fixed neutral points. Longitudinal control,

Module -2: Elevator Control and Stick free **8Hours**

Elevator power, Elevator angle versus equilibrium lift coefficient, Elevator required forlanding, Restriction on forward C.G. range. Hinge moment parameters, Control surface floating characteristics and aerodynamic balance, Estimation of hinge moment parameters, the trim tabs, Stick-free Neutral point, Restriction on aft C.G.

Module -3: Static directional stability and control **8 Hours**

Introduction, Definition of directional stability, Static directional stability rudder fixed, Contribution of airframe components, Directional control. Rudder power, Stick-free directional stability, Requirements for directional control, Rudder lock, Dorsal fin, one engine inoperative condition, Weather cocking effect.

Module -4: Static Lateral stability and control **8 Hours**

Introduction, definition of roll stability, estimation of dihedral effect. Effect of wing sweep,flaps, and power, Lateral control, Estimation of lateral control power, Aileron control forces,balancing the aileron. Coupling between rolling and yawing moments. Adverse yaw effects,Aileron reversal.

Module -5: Dynamic Lateral and Directional Stability **8Hours.**

Types of modes of motion: long or phugoid motion, short period motion, Airplane Equations of longitudinal motion. Factorsaffecting period and damping of oscillations. Effect of wind shear, sideslip excursion. Dutch roll and Spiral instability. Auto- rotation andspin.

Text Books:

1. Perkins, C.D., and Hage, R.E., "Airplane Performance stability and Control", John Wiley Son Inc, New York, 1988.
2. Nelson, R.C. "Flight Stability and Automatic Control", McGraw-Hill Book Co., 2007.

Reference Books:

1. Bandu N. Pamadi, `Performance, Stability, Dynamics and Control of Airplanes`, AIAA 2nd Edition Series, 2004.
2. John D. Anderson, Jr., "Introduction to flight" McGraw-Hill, International Editions, Aerospace Science Technology Editions, 2000.

SEMESTER/YEAR : VI / III
COURSE CODE : 19AS3604
TITLE OF THE COURSE : ORBITAL MECHANICS
L: T: P: S/P: C : 03:00: 00:00: 03

COURSE OBJECTIVES:
This course will enable students to:

1. Understand the basic concepts of space mechanics and the general N- body.
2. Study satellite injection and satellite orbit perturbations.
3. Acquire the knowledge of interplanetary and ballistic missile trajectories

COURSE OUTCOMES:
Upon successful completion of this course, the students:

1. Apply the basic concepts of space mechanics and the general N- body.
2. Explain satellite injection and satellite orbit perturbations.
3. Distinguish between interplanetary and ballistic missile trajectories

Module -1 **8 Hours**

Basic knowledge of Space: Overview of major contents of universe, Black body radiation, specific intensity, flux density, luminosity, Basics of radiative transfer (Emission/absorption coefficients, source functions) formation of the solar system, stars, and planets physical processes in the solar system; dynamics of the solar system; physics of planetary atmospheres; individual planets; comets, asteroids, and other constituents of the solar system; extra-solar planets.

Module-2 **8 Hours**

Fundamentals of Orbit Mechanics, Orbit Maneuvers: Coordinate Systems, Classical Orbital Elements, Determining the Orbital Elements, the Gauss Problem - General Methods of Solution. Ground trace In-Plane Orbit changes, Hohmann Transfer, Bielliptical Transfer, Plane Changes, Combined Maneuvers and Propulsion for Maneuvers.

Module -3 **8 Hours**

Interplanetary Trajectories: Two-dimensional interplanetary trajectories, fast interplanetary trajectories, three dimensional interplanetary trajectories, launch of interplanetary spacecraft, trajectory estimation about the target planet, concept of sphere of influence, Lambert's theorem.

Module-4 **8 Hours**

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

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

Module- 5 **8 Hours**

Launch Vehicle Dynamics: Tsiolskovsky's rocket equation, range in the absence of gravity, vertical motion in the earth's gravitational field, inclined motion, flight path at constant pitch angle, motion in the atmosphere, the gravity turn – the culmination altitude, multi staging. Earth launch trajectories – vertical segment, the gravity turn, constant pitch trajectory, orbital injection. Actual launch vehicle trajectories, types. Reusable launch vehicles, future launchers, launch assist technologies. Rocket Thrust Vector Control – Methods of Thrusts Vector Control for solid and liquid propulsion systems, thrust magnitude control, thrust termination; stage separation dynamics, separation techniques.

Text Books:

1. Cornelisse, J.W., Rocket Propulsion and Space Dynamics, W.H. Freeman & co, 1984.
2. Thomson, Introduction to Space Dynamics, Dover Publications, Revised edition,2012

Reference Books:

1. Van de Kamp, P., "Elements of Astromechanics", Pitman, 1979
2. Willian E. Wiesel, Space Flight Dynamics, Create Space Independent PublishingPlatform, 3rd Edition ,2010,ISBN-13: 978-1452879598
3. George P. Sutton and Oscar Biblarz, Rocket Propulsion Elements, Wiley India Pvt Ltd,

SEMESTER/YEAR	**: VI / III**
COURSE CODE	**: 19AS3605**
TITLE OF THE COURSE	**: SIMULATION LAB**
L: T/A: P: C	**: 03:00: 00:00: 1**

COURSE OBJECTIVE:

This course will enable students to:

1. To know fundamental skills and knowledge required to use MATLAB for the simulationof Engineering systems
2. To introduce concepts of numerical methods and introduce Matlab in an Engineering Framework.

COURSE OUTCOMES:

Upon successful completion of this course, the students:

1. Students can able to understand the use of software tools for modelling and analysis of Mathematical concepts for engineering applications
2. Students will be able to model and analyze simple engineering concepts andIts importance in engineering applications

LIST OF EXPERIMENTS:

1. Introduction to MATLAB:

Familiarization with MATLAB and MATLAB control system toolbox. Representation of scalars, vectors and matrices in MATLAB. Basic 2D and 3D plot using MATLAB. Locating the roots of equations using various methods. Numerical differentiation & integration using MATLAB. Solution of linear and non-linear differential equations. Matrix factorization.

2. Frequency response for a spring-mass system; simulation of the oscillations
3. Stability analysis using Root locus, Bode plot, Nyquist plot and Polar plot techniques.
4. Simulate a bomb drop from an aircraft on a moving tank in pure pursuit motion.
5. Develop a straight and level flight simulation program using MATLAB
6. Simulate aircraft Take-off and Landing with trajectory tracing
7. Simulation of Hoffmann transfer
8. Simulation of velocity calculations for orbit maneuvering
9. Simulation of time period calculations for orbital motion

SEMESTER/YEAR : VI / III
COURSE CODE : 19AS3606
TITLE OF THE COURSE : MODEL BASED SYSTEM ENGINEERING
L: T/A: P: C : 01 :00 : 03 :00: 2

COURSE OBJECTIVES:

This course will enable students to:

1. Student uses the knowledge and information gained in the course to expand and improvethe application of model-based systems engineering in their field.
2. Student implements model-based systems engineering practices in their field that result in higher levels of value and satisfaction with engineered systems.
3. Student pursues further in-depth education and training in systems engineering

COURSE OUTCOMES:

Upon successful completion of this course, the students:

1. Demonstrate analysis of systems using model-based systems engineering approaches thatlead to better and increased performance of systems.
2. Describe the processes, methods, and practices of model-based systems engineering.

Model based system Engineering sessions: 3Hours

What is Landing Gear & it's function, Types of Landing Gear, Different parts of a Modern Landing Gear, Different parts of a Modern Landing Gear Shock Strut.

Assessment 1 4 Hours
Steering System, Brakes, Uplock & Downlock, Retraction & Extension, Emergency lowering of Landing Gear

Assessment 2 4 Hours
Introduction to MBSE Process LG Design Process Requirement Management Theory,Requirement Management Lab, Functional Architecture, Mapping Requirements and Functional Components, practice sessions.

Assessment 3 18 Hours
Introduction to Mathematical modeling & Design of a DC motor, LG Detail Design Process Practice session, Logical Architecture Definition, Physical CAD Integration, Mapping Functional and Logical Components, Test Case Validation and Impact Analysis

Assessment 4 8 Hours
Final Practice session, End Examination (theory & lab).

SEMESTER/YEAR : VI / III
COURSE CODE : 19AS3607
TITLE OF THE COURSE : Mini Project IV
L: T/A: P: C : 00 :00 : 02 :00: 1

Mini project is Project-based learning that involves students in designing, developing, and constructing hands-on solutions to a problem. It aims to build students' creative capacity to work through difficult or ill-structured problems, commonly in small teams of 2-4 members. This creates an opportunity for students to apply conceptual knowledge gained in classrooms to real-time projects. The students have to build computer models and analyse them using simulation tools. The students are required to make prototypes and assembly the components or products designed

SEMESTER/YEAR : VI / III
COURSE CODE : 19AS3608
TITLE OF THE COURSE : INTRODUCTION TO COMPUTATION FLUID DYNAMICS
L: T: P: S/P: C : 03:00: 00:00: 03

COURSE OBJECTIVES

This course will enable students to:

1. Introduce Governing Equations of viscous fluid flows
2. Introduce numerical modeling and its role in the field of fluid flow and heat transfer
3. Enable the students to understand the various discretization methods, solution procedures and turbulence modeling.
4. Create confidence to solve complex problems in the field of fluid flow and heat transfer byusing high speed computers.

COURSE OUTCOMES

Upon successful completion of this course, the students:

1. After completion of the course student would be able to
2. Create numerical modelling and its role in the field of fluid flow and heat transfer.
3. Use the various discretization methods, solution procedures and turbulence modelling tosolve flow and heat transfer problems.

Module 1:

Governing equations and boundary conditions 8Hours

Basics of computational fluid dynamics – Governing equations of fluid dynamics –Continuity, Momentum and Energy equations – Chemical species transport – Physical boundary conditions – Time-averaged equations for Turbulent Flow – Turbulent–Kinetic Energy Equations– Mathematical behaviour of PDEs on CFD - Elliptic, Parabolic and Hyperbolicequation

Module 2:

Finite difference and finite volume methods for diffusion 9Hours

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

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

Module 3:

Finite volume method for convection diffusion **10Hours**

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

Module 4:

Flow field analysis **9 Hours**

Finite volume methods -Representation of the pressure gradient term and continuity equation– Staggered grid – Momentum equations – Pressure and Velocity corrections – PressureCorrection equation, SIMPLE algorithm and its variants – PISO Algorithms.

Module 5:

Hands on Simulia/Ansys

Text books

1. Versteeg, H.K., and Malalasekera, W., "An Introduction to Computational Fluid Dynamics: The Finite Volume Method", Second Edition Pearson Education Ltd. 2007.
2. Ghoshdastidar, P.S., "Computer Simulation of flow and heat transfer", Tata McGraw Hill Publishing Company Ltd., 1998.

Reference Books

1. Patankar, S.V. "Numerical Heat Transfer and Fluid Flow, Hemisphere" PublishingCorporation, 2004.
2. Chung, T.J. "Computational Fluid Dynamics", Cambridge University, Press, 2002.
3. Ghoshdastidar P.S., "Heat Transfer", Oxford University Press, 2005
4. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 1995.

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 20AS2302
TITLE OF THE COURSE :
THERMODYNAMICSL: T/A: P: C : 03: 00: 00: 00:03

COURSE LEARNING OBJECTIVES

This course will enable students to:

- Understand the basic concepts of thermodynamics
- Understand the thermodynamics laws
- Develop an understanding of working principles of gas power cycles
- Understand the working principles aircraft propulsion systems

COURSE OUTCOMES

Upon successful completion of this course, the students:

- Apply the concepts of thermodynamics to different processes
- Analyse the various gas power cycles
- Analyse different aero engine cycles and propulsion systems

Module -1: BASIC CONCEPTS OF THERMODYNAMICS 8L hrs.

Introduction- Basic Concepts: System, Control Volume, Surrounding, Boundaries, Universe, Types of Systems, Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic Equilibrium, Thermodynamic properties: definition and units. Intensive and extensive properties. Thermodynamic state, state point, path and process, quasi-static process, cyclic and non-cyclic processes, Energy and its forms, Work and heat (sign convention), irreversible process, causes of irreversibility

Module -2: ZEROTH LAW AND FIRST LAW THERMODYNAMICS 7L hrs.

Zeroth law of thermodynamics statement, Concept of Temperature and its measurement, Temperature scales.

First Law of Thermodynamics: First law of thermodynamics-application to closed and open system, Joules experiments, equivalence of heat and work, Internal energy and enthalpy, energy as a property, steady state, Steady Flow Energy Equation, extension of first law to control volume, Application of SFEE, Limitations of first law of thermodynamics

Module -3: SECOND LAW OF THERMODYNAMICS AND PURE SUBSTANCE 8L hrs.

Thermal reservoirs, Efficiency, devices converting work to heat in a thermodynamic cycle, direct heat engine, reversed heat engine, Refrigerator and Heat Pump, Coefficient of Performance, Kelvin-Planck and Clausius statement of second law of thermodynamics,

Equivalence of the two statements, reversible and irreversible processes, , Carnot theorem and its corollaries. Second law, entropy and absolute temperature, third law and absolute entropy, Introduction to energy.

Pure substance: P-T and P-V diagrams, triple point and critical points. Sub-cooled liquid, saturated liquid, mixture of saturated liquid and vapor, saturated vapor and superheated vapor states of pure substance with water as example. Enthalpy of change of phase (Latent heat), Dryness fraction (quality), T-S and H-S diagrams.

Module -4: THERMODYNAMIC GAS & VAPOUR CYCLES 8L hrs.

Otto cycle, Diesel cycle, dual cycle, Rankine cycle, Joule-Brayton cycle, ideal and real cycles. Numerical problems

Module -5: INTRODUCTION TO HEAT TRANSFER 8L hrs.

Thermodynamics and Heat Transfer, Applications, Historical background, Heat transfer modes, Conduction, Fourier law, Thermal conductivity, diffusivity, Convection; Newton's law of cooling, Radiation heat transfer, Simultaneous heat transfer mechanisms, Overall heat transfer coefficient.

Text Books:

1. Sonntag, R. E., Borgnakke ,C. and Van Wylen , G. J., "Fundamentals of Thermodynamics", 6th ed., Wiley, 2002
2. Cengel, Y., and Boles, M., "Thermodynamics: an Engineering Approach", 7th Ed., McGraw Hill, 2010
3. Rogers and Mayhew, "Engineering Thermodynamics: Work and Heat Transfer", 4th Ed, Longman Scientific, 1992.

Reference Books:

1. Nag, P. K., "Engineering Thermodynamics", 4th ed., Tata McGraw Hill, 2008
2. Sutton G.P., "Rocket Propulsion Elements", John Wiley, New York, 9th edition, 2016, ISBN: 9781118753910.
3. Cengel, Y., and Ghajar, "Heat transfer: A practical approach", McGraw Hill, 2nd Ed., 2002
4. Hill, P., and Peterson, C., "Mechanics and Thermodynamics of Propulsion", Pearson Education, 2009
5. Farokhi, Saeed, "Aircraft Propulsion", Wiley-Blackwell 2nd Ed., 2014.

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 20AS2303
TITLE OF THE COURSE : FLUID
MECHANICSL: T/A: P: C : 03:00:00:00:03

COURSE LEARNING OBJECTIVES

This course will enable students to:

- Understand the basics of incompressible fluid properties and flow regimes
- Study different types of fluid flows and governing laws
- Understand the concept of boundary layer theory

COURSE OUTCOMES

Upon successful completion of this course, the students:

- Solve problems on incompressible fluid flow
- Analyse different flow regimes using governing laws of fluid flow
- Apply the concept of boundary layer in fluid flow
- Apply the principles of dimensional analysis for incompressible flow

Module -1: FLUID PROPERTIES AND FLUID STATICS 8L hrs.

Introduction, properties of fluids, viscosity, thermodynamics properties, surface tension and capillarity, vapor pressure. Fluid pressure at a point, Pascal's law, pressure variation in a static fluid, absolute, gauge, atmospheric and vacuum pressures, simple manometers and differential manometers.
Hydrostatic forces on plane inclined and curved surfaces, Fluid Statics: Fluid pressure at apoint, Pascal's law, and pressure variation in a static fluid.

Module -2: FLUID KINEMATICS 8 L hrs.

Lagrangian and Eulerian descriptions, Types of flows; Steady flow, Unsteady flow, Uniformand Non-Uniform flow, Rotational flow, Irrational flow, 1-D, 2-D, 3-D flows, Continuity equation, velocity and acceleration, velocity potential function, Stream function, lines of constant stream function and equipotential line, Streamline, Path line, and Streak line, Dilatation strain rate, Circulation, Vorticity.

Module -3: FLUID DYNAMICS AND FLOW MEASUREMENT 7L hrs.

Introduction, Euler's Equation of motion, Assumptions, Bernoulli's equation, Bernoulli's equation for real fluids and application, Measurement of flow, venturi meter, orifice meter,pitot tube.

Module -4: DIMENSIONAL ANALYSIS **8L hrs.**

Introduction, Dimensional homogeneity – Raleigh and Buckingham theorems Non - Dimensional numbers – Model laws and distorted Models-Unit Quantities-Specific Quantities.

Module -5: BOUNDARY LAYER THEORY **8L hrs.**

Equation of motion in differential form, Viscous flow, exact solutions, pipe flow. Laminar boundary layers. Boundary layer solution methods. Introduction to Turbulence, Reynolds averaging, Reynolds stress, turbulent boundary layer.

Text Books:

1. White, F. M., "Fluid Mechanics (SI Units)", 7th Ed., Special Indian Edition, McGraw Hill, 2011.
2. Panton, R. L., "Incompressible Flow", 3rd Ed., Wiley India Edition, 2006.
3. Cengel Y. A., Cimbala J.M., "Fluid Mechanics (Fundamentals and Applications)", 2nd Ed., Tata McGraw Hill, 2010.

Reference Books:

1. Dr. R.K. Bansal, (2000), "Fluid Mechanics and Hydraulic Machines", Laxmi Publication (P) Ltd., New Delhi.
2. P.N. Modi and S.M. Seth (1999), "Hydraulics and Fluid Mechanics including Hydraulic Machines", Standard Book House, Naisarak, Delhi

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 20AS2304
TITLE OF THE COURSE : MECHANICS OF
SOLIDSL: T/A: P: C : 03: 00: 00:00:03

COURSE LEARNING OBJECTIVES

This course will enable students to:

- Understand the basic concepts of Engineering materials
- Understand center of gravity, centroid & Moment of Inertia under different loading
- Study of particle dynamics & Kinetics of rigid bodies.

COURSE OUTCOMES

Upon successful completion of this course, the students:

- Recognize the concept of rigid body equilibrium and equation of equilibrium.
- Plot Free body diagram for trusses and moment of inertia of plate, prism, cylinder.
- Solve the problems on trusses and friction.

Module 1: INTRODUCTION TO ENGINEERING MECHANICS 7L hrs.

Introduction to Engineering Mechanics covering, Force Systems Basic concepts, Particle Equilibrium in 2-D & 3-D; Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces, Resultant- Moment of Forces and its Application; Couples and Resultant of Force System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium.

Module 2: FRICTION AND BASIC STRUCTURAL ANALYSIS 7L hrs.

Friction: Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, wedge friction

Basic Structural Analysis: Equilibrium in three dimensions; Method of Sections; Method of Joints; Methods of analysis of truss; Simple Trusses; Zero force members; Beams & types of beams.

Module 3: CENTROID, CENTRE AND GRAVITY AND MOMENT OF INERTIA: 7L hrs.

Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity and its implications; Area moment of inertia Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Mass moment inertia of circular plate, Cylinder, Prism.

Module 4: PARTICLE DYNAMICS: 9L hrs.

Rectilinear motion: Plane curvilinear motion (rectangular path, and polar coordinates). Curvilinear motion: Projectile motion, Relative and constrained motion; Newton's 2nd law. Work - kinetic energy, power, potential energy. Impulse-momentum (linear, angular).

Module5: KINETICS OF RIGID BODIES: 9L hrs.

Basic terms, general principles in dynamics; Types of motion, Instantaneous center of rotation in plane motion and simple problems; D - Alembert's principle and its applications in plane motion and connected bodies; Work energy principle and its application in plane motion of connected bodies; Kinetics of rigid body rotation.

Text Books:

1. Irving H. Shames (2006), Engineering Mechanics, 4th Edition, Prentice Hall publications.
2. A Nelson (2009), Engineering Mechanics: Statics and dynamics, Tata McGraw Hill publications.

References:

1. F. P. Beer and E. R. Johnston (2011), Vector Mechanics for Engineers, Vol I - Statics, Vol II, – Dynamics, 9th Ed, Tata McGraw Hill publications.
2. R.C. Hibbler (2006), Engineering Mechanics: Principles of Statics and Dynamics, Pearson Press.
3. Bansal R.K.(2010), A Text Book of Engineering Mechanics, Laxmi Publications.

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 20AS2305
TITLE OF THE COURSE : AEROSPACE
MATERIALSL: T/A: P: C : 03: 00: 00:00:03

COURSE LEARNING OBJECTIVES:

This course will enable students to:

- Develop an understanding of different materials used in aerospaceengineering
- Understand different mechanical tests to study the strength of material
- Understand the material requirement for aircraft and space shuttlestructures
- Study various metal based alloys, super alloys and high performancepolymers for aerospace applications

COURSE OUTCOMES:

Upon successful completion of this course, the students:

- Demonstrate knowledge to select appropriate material for aerospace structures
- Comprehend the results of mechanical tests on materials
- Selecting the right materials for engineering process and application
- Characterize different aerospace materials of aircraft and space shuttle structures

Module -1: INTRODUCTION TO AEROSPACE MATERIALS AND THEIR REQUIREMENTS 7L hrs.

Brief history of aerospace materials, Materials for the global aerospace industry, Types,Future advances in aerospace materials

Material requirements for aerospace structures and engines, Introduction to Fixed-wingaircraft structures, Helicopter structures, Space shuttle structures

Module -2: STRENGTH, DURABILITY AND TESTING OF AEROSPACE MATERIALS 8L hrs.

Strengthening of metal alloys: Introduction, Crystal structure of metals, Defects in crystal structures, strengthening of metal, Corrosion of aerospace metals

Introduction to Tension test, Compression test, Flexure test, Hardness test, Fracture test, Drop-weight impact test, Fatigue test, Creep test, Environmental durability testing, certification of aerospace materials, Non Destructive Testing (NDT).

Module -3: LIGHT METAL ALLOYS **8L hrs.**

Aluminum alloys for aircraft structures: Introduction, Aluminum alloy types, Heat treatmentof aluminum alloys, High-temperature strength of aluminum,

Introduction to Titanium alloys and their applications, Types of titanium alloy, Titanium aluminides, Shape memory titanium alloys

Introduction to Magnesium alloys and their applications, types, Metallurgy of magnesiumalloys

Module -4: COMPOSITE MATERIALS: **8L hrs.**

Applications of Composites, Fibers, Resins and other materials for composite manufacturing, manufacturing techniques of composites, Introduction to polymer matrix composites,metal matrix composites, ceramic matrix composites, carbon fiber composites.

Module -5: STEELS & SUPER ALLOYS **8L hrs.**

Steels for aircraft structures: Introduction, Basic principles of steel metallurgy, Maraging steel, Medium-carbon low-alloy steel, Stainless steel

Super alloys for gas turbine engines: Introduction, Nickel-based super alloys, Iron–nickel super alloys, Cobalt super alloys, Thermal barrier coatings for jet engine alloys, advanced materials for jet engines

Text Books:

1. Adrian P. Mouritz, "Introduction to aerospace materials", Wood head PublishingLimited, 2012, ISBN 978-1-85573-946-8
2. George E. Dieter "Mechanical Metallurgy", McGraw Hill Publications
3. William D. Callister, "Materials Science and Engineering: an Introduction", John Wiley and sons

Reference Books:

1. Brian Cantor, Hazel Assender and Patrick Grant, "Aerospace Materials", Institute of Physics Publishing, ISBN: 0 7503 0742 0
2. Sam Zhang, Dongliang Zhao "Aerospace Materials Handbook" CRC Press Taylor & Francis Group, ISBN: 978-1-4398-7330-4

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 20AS2306
TITLE OF THE COURSE : COMPOSITES LAB
L: T/A: P: C : 00: 00: 02: 00: 1

COURSE LEARNING OBJECTIVES

This course will enable students to:

- Conduct experimentation on different Fabrication techniques for compositematerial.
- Conduct testing on fabricated composites as per ASTM standards for composite materials.
- Basic understanding of Composite materials

COURSE OUTCOMES

Upon successful completion of this course, the students:

- Understand different fabrication techniques for composite materials.
- Understand Non-destructive techniques on fabricated composites

LIST OF EXPERIMENTS:

1) Fabrication of 200X200 mm- 4 layer laminate by hand lay-up set up
2) Fabrication of 200X200 mm- 4 layer laminate by Vacuum Bagging set up
3) Curing of 200X200 mm- 4 layer laminate by Auto clave set up
4) Fabrication of hollow shaft by filament winding
5) Non-destructive test (Ultrasonic test) to compare the quality of productmanufacture by hand layup, vacuum bagging, and Auto clave setup.
6) Tensile test of composite material as per ASTM
7) Flexural testing of composite materials as per ASTM

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 20AS2307
TITLE OF THE COURSE : FLUID MECHANICS
LABL: T/A: P: C : 0: 0: 2: 0: 1

COURSE LEARNING OBJECTIVES:

This course will enable students to:

- Conduct experiments on using flow measurement devices including Notch, Venturi meter, orifice meter and rotameter
- Conduct experiments to calculate major and minor losses in pipes
- Basic understanding of fluid machinery

COURSE OUTCOMES:

Upon successful completion of this course, the students:

- Understand major and minor losses in pipe flow
- Understand various methods to calculate discharge using different flow measurement devices including Notch, Venturi meter, orifice meter
- Determine Performance characteristics of pumps and turbines

LIST OF EXPERIMENTS:

1. Measurement of force and Centre of pressure on a plane surface
2. Study of potential flows
3. Verification of Bernoulli's theorem – Pressure measurement with pitot static tube
4. Performance test on air blower
5. Determination of friction factor for flow through pipes
6. Loss of Head on Pipe Fittings Apparatus-To determine and compare pressure drop across various pipe settings
7. Determination of the Coefficient of Discharge of the Given Orifice Meter.
8. Determination of the Coefficient of Discharge of the Given Venturimeter.

SEMESTER/YEAR	**: III SEM / II YEAR**
COURSE CODE	**: 20AS2308**
TITLE OF THE COURSE	**: Mini Project I**
LABL: T/A: P: C	**: 0: 0: 2: 0: 1**

Mini project is Project-based learning (PBL) that involves students in designing, developing, and constructing hands-on solutions to a problem. The students are encouraged to forms groups of 2-4 members per batch. This mini project will provide technical aid related to design using modelling tools. They are evaluated based on the presentation they make at the end of the semester.

SEMESTER/YEAR : IV / II
COURSECODE : 20AS2401
TITLE OFTHECOURSE : AIRCRAFT PROPULSION
L: T/A: P: C : 03: 00:00:00:03

COURSE OBJECTIVES:

This course will enable students to:

1. Understand the working principles of gas turbine and ramjet propulsion systems, the design principles of inlets, combustion chambers, nozzles used in them
2. Understand the operation of compressors and turbines in gas turbine propulsion systems
3. Understand rocket propulsion

COURSE OUTCOMES:

Upon successful completion of this course, the students:

1. Analyze the engineering concepts of propulsion systems
2. Determine the performance characteristics of compressors and turbines
3. Choose the propellant based on the application.

Module -1: INTRODUCTION TO PROPULSION TECHNIQUES 7Hours

Introduction: Classification of power plants - Methods of aircraft propulsion – Propulsive efficiency – Specific fuel consumption - Thrust and power- Factors affecting thrust and power.

Gas turbine engine: Illustration of working of Gas turbine engine - Characteristics of turboprop, turbofan and turbojet– Methods of Thrust augmentation.

Module -2: PROPELLER THEORYAND PERFORMANCE 7Hours

Propeller Blade Theory: Momentum theory, Blade element theory, combined blade element and momentum theory, propeller power losses.

Propeller performance: prediction of static thrust- and in flight, negative thrust, prop fans, ducted propellers, propeller noise, propeller selection, propeller charts

Module -3: INLETS AND COMBUSTION 8 Hours

Nozzles: Subsonic and supersonic inlets – Relation between minimum area ratio and external deceleration ratio, starting problem in supersonic inlets–Modes of inlet operation, jet nozzle– Efficiencies–Over expanded, under and optimum expansion in nozzles–Thrust reversal.

Combustion Chamber: Classification of Combustion chambers - Combustion chamber performance – Flame tube cooling – Flame stabilization.

Module-4: COMPRESSORS **8 Hours**

Compressor types: Introduction to centrifugal compressors, Axial flow compressor- geometry- twin spools- three spools- stage analysis- velocity polygons- degree of reaction – radial equilibrium theory- performance maps.

Module-5: TURBINES **8 Hours**

Axial and radial flow turbines: geometry- velocity polygons- stage analysis- performance maps- thermal limit of blades and vanes.

Text Books:

1. Hill, P.G. and Peterson, C.R. "Mechanics and Thermodynamics of Propulsion", Pearson India, 2nd edition, 2009, ISBN-13:978-8131729519

2.Cohen, H. Rogers, G.F.C. and Saravanamuttoo, H.I.H, "Gas Turbine Theory", DORLING KINDERSLEY,5th edition,2002,ISBN-13:978-8177589023

Reference Books:

1. G.C. Oates, "Aerothermodynamics of Aircraft Engine Components", AIAA Education Series, 1985, ISBN-13:978-0915928972.

2. G.P.Sutton, "Rocket Propulsion Elements", Wiley India Pvt Ltd, 7th Edition, 2010, ISBN-13:978-8126525775.

3.W.P.Gill, H.J.Smith & J.E. Ziurys, "Fundamentals of Internal Combustion Engines as applied to Reciprocating, Gas turbine & Jet Propulsion Power Plants", Oxford & IBH Publishing Co., 4th revised edition,2007,ISBN-13:978-8120417106.

SEMESTER/YEAR : IV / II
COURSECODE : 20AS2402
TITLE OFTHECOURSE: AERODYNAMICS–I
L: T/A: P: C : 03: 01:00:00:03

COURSE OBJECTIVES:

This course will enable students to:

1. To introduce the concepts of mass, momentum and energy conservation relating to aerodynamics.
2. To make the student understand the concept of vorticity, irrotationality, theory of airfoils and wing sections
3. Acquire knowledge on typical airfoil characteristics and two-dimensional flows over airfoil and study the incompressible over finite wings
4. To introduce the basics of viscous flow.

COURSE OUTCOMES:

Upon successful completion of this course, the students:

1. Potential flows and Viscous flows
2. Understanding of flow past streamlined bodies and bluff bodies
3. Lift generation mechanisms, Lifting line theory and applications
4. Boundary layer theory: Laminar and turbulent flows

Module -1: INTRODUCTION TO LOWSPEEDFLOW 8 Hours

Potential flow analysis, Euler equation, incompressible Bernoulli's equation. Circulation and Vorticity, Green's lemma and Stoke's theorem, Barotropic flow, kelvin's theorem, stream line, stream function, irrotational flow, potential function, equipontentiallines, elementary flows and their combinations.

Module -2: TWO DIMENSIONAL INVISCID INCOMPRESSIBLE FLOW 9 Hours

Scalar and vector fields, velocity potential, line, surface and volume integrals, circulation and lift generation, Kutta-Joukovskii theorem, Source Flow, Sink flow, doublet flow, 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.

Module -3: AIR FOIL THEORY 9 Hours

Cauchy-Riemann relations, complex potential, methodology of conformal transformation,

KuttaJoukowski transformation and its applications, Classical thin airfoil theory for symmetric and asymmetric airfoils and its applications.

Module -4: SUBSONIC WING THEORY **9 Hours**

Biot-Savartlaw and Helmholtz's theorems, Vortex filament: Infinite and semi-infinite vortex filament, Induced velocity. Prandtl's classical lifting line theory, Downwash and induced drag, Elliptical and modified elliptical lift distribution .Lift distribution on wings. Limitations of Prandtl are lifting line theory. Extended lifting line theory- lifting surface theory, vortex lattice method for wings .Lift, drag and moment characteristics of complete airplane. Simplified horse-shoe vortex model, formation flight, influence of downwash on tail plane.

Module -5: INTRODUCTION TO BOUNDARY LAYER THEORY **9 Hours**

Boundary layer and boundary layer thickness, displacement thickness, momentum thickness, energy thickness, shape parameter, boundary layer equations for a steady, two dimensional incompressible flow, boundary layer growth over a flat plate, critical Reynolds number, Blasius solution, basics of turbulent flow.

Text Books:

1. Houghton, E.L., and Caruthers, N.B., "Aerodynamics for Engineering students", Edward Arnold Publishers Ltd., London, 1989.

2. Anderson, J.D., "Fundamentals of Aerodynamics", McGraw Hill Book Co., 1999

Reference Books:

1. Milne Thomson, L.H., "Theoretical Aerodynamics", Macmillan, 1985

2. John J Bertin., "Aerodynamics for Engineers", Pearson Education Inc, 2002

3. Clancy L. J. "Aerodynamics", Sterling book house, New Delhi. (2006), ISBN 13: 9780582988804

4.Kuethe, A.M and Chow, C.Y, "Foundations of Aerodynamics", Fifth Edition, John Wiley &Sons,2000.

5. Louis M. Milne-Thomson, "Theoretical Aerodynamics", Imported Edition, Dover Publications, USA (2011), ISBN9780486619804

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 20AS2403
TITLE OF THE COURSE : AEROSPACE STRUCTURAL MECHANICSL: T/A: P: C : 03: 00: 00: 00:03

Course Learning Objectives:

This course will enable students to:

Course Outcomes:

1.Understand basic principles of aviation and the history of space vehicles
2.Acquire the basic knowledge of aircraft structures, aerodynamics, materials, aircraft systems & instrumentation
3. Understand the basics of spacecraft and orbital mechanics

Upon successful completion of this course, the students:

- Apply the basic knowledge & principles of aerospace vehicles and spacecraft
- Apply the concepts of fundaments of flight, basics of aircraft structures, aircraft & rocket propulsion and aircraft materials during the development ofan aircraft
- Understand the complexities involved during development of aerospace vehicles.

Module -1: Engineering materials 7 Hrs

Engineering materials, properties of materials, Stress and strain, types of stress and strain, Stress and strain relation, hook's law. Stress-strain relation, Plane stress and strain, Principle stresses, Mohr's circle of stress, Failure theories.

Module -2: Beam Analysis 8 Hrs

Shear force and Bending moment, Stress in beam, shear stress in beam and deflection in beam,and thin walled sections. Strain energy due to stresses, Castigliano's theorems.

Module -3: Torsion, Buckling and Vibration 8 Hrs

Torsion of a solid section, hollow sections and thin- walled sections. Buckling and stability of columns, critical load, Euler's column theory, types of end condition Structural Dynamics: Free and forced vibrations of undamped and damped SDOF systems.

Module -4: Flight vehicle structures **8 Hrs**

Analysis of aircraft structures, Principles of stressed skin construction: materials, Propertiesof material, Loads on structural components and its function, fabrication, construction.
Loads on aircraft: airworthiness, airframe loads, fatigue

Module -5: Simulation **8 Hrs**

Simulation software's. Simulation problems: pre-processing, processing post processing.
Simulation of simple problems of beams, truss.

Text Books:

1. T.H.G.Megson, Aircraft Structures for Engineering students, Elsevier. 5th edition, 2007.
2. Lalit Gupta and O P Sharma, Fundamentals of Flight Vol-I to Vol-IV, Himalayan Books. 2006, ISBN: 9788170020752

Reference Books:

1. J.B.K.Das and Dr. P.L.Srinivas Murthy , "Mechanics of Materials", Sapna, 2016.
2. John D. Anderson, "Introduction to Flight", McGraw-Hill Education, 8th edition, 2015, ISBN: 978-0078027673.

SEMESTER/YEAR : IV / II
COURSECODE : 20AS2404
TITLE OFTHECOURSE : MECHANISMS AND MACHINE THEORY
L: T/A:P: C : 03: 00: 00:00:03

COURSE OBJECTIVES:

This course will enable students to:

1. Understand different types of mechanisms and kinematic pairs
2. Understand the techniques for studying the dynamics of machines and its components
3. Study the effect of gyroscopic couple on aircrafts

COURSE OUTCOMES:

Upon successful completion of this course, the students:

1. Analyze different types of mechanisms using analytical and graphical methods
2. Determine the terminologies gear and gear trains.
3. Solve problems on balancing of reciprocating and rotating masses
4. Determine the performance characteristics of Gyroscope

Module -1: BASICS OF MECHANISMS 7 Hours

Definitions Link or element, kinematic pairs, Degrees of freedom, Grubler's criterion (without derivation), Kinematic chain, Mechanism, Structure, Mobility of Mechanism, Inversion, Machine. Kinematic Chains and Inversions: Inversions of Four bar chain; Single slider crank chain and Double slider crank chain.

Straight line motion mechanisms. Intermittent Motion mechanisms -Geneva wheel mechanism and Ratchet and Pawl mechanism. Toggle mechanism, Pantograph

Module -2: VELOCITY ANDACCELERATION ANALYSIS 8 Hours

Velocity and Acceleration Analysis of Mechanisms (Analytical Method): Velocity and acceleration analysis of four bar mechanism, slider crank mechanism. Freudenstein’s equation for four bar mechanism and slider crank mechanism. Function Generation for four bar mechanism. Velocity Analysis by Instantaneous Center Method: Definition, Kennedy's Theorem.

Module -3: GEARS TERMINOLOGY **8Hours**

Gear nomenclature, types, law of gearing, Path of contact, Arc of contact, Contact ratio of spur gear, Interference in involute gears, Methods of avoiding interference.

Gear Trains: Simple gear trains, Compound gear trains, Reverted gear trains, Epicyclic gear trains, Analysis of epicyclic gear train (Algebraic and tabular methods), torques in epicyclic trains.

Module 4: BALANCING OF ROTATING & RECIPROCATING MASSES **8Hours**

Balancing of Rotating Masses: Balancing of Several Masses Rotating in the Same Plane, Balancing of Several Masses Rotating in Different Planes. Inertia effect of crank and connecting rod, numerical problems.

Module -5: GYROSCOPES **8Hours**

Gyroscope: Vectorial representation of angular motion. Gyroscopic couple, effect of gyroscopic couple on ship, plane disc, aero plane, stability of aircrafts.

Text Books:

1. Sadhu Singh, Theory of Machines, Pearson Education. 2nd Edition, 2007.

2.Rattan S.S. Theory of Machines, Tata McGraw Hill Publishing Company Ltd., New Delhi, 3rd Edition,2009

Reference Books:

1. J.J. Uicker, G.R. Pennock, J.E. Shigley, “Theory of Machines & Mechanisms”, Oxford 3rd Ed.2009

2. A.G.Ambekar, “Mechanism and Machine Theory”, PHI, 2007

SEM/YEAR : IV/II
COURSE CODE : 20AS2405
TITLE OFTHECOURSE : MANUFACTURING PROCESSES
L: T/A: P: C : 3:0: 0: 0:3

COURSE OBJECTIVES:

This course will enable students to:

1. To introduce the concepts of manufacturing processes.
2. To understand the fundamentals and principles of different processes like forging, rolling.
3. To understand fundamentals of Rapid prototyping.

COURSE OUTCOMES:

Upon successful completion of this course, the students:

1. Understand and gain knowledge on casting processes.
2. Understand the extrusion & sheet metal forming.
3. Understand the principles of lathe machines and rapid prototyping.

Module 1: Metal casting and forging 10 Hours

Introduction, processes and applications of casting Light alloy casting, mounding practice, melting practice, precision investment casting, effect of casting parameters on properties titanium casting, directional solidification, powder metallurgy technique and forging equipment, press, recent trends, quality control aspects of thermo mechanical processing,

Module 2: Metal cutting and joining Process 10 Hours

Alloy requirements, sheet materials, steels, titanium alloys, high temperature super alloys, heat treatment and de-scaling, forming, chemical machining, electron beam welding, brazing of super alloys, ultrasonic machining, water jet cutting, electrochemical processing, laser cutting for rotating machinery components, joining technologies like plasma technique, laser welding

Module 3: Sheet Metal Working 10 hrs

Shearing mechanisms, Processes like blanking, piercing, punching. Metal Forming processes like bending, cup drawing, coining, embossing. High energy rate forming-superplastic forming-principles & process parameters. Applications of sheet formed products in aerospace.Riveted joints, desirable properties of rivets, basic terminologies, and advantages of riveted joints.

Module 4: **Additive Manufacturing** **10 Hours**

Basic Principles of Additive Manufacturing and Processes, Designing for Additive Manufacturing, Multiple Materials, Hybrids, Composite Materials, current and future directions, Rapid Prototyping, Rapid Tooling. Rapid Manufacturing; Powder-based AM processes. Printing processes, extrusion based fused deposition modeling object, Stereo lithography Micro- and nano-additive, Advantages and application, smart manufacturing concepts based on industrial 4.0.

Module 5: Aerospace components and protective measures **10 Hours**

Major engine components, material trends, component operating environments and material requirements, compressor and turbine discs, blades. Combustion chambers, shafts, bearings Corrosion behavior, coatings and surface treatments, erosion behaviour of compressor components, surface degradation and protection of combustor and turbine components

Text books:

1. "Manufacturing Process-I", Dr.K.Radhakrishna, Sapna Book House, 5th Revised Edition 2009.
2"Manufacturing & Technology: Foundry Forming and Welding", P.N.Rao, 3rd Ed., Tata McGraw Hill, 2003.
3. Workshop Technology- Hazara Choudhry, Vol-II, Media Promoters & Publishers Pvt. Ltd. 2004
4. Production Technology-R. K. Jain, Khanna Publications, 2003.
5. Production Technology- HMT, Tata MacGraw Hill, 2001.
6. Paul F. Jacobs: "Stereo lithography and other RP & M Technologies", SME, NY 1996.
7.Flham D. T & Dinjoy S.S "Rapid Manufacturing" Verlog London 2001.

Reference books:

1. "Process and Materials of Manufacturing", Roy A Lindberg, 4th Ed. Pearson Edu. 2006.
2. "Manufacturing Technology", Serope Kalpakjian, Steuen. R. Sechmid, Pearson Education Asia, 5th Ed. 2006.
3. Manufacturing Science- Amitabh Ghosh and Mallik, affiliated East West Press, 2003.
4. Rapid prototyping materials by Gurumurthi, IISc Bangalore

SEMESTER/YEAR : IV / II
COURSECODE : 20AS2406
TITLE OFTHECOURSE : PRODUCT DESIGN- I
L: T/A: P: C : 02:00: 02:00:03

COURSE OBJECTIVES:

This course will enable students to:

1. Acquire practical knowledge regarding conceptualization, design and development of a new product.
2. Understanding costing and economic decision making
3. Familiarization with design software on 3D modeling, section of solids, orthographic view and dimensioning

COURSE OUTCOMES

Upon successful completion of this course, the students:

1. Understand the need of a new product, the product life cycle and the product design process.
2. Get awareness of the role of multiple functions in creating a new product (e.g. marketing, finance, industrial design, engineering, production).
3. Get competence with a set of tools and methods for product design and development.
4. Generate detailed 3Ddrawing

Module1: INTRODUCTION 8 Hours

Importance of product design, life cycle of a product, steps involved in the design process, communication during the design process, team behavior and tools, design review, delta design exercise.

Module 2: IDENTIFICATION AND UNDERSTANDING OF CUSTOMER NEEDS 8 Hours

Voice of customer, gather raw data from customers, interpret raw data in terms of customer needs, organize the needs into a hierarchy, establish the relative importance of the needs and reflect on the results and the process. Requirements capture, development of product design specifications, quality function deployment (QFD) technique, case studies in QFD.

Module 3: CONCEPT GENERATIONANDEVALUATION 8 Hours

Generating engineering specifications, functional analysis and design, concept generation methods, creativity and problem solving, creativity method, creative idea evaluation, TRIZ, axiomatic design. Concept evaluation: Information representation, concept evaluation overview, evaluation techniques based on 1) feasibility judgment, 2) GO-NO-GO screening,3)technological readiness, 4) basic decision matrix (Pugh's Method). Time value of money, cost comparison, profitability of investment, sensitivity and break even analysis.

Module 4: PRODUCT ARCHITECTURE AND PROTOTYPING 8 Hours

Product Architecture- What is product architecture, implications of the architecture, establishing the architecture, variety and supply chain considerations, platform planning, related system level design issues.

Prototyping- Prototyping basics, principles of prototyping, technologies, planning for prototypes

Module 5: SOFTWARE BASICS AND 3D MODELING (ONLY FOR INTERNALS)

8 Hours

Introduction to software (CATIA), CAD Basics, solid modeling, surface modeling (Theory on Bezier curves), sectioning, views, dimensioning, 2D drawing preparation, bill of materials Product design of own choice – part drawing, exploded view and assembly and simulation of the model using simulia.

Text books

1. Dieter, G.E., Engineering Design: A materials and process in approach, McGraw-Hill International Series, 2000.

2. Ullman, D. G., Mechanical Design Process, McGraw Hill, 2004.

Reference books

1. Ulrich, K. T. and Eppinger, S. D., Product Design and Development, Irwin McGraw Hill, 2000.

2.Eide,R., Jenison, R. D., Marshaw , L. H., and Northup L. R., Introduction to Engineering Design,McGrawHillBasicEngineeringSeriesandTools,1998.

SEMESTER/YEAR	**: IV / II**
COURSECODE	**: 20AS2407**
TITLE OFTHECOURSE	**: AEROSPACE STRUCTURES LAB**
L: T/A: P: C	**: 00: 00: 02:00:1**

COURSE OBJECTIVES:

This course will enable students to:

1. Conduct experiments on various structural elements like beams, columns, frames and pressure Vessels.
2. Conduct experiments on different testing machines like universal testing machine, fatigue testing machine, creep testing machine
3. Calculate tensile strength, fatigue strength and creep strength of different materials

COURSE OUTCOMES:

Upon successful completion of this course, the students:

1. To understand the basic concepts of material science and real experience getting to determine different strength properties.
2. To understand the application of Aircraft material science
3. To understand various aerospace structural components like longerons, stringers, bulk head and ribs
4. To understand different instrumentation and different industry standards

LIST OF EXPERIMENTS:

1. Deflection of beams using Beam testing set-up
2. Deflection of columns using Column testing set-up
3. Determination of stress in thin wall pressure vessel
4. Pin jointed frame analysis
5. Determination of bending stress in beam
6. Determination of Fatigue strength
7. Vibration testing
8. Creep testing

SEMESTER/YEAR : IV / II
COURSE CODE : 20AS2408
TITLE OF THE COURSE : MANUFACTURING PROCESSES LAB
L: T/A: P: C : 00:00: 03:00: 1

COURSE OBJECTIVES:

This course will enable students to:

1. To provide an insight to different machine tools, accessories and attachments
2. To train students into machining operations to enrich their practical skills
3. To inculcate team qualities and expose students to shop floor activities
4. To educate students about ethical, environmental and safety standards

COURSE OUTCOMES:

Upon successful completion of this course, the students:

1. Perform turning, facing, knurling, thread cutting, eccentric turning and all other allied operations.
2. Understand surface milling/slot milling.

LIST OF EXPERIMENTS

1. Foundry practice: Preparation of a sand mould using single pattern
2. Preparation of sand mould using split piece pattern
3. Preparation of sand mould using match type pattern.
4. Preparation of three models on lathe involving Plain turning, Taper turning, Step turning.
5. Preparation of three models on lathe involving Thread cutting, Facing, Knurling.
6. Demonstration on gear cutting operation using milling machine.
7. Demonstration of various cutting operations by using of grinding machine, drilling machine & shaper machine
8. Design and development of a 3D printing part by using fused deposition modeling process (FDM)

SEMESTER/YEAR : IV / II
COURSE CODE : 20AS2409
TITLE OF THE COURSE : MINI PROJECT II
L: T/A: P: C : 00:00: 02:00: 1

Mini project is Project-based learning (PBL) that involves students in designing, developing, and constructing hands-on solutions to a problem. The mini project will provide technical aid related to design and analyzing through simulations the models built. The students are exposed to new technologies in manufacturing namely additive manufacturing.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16AS304
TITLE OF THE COURSE : PRINCIPLES OF MANAGEMENT & ECONOMICS FOR ENGINEERS
L: T: P: S/P: C : 03:01: 00:00: 04

COURSE OBJECTIVES

This course will enable students to:

- To help the students to understand the fundamental concepts and principles of management; the basic roles, skills, functions of management, various organizational structures and basic knowledge of marketing
- To impart knowledge, with respect to concepts, principles and practical applications of Economics, which govern the functioning of a firm/organization under different market conditions

COURSE OUTCOMES:

Upon successful completion of this course, the students:

- Understand needs, functions, roles, scope and evolution of management
- Understand importance, purpose of planning and hierarchy of planning and also analyse Its types
- Discuss decision making, organizing, staffing, directing and controlling.
- Select the best economic model from various available alternatives.
- Understand various interest rate methods and implement the suitable one.
- Estimate various depreciation values of commodities.
- Prepare the project reports effectively.

Module 1: MANAGEMENT 8L hrs.

Introduction - Meaning - nature and characteristics of Management, Scope and Functional areas of management - Management as a science, art of profession - Management & Administration - Roles of Management, Levels of Management, and Development of Management Thought- early management approaches – Modern management approaches. Planning: Nature, importance and purpose of planning process Objectives - Types of plans(Meaning Only) - Decision making Importance of planning - steps in planning & planning premises - Hierarchy of plans.

Module 2: ORGANIZING AND STAFFING **8L hrs.**

Nature and purpose of organization Principles of organization - Types of organization - Department Committees Centralization Vs Decentralization of authority and responsibility - Span of control - MBO and MBE (Meaning Only) Nature and importance of staffing--Process of Selection & Recruitment (in brief). Directing & Controlling: Meaning and nature of directing Leadership styles, Motivation Theories, Communication - Meaning and importance - coordination, meaning and importance and Techniques of Co Ordination. Meaning and steps in controlling - Essentials of a sound control system - Methods of establishing control (in brief).

Module 3: INTRODUCTION: ENGINEERING AND ECONOMICS **8L hrs.**

Problem solving and decision making, Laws of demand and supply, Difference between Microeconomics Macroeconomics, equilibrium between demand & supply, elasticity of demand, price elasticity, income elasticity. Law of Returns, Interest and interest factors, simple and compound interest, Cash flow diagrams, personal loans and EMI payment calculation with flexible interest rates, Discussion and problems.

Module-4 **8L hrs.**

Present, future and annual worth and rate of returns: Basic present worth comparisons, Present worth equivalence, Assets with unequal lives and infinites lives, future worth comparisons, payback comparisons, Equivalent annual worth comparisons, situations for annual worth comparisons. Asset life, Rate of return, minimum acceptable rate of return, IRR anomalies and misconceptions, Cost of capital, comparisons of all present future and annual worth with IRR, product costing, Balance sheet, Discussions and problems.

Module 5: COSTING AND DEPRECIATION **8L hrs.**

Components of costs, estimation of selling price, marginal cost, first cost, all kinds of overheads, indirect cost estimation with depreciation, mensuration and estimation of material cost, cost estimation of mechanical process, idling time. Product costing (approaches to product costing), causes of depreciation, methods of computing depreciation charges, straight line method, declining balance method, sum of years method, sinking fund method, service output methods, taxation concepts, personal income taxes and corporate taxes, Discussions and problems.

Text Books:

1) Principles of Management by Tripathy and Reddy
2) Mechanical estimation and costing, T.R. Banga & S.C. Sharma, 17th edition 2015
3) Engineering Economy, Riggs J.L. McGraw Hill, 2002
4) Engineering Economy, Thuesen H.G. PHI , 2002

Reference Books:

1) Management Fundamentals - Concepts, Application, Skill Development - Robers Lusier Thomson
2) Basics of Engineering Economy, Leland Blank & Anthony Tarquin, McGraw Hill Publication (India) Private Limited
3) Engineering Economics, R.Paneerselvam, PHI publication
4) Management & Engineering Economics, Ravi Kumar R, Sunstar Publications
5) Fundamentals of Management: Essential Concepts and Applications, Pearson Education, Robbins S.P. and Decenzo David A.
6) Economics: principles of economics, and gregory mankiw, cengage learning

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16AS313
TITLE OF THE COURSE : FINITE ELEMENTAL METHODS
L: T: P: C : 03: 00: 00:03

COURSE LEARNING OBJECTIVES

This course will enable students to:

- To enable the students to appreciate the use of finite element methods to analyze structural and dynamic problems.
- To enable the students to understand and perform finite element analysis of 1D and 2D structures.
- To teach the procedure to perform finite element based steady-state and transient response analysis.

COURSE OUTCOMES

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

- At the end of the course, the student will be able to
- Calculate element energy functions for 1-D and 2D finite elements.
- Understand and apply Raleigh Ritz method and develop mathematical expressions for bars and beams.
- Understand and appreciate the finite element method in solving simple problems of engineering significance.
- Understand and appreciate the finite element method in solving steady state heat transfer problems.

MODULE 1: Introduction: 8L HRS

Introduction: Equilibrium equations in elasticity subjected to body force, traction forces, and stress- strain relations for plane stress and plane strains. General description of finite element method, application and limitations, types of elements based on geometry. Node numbering, half band width.

MODULE 2: BASIC METHODS 8L HRS

Basic Methods in FEM Euler - Lagrange equation for bar, beam (cantilever / simply supported fixed). Principle of virtual work, principle of minimum potential energy, Raleigh's Ritz method. Direct approach or stiffness matrix formulation of bar element and Galerkin's method.

MODULE 3: INTERPOLATION MODELS 8L HRS

Interpolation polynomials- linear, quadratic and cubic. Simplex complex and multiplex elements, 2D PASCAL's triangle, CST elements-shape functions and nodal load vector, strain displacement matrix and Jacobian for triangular and rectangular element. Higher Order Elements: LaGrange's interpolation, one dimensional elements-quadratic element and their shape functions. Shape

function of 2-D quadrilateral element-linear, quadric element Isoperimetric, sub parametric and super parametric elements.

MODULE 4: 1-D BARS &TRUSSES: 7L HRS

Solution of 1-D Bars: Solutions of bars and stepped bars for displacements, reactions and stresses by sing penalty approach and elimination approach. Gauss-elimination technique. Trusses: Stiffness matrix of truss element. Numerical problems

MODULE 5: BEAMS & HEAT TRANSFER BEAMS 8L HRS

Beams & Heat Transfer Beams: Hermite shape functions for beam element, derivation of stiffness matrix. Numerical problems of beams carrying concentrated, UDL and linearly varying loads. Heat transfer: Steady state heat transfer, 1D heat conduction governing equations. Functional approach for heat conduction, Galerkin's approach for heat conduction, 1D heat transfer in thin fins.

Text Books:

1) T.R. Chandrupatla and A.D Belegunde , Finite Elements in Engineering, 3rd Ed PHI.
2) S.S. Rao, Finite Element Method in Engineering,4th Edition, Elsevier, 2006.

Reference Books:

1) R.D. Cook D.S Maltus, M.E Plesha and R.J.Witt, Concepts and applications of Finite Element Analysis, Wiley 4th Ed, 2009
2) J.N.Reddy, Finite Element Method, McGraw -Hill International Edition, 2009.

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 16AS274
TITLE OF THE COURSE : MATERIAL TESTING
LAB L: T/A: P: C : 00: 00: 03: 00:1.5

Course Learning Objectives:

This course will enable students to:

- Conduct various mechanical testing of materials

Course Outcomes:

Upon successful completion of this course, the students:

- Analyse the results of different mechanical testing of materials

LIST OF EXPERIMENTS:

1. Tension Test- To determine mechanical properties such as ultimate tensile strength, elastic modulus, proportionality limit, yield point, fracture stress, percentage elongation & reduction in area of metals & alloys and also study the behaviour of material & characterize types of fracture under tensile load.
2. Compression Test -To conduct compression test on the given material and to determine properties such as compressive strength, modulus of elasticity, percentage constriction & percentage increase in area.
3. Shear Test - To determine ultimate shear stress of the given specimens in single and double shear.
4. Bending Test -To study the characteristics of materials under the gradually increasing flexural loading and to determine Modulus of rupture, Modulus of elasticity, Maximum shear stress.
5. Impact Test - (Charpy and Izod) - To find out the impact strength of the given notched specimens.
6. Brinell hardness Test -To determine the Brinell Hardness Number (BHN) of the given specimens.
7. Vicker's Hardness Test - To determine Vickers Hardness Number for a given specimen.
8. Wear Test - To determine the wear rate of different materials by using pin and disc apparatus.