SATHYABAMA
INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)
Accredited with "A" Grade by NAAC
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SAEA1303	AIRCRAFT SYSTEMS AND INSTRUMENTS (For Aeronautical)	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

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

UNIT 1 AIRCRAFT SYSTEMS **9 Hrs.**

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

UNIT 2 LANDING GEAR SYSTEMS **9 Hrs**

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

UNIT 3 FUEL AND PRESSURIZING SYSTEM **9 Hrs.**

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

UNIT 4 AIRPLANE CONTROL SYSTEMS **9 Hrs**

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

UNIT 5 AIRCRAFT INSTRUMENTS **9 Hrs.**

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

Max.45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Choose the suitable hydraulic and pneumatic systems for different modes of operation in aircraft systems.
CO2 - Illustrate the functions of landing gear systems possessing retraction/ extension mechanism of an aircraft.
CO3 - Scrutinize the airplane control systems and control actuation systems utilized in control surfaces.
CO4 - Categorize the different types of fuel systems and environmental control systems of aircraft components.
CO5 - Recommend the types of flight navigation instruments used in aircraft.
CO6 - Recommend the types of gyroscopic and engine instruments to be used in aircrafts.

TEXT / REFERENCE BOOKS

1. Mekinly, J.L. and Bent, R.D., "Aircraft Power Plants", McGraw Hill, 1993.
2. Pallet, E.H.J., "Aircraft Instruments & Principles", Pitman & Co., 1993.
3. Treager, S., "Gas Turbine Technology", McGraw Hill, 1997.
4. Mckinley, K.L., and Bent, R.D., "Aircraft Maintenance & Repair", McGraw Hill1993

SAEA1503	COMPUTATIONAL FLUID DYNAMICS FOR AEROSPACE APPLICATION	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVES

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

UNIT 1 INTRODUCTION **9 Hrs.**

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

UNIT 2 FINITE DIFFERENCE METHODS AND SOLUTIONS **9 Hrs.**

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

UNIT 3 INCOMPRESSIBLE VISCOUS FLOWS AND COMPRESSIBLE FLOWS 9 Hrs.

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

UNIT 4 STRUCTURED AND UNSTRUCTURED GRID GENERATION **9 Hrs.**

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

UNIT 5 COMPUTING TECHNIQUES AND APPLICATION **9 Hrs.**

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

Max.45 Hrs.

COURSE OUTCOMES

On completion of the course, students will be able to

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

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

CO3 - Derive the Incompressible Viscous flows and Compressible flows for aerospace applications CO4 - Analyse the Structured and Unstructured Grid generation, transformation and Mapping

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

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

TEXT / REFERENCE BOOKS

1. Chung T.J Computational fluid dynamics, second edition –Cambridge University press USA, 2010.
2. Suhas V Patankar,"Numerical Heat Transfer and Fluid Flow", Taylor and Francis, 2011.
3. Principles of Computational Fluid Dynamics by P. Wesseling., 2011.
4. Shaw C T, "Using Computational Fluid Dynamics" Prentice Hall, 1992.
5. Anderson.J.D.Jr. "Computational Fluid Dynamics: An Introduction", 3rd Edition, 2012

SAEA1702	UNMANNED AERIAL VEHICLE	L	T	P	Credits	Total

	DESIGN					Marks
		3	0	0	3	100

COURSE OBJECTIVES

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

UNIT 1 INTRODUCTION TO UAV **9 Hrs.**

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

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

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

UNIT 3 AVIONICS HARDWARE **9 Hrs.**

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

UNIT 4 COMMUNICATION PAYLOADS, CONTROLS AND NAVIGATION **9 Hrs.**

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

UNIT 5 DIGITAL IMAGE PROCESSING FOR UAV **9 Hrs.**

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

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Summarise the various stages for designing the Unmanned Aerial Vehicle
CO2 - Comprehend the sound foundation in the Aerodynamics and Airframe characteristics
CO3 - Choose the various Avionics Hardware based on the UAV application
CO4 - Choose the Communication payloads, Controls and Navigation for UAV
CO5 - Apply the Digital Aerial Photography techniques for UAV
CO6 - Apply the Digital image processing techniques for UAV

TEXT / REFERENCE BOOKS

1. Kimon P. Valavanis, George J. Vachtsevanos, " Handbook of Unmanned Aerial Vehicles " Volume Set- FIRST Edition, ISBN-13: 978-9048197064, 2015.
2. R. Jha. "Theory, Design, and Applications of Unmanned Aerial Vehicles".1st Edition, 2015.
3. Jane's Unmanned Aerial Vehicles and Targets, Jane' s Information Group; ASIN: 071 061 2575,1999.
4. Alex Elliott,"Build Your Own Drone Manual: The practical guide to safely building, operating and maintaining an Unmanned Aerial Vehicle (UAV)".2016.
5. R. Said and H. Chayeb, "Power supply system for UAV", KTH, 2002.
6. Robert C. Nelson, Flight Stability and Automatic Control, McGraw -Hill, Inc, 1998

SMEA3001	ADDITIVE MANUFACTURING	L	T	P	Credits	Total Marks

		3	0	0	3	100

COURSE OBJECTIVES

- Exploit technology used in additive manufacturing.
- Understand importance of additive manufacturing in advance manufacturing process.
- Acquire knowledge, techniques and skills to select relevant additive manufacturing process.
- Eplore the potential of additive manufacturing in different industrial sectors.
- Apply 3D printing technology for additive manufacturing.

UNIT 1 INTRODUCTION **9 Hrs.**

Overview, Basic principle need and advantages of additive manufacturing, Procedure of product development in additive manufacturing, Classification of additive manufacturing processes, Materials used in additive manufacturing, Challenges in Additive Manufacturing.

UNIT 2 ADDITIVE MANUFACTURING PROCESSES **9 Hrs.**

Z-Corporation 3D-printing, Stereolithography apparatus (SLA), Fused deposition modeling (FDM), Laminated Object Manufacturing (LOM), Selective deposition lamination (SDL), Ultrasonic consolidation, Selective laser sintering (SLS), Laser engineered net shaping (LENS), Electron beam free form fabrication (EBFFF), Electron beam melting (EBM), Plasma transferred arc additive manufacturing (PTAAM), Tungsten inert gas additive manufacturing (TIGAM), Metal inert gas additive manufacturing (MIGAM).

UNIT 3 ADDITIVE MANUFACTURING MACHINES AND SYSTEMS **9 Hrs.**

Axes, Linear motion guide ways, Ball screws, Motors, Bearings, Encoders/ Glass scales, Process Chamber, Safety interlocks, Sensors. Introduction to NC/CNC/DNC machine tools, CNC programming and introduction, Hardware Interpolators, Software Interpolators, Recent developments of CNC systems for additive manufacturing.

UNIT 4 PRE-PROCESSING IN ADDITIVE MANUFACTURING **9 Hrs.**

Preparation of 3D-CAD model, Reverse engineering, Reconstruction of 3D-CAD model using reverse engineering, Part orientation and support generation, STL Conversion, STL error diagnostics, Slicing and Generation of codes for tool path, Surface preparation of materials.

UNIT 5 POST-PROCESSING IN ADDITIVE MANUFACTURING **9 Hrs.**

Support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non-thermal and thermal techniques, Brief information on characterization techniques used in additive manufacturing, Applications of additive manufacturing in rapid prototyping, rapid manufacturing, rapid tooling, repairing and coating.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Able to define the various process used in Additive Manufacturing.
CO2 - Able to analyse and select suitable process and materials used in Additive Manufacturing.
CO3 - Able to identify, analyse and solve problems related to Additive Manufacturing.
CO4 - Able to apply knowledge of additive manufacturing for various real-life applications.
CO5 - Able to apply technique of CAD and reverse engineering for geometry transformation in Additive Manufacturing.
CO6 - Understand the basic concept of additive manufacturing application.

TEXT/REFERENCE BOOKS

1. Gibson, I, Rosen, D W. and Stucker ,B., Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, 2010.
2. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", Third Edition, World Scientific Publishers, 2010.
3. Chee Kai Chua, Kah Fai Leong, 3D Printing and Additive Manufacturing: Principles and Applications: Fourth Edition of Rapid Prototyping, World Scientific Publishers, 2014
4. Gebhardt A., "Rapid prototyping", Hanser Gardener Publications, 2003.Kenneth G. Budinski & Michael K. Budinski, "Engineering Materials: Properties and Selection", 9th Edition, Pearson, 2009, 792 pages

SAEA3014	BOUNDARY LAYER THEORY	L	T	P	Credits	Total

						Marks
		3	0	0	3	100

COURSE OBJECTIVES

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

UNIT 1VISCOUS FLOW EQUATIONS **9 Hrs.**

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

UNIT 2 LAMINAR BOUNDARY LAYER **9 Hrs.**

Development of boundary layer – Estimation of boundary layer thickness, Displacement thickness-Momentum and energy thicknesses for two dimensional flow – Two dimensional boundary layer equations – Similarity solutions - Blasius solution.

UNIT 3 TURBULENT BOUNDARY LAYER **9 Hrs.**

Physical and mathematical description of turbulence, two-dimensional turbulent boundary layer equations, Velocity profiles – Inner, outer and overlap layers, Transition from laminar to turbulent boundary layers, turbulent boundary layer on a flat plate, mixing length hypothesis.

UNIT 4 APPROXIMATE SOLUTION TO BOUNDARY LAYER EQUATIONS **9 Hrs.**

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

UNIT 5THERMAL BOUNDARY LAYER **9 Hrs**

Introduction to thermal boundary layer- Heat transfer in boundary layer - Convective heat transfer, importance of non-dimensional numbers – Prandtl number, Nusselt number, Lewis number etc

COURSE OUTCOMES

On completion of the course, student will be able to

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

TEXT / REFERENCE BOOKS

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

SAEA3015	HIGH-TEMPERATURE MATERIALS	L	T	P	Credits	Total Marks

		3	0	0	3	100

COURSE OBJECTIVES

- To learn damage mechanism and failure of components of elevated temperatures.
- To know the basic functions of creep and fracture of materials.
- To discuss oxidation and hot corrosion.

UNIT 1 CREEP **9 Hrs.**

Factors influencing functional life of components at elevated temperatures, definition of creep curve, various stages of creep, metallurgical factors influencing various stages, effect of stress, temperature and strain rate.

UNIT 2 DESIGN FOR CREEP RESISTANCE **9 Hrs.**

Design of transient creep time, hardening, strain hardening, expressions of rupture life of creep, ductile and brittle materials, Monk man-Grant relationship.

UNIT 3 FRACTURE **9 Hrs.**

Various types of fracture, brittle to ductile from low temperature to high temperature, cleavage fracture, ductile fracture due to micro void coalescence-diffusion controlled void growth; fracture maps for different alloys and oxides.

UNIT 4 OXIDATION AND HOT CORROSION **9 Hrs.**

Oxidation, Pilling, Bed worth ratio, kinetic laws of oxidation- defect structure and control of oxidation by alloy additions, hot gas corrosion deposit, modified hot gas corrosion, fluxing mechanisms, effect of alloying elements on hot corrosion.

UNIT 5 SUPERALLOYS AND OTHER MATERIALS **9 Hrs.**

Iron base, Nickel base and Cobalt base super alloys, composition control, solid solution strengthening, precipitation hardening by gamma prime, grain boundary strengthening.

Max.45 Hrs.

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Recall the basics of materials.
CO2 - Understand the behavior of creep and fracture.
CO3 - Understand the oxidation and hot corrosion.
CO4 - Recognize the functions of super alloys.
CO5 - Analyze the ductile and brittle materials.
CO6 - Analyze the temperature strain rate.

TEXT /REFERENCE BOOKS

1. Raj. R., "Flow and Fracture at Elevated Temperatures", American Society for Metals USA, 2011.
2. Hertzberg R.W., "Deformation and Fracture Mechanics of Engineering materials", 4th Edition, John Wiley, USA, 2012.
3. Courtney T.H, "Mechanical Behaviour of Materials", McGraw Hill, USA, 2012.
4. Boyle J.T, Spencer J, "Stress Analysis for Creep", Butterworths, UK, 2013.
5. Bressers.J., "Creep and Fatigue in High Temperature Alloys", Applied Science, 1981.
6. McLean D., "Directionally Solidified Materials for High Temperature Service", The Metals Society, USA, 1985

SAEA3016	FLIGHT VEHICLES' GUIDANCE	L	T	P	Credits	Total

	AND CONTROL					Marks
		3	0	0	3	100

COURSE OBJECTIVES

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

UNIT 1 GUIDANCE 9 Hrs.

Over view of flight vehicles: The initial conceptual sketches, L / D estimation. Initial takeoff weight build-up, empty weight estimation, historical trends, fuel fraction estimation, mission profiles, mission segment weight fractions, Review of governing equations of motion for aerospace vehicles, Linear systems analysis of aerospace systems, Applications - aircraft, spacecraft, missiles, launch vehicles.

UNIT 2 FLIGHT VECHICE'S TRANSFORMATION 9 Hrs.

Introduction to the concepts of navigation guidance and control: General principles of early conventional navigation systems. Geometric concepts of navigation. Reference frames. Direction cosine matrix, Euler angles, Transformation of angular velocities, Quaternion representation in co-ordinate transformation. Comparison of transformation methods.

UNIT 3 NAVIGATION 9 Hrs.

Navigation: Navigation computation and error modeling, Inertial navigation systems, External navigation aids - GPS, Doppler radar, Star trackers, Multi-sensor fusion.

UNIT 4 PERFORMANCE 9 Hrs.

Guidance: Guidance mission and performance, Guidance algorithm - guidance laws, single-dual-multi-mode guidance, Advanced guidance system design.

UNIT 5 MODELLING 9 Hrs.

Modeling of Aerospace vehicles: Linear system analysis, Stabilization and Control of space crafts, Missile control systems and Autopilots, Launch vehicle flight control systems. Longitudinal and lateral autopilots for aircraft. Radar systems command and housing guidance system.

Max.45 Hrs.

COURSE OUTCOMES

On completion of the course, students will be able to

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

TEXT / REFERENCE BOOKS

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

SAEA3017	MANNED SPACE MISSIONS	L	T	P	Credits	Total Marks

		3	0	0	3	100

COURSE OBJECTIVES

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

UNIT 1 FUNDAMENTALS OF SPACE MISSIONS 9 Hrs.

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

UNIT 2 SPACE VS EARTH ENVIRONMENT 9 Hrs.

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

UNIT 3 LIFE SUPPORT SYSTEMS AND COUNTERMEASURES 9 Hrs.

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

UNIT4 MISSION LOGISTICS AND PLANNING 9 Hrs.

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

UNIT 5 SUBSYSTEMS 9 Hrs.

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

Max.45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Understand the working principles of basic control system.
CO2 - Comprehend the sound foundation in the various subsystems.
CO3 - Learn the advanced concepts of manned space missions to the engineers.
CO4 - Understand the space and environment and its conditions.
CO5 - Understand the the principle and performance of various subsystems.
CO6 - Applying the importance of the mission logistics and planning.

TEXT / REFERENCE BOOKS

1. Larson, W. J. and Pranke, L. K., Human Spaceflight: Mission Analysis and Design, McGraw-Hill Higher Education, Washington, DC , 1999 2. McNamara, Bernard. 2010.
2. Into the Final Frontier: The Human Exploration of Space, 2012.
3. Connors, M.M., Harrison, A.A., and Akins, F.R. 2005. Living Aloft: Human Requirements for Extended Spaceflight, University Press of the Pacific, Honolulu, Hawaii: ISBN: 1-4102-1983-6 4 Eckart, P. 1996.
4. Jones, T., Sky Walking – An Astronaut's Memoir, Harper Collins, New York, NY, 2006
5. Mullane, M., Riding Rockets – The Outrageous Tales of a Space Shuttle Astronaut, Scribner, New York, NY, 2006

SAEA3019	ORBITAL MECHANICS	L	T	P	Credits	Total Marks

		3	0	0	3	100

COURSE OBJECTIVES

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

UNIT 1 BASIC CONCEPTS 9 Hrs.

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

UNIT 2 THE GENERAL N-BODY PROBLEM 9 Hrs.

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

UNIT 3SATELLITE INJECTION AND SATELLITE ORBIT PERTURBATIONS 9 Hrs.

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

UNIT 4INTERPLANETARY TRAJECTORIES BALLISTIC MISSILE -TRAJECTORIES 11 Hrs.

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

UNIT 5MATERIALS FOR SPACE CRAFT 7 Hrs.

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

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, students will be able to

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

TEXT / REFERENCE BOOKS

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

SMEA2201	WORKSHOP PRACTICE	L	T	P	Credits	Total Marks
		0	0	4	2	100

COURSE OBJECTIVE

- To provide the students with hands on experience on different trades of engineering like Plumbing work, fitting, carpentry, Foundry, welding and sheet metal.

A. PLUMBING WORKS

i. Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, and elbows in household fittings.
ii. Study of pipe connections requirements for pumps and turbines.
iii. Preparation of plumbing line sketches for water supply and sewage works.
iv. Hands-on-exercise: Basic pipe connections – Mixed pipe material connection – Pipe connections with different joining components.
v. Demonstration of plumbing requirements of high-rise buildings.

B. CARPENTRY

i. Handling of carpentry tools, A practice in marking, sawing planning and chiseling to size. Making simple joints such as half-lap, dove-tail and mortise and tenon joints.
ii. Use of modern materials such as plywood, chip board, novapan, laminated sheet (Demonstration only).

C. **FITTING**

Use of fitting tools-practice in marketing, fitting to size and drilling-making of simple mating and profiles such as V, Square, Dove-tail, Half-round joints.

D. WELDING

i. Electric Arc Welding
   a) Study on Edge preparation techniques for Arc welding
   b) List of Welding Exercises
      1. Lap Joint 2. Butt Joint 3. Fillet Joint 4. Tee Joint 5. V Joint 6. Corner Joint
ii. Study on gas welding and gas cutting.
iii. Study on TIG & MIG welding.

E. FOUNDRY

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

F. SHEET METAL

i. Tools and equipments– practice.
ii. Making rectangular tray, hopper, scoop, etc.
iii. Mini project - Fabrication of a small cabinet, dust bin, etc.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Work with various components used in fluid flow pipelines and to make connections for various applications suitably.
CO2 - Handle carpentry tools for wood working.
CO3 - Perform various fitting operations.
CO4 - Make precise weld joints using arc and gas welding processes.
CO5 - Make mould precisely and to place runner, riser at suitable places also they understand how to provide various allowances.
CO6 - Handle sheet metal tools for making various sheet metal components.

SAIC4001	INDUSTRY 4.0	L	T	P	Credits	Total

						Marks
		3	0	0	3	100

UNIT 1 ADVANCED TECHNOLOGY AND ADVANCED MATERIALS **7 Hrs.**

Advanced electro-optical sensing technology-active, passive multi-spectral and hyper spectral imaging; electronic beam steering; vacuum technology, surface and coating technology, health care technology, Nanotechnology- Nanomechanics, Nano optoelectronics; energy storage technology-next generation Li-based Batteries, Hydrogen storage, solar photovoltaic's, Flexible electronics. Intellectual Property Rights - case studies governing/pertaining to Materials/Technology.

UNIT 2 TRANSFORMING TECHNOLOGIES IN BIOENGINEERING **7 Hrs.**

Establishment of smart biotechnology factory, Artificial intelligence in Bioprocess technology, Omics – Big data analysis through automation, 3D bio printing for tissue engineering. Simulation tools, RSM and Box model. Cyber physical system based telemedicine, diagnosis and therapeutics through real time biosensors. Bionanotechnology. Intellectual Property rights (IPR): Case Studies.

UNIT 3 ADVANCEMENTS IN SUSTAINABLE BUILT ENVIRONMENT **7 Hrs.**

Introduction – Technological developments in Architectural, Engineering and Construction (AEC) - Building Information Modelling (BIM) using Cloud computing technology and Internet of things (IoT) – Unmanned Aerial Vehicles, sensors – Additive manufacturing in construction – Concrete 3D printing - Materials used - Lightweight and functionally graded structures - Net Zero Energy buildings, Bioswales, Biofiltration pond, Ecosan systems- Recent developments in Waste water Management, Air pollution control, waste disposal - Integration of energy, water and environmental systems for a sustainable development- Emerging Technologies: Robot Highway-Vertical farming - Intellectual Property rights: Case studies.

UNIT 4 SMART MANUFACTURING **8 Hrs.**

Smart factories and interconnection, Smart Manufacturing – automation systems, Additive Manufacturing, Smart grids, Micro Electro Mechanical Systems (MEMS), Stealth technology, Metal Finishing, Self propelled vehicles, e mobility, Green fuels, drones – unmanned aerial vehicles(UAVs), aerodynamics. Robotic Automation and Collaborative Robots – Augmented reality and haptics, engineering cybernetics and artificial intelligence (AI), Disruptive Technologies – Frugal Innovations – Emerging Technologies - Autonomous Robots, Swam Robot, Modular Robotics, Space craft, Intellectual Property Rights (IPR): Case Studies.

UNIT 5 SMART WORLD **8 Hrs.**

Smart Sensors and IIOT, Smart grid, Hybrid renewable energy systems, Electronics in Smart city, Integration of Sensors in Robots and Artificial Intelligence, 5G Technology, Communication protocols, Human-Machine Interaction, Virtual Reality, Quantum Computing: Changing trends in transistor technology: Processor, Emerging Trends: Deep Space, Swarm Robots, Cyborg, Geofencing, Pervasive Computing, Intellectual Property Rights- Case Studies.

UNIT 6 CYBER PHYSICAL SYSTEMS **8 Hrs.**

Introduction to Cyber Physical Systems (CPS), Architecture of CPS, Data science and technology for CPS, Prototypes of CPS, Emerging applications in CPS including social space, crowd sourcing, healthcare and human computer interactions, Industrial Artificial Intelligence, Networking systems for CPS applications, Wearable cyber physical systems and applications, Domain applications of CPS: Agriculture, Infrastructure, Disaster management, Energy, Transportation, Intellectual Property Rights (IPR) : Case Studies

TEXT / REFERENCE BOOKS

1. William D. Callister,"Materials Science and Engineering, An Introduction, John Willey and Sons Inc. Singapore, 2001.
2. V. Raghavan, "Physical Metallurgy: Principle and Practice,. Prentice Hall India Pvt Ltd, 2006.
3. Flavio Craveiro, Jose Pinto Duarte, Helena Bartolo and Paulo Jorge Bartolo, "Additive manufacturing as an enabling technology for digital construction: A perspective on Construction 4.0", Automation in Construction, Vol. 103,pp. 251-267, 2019.
4. Klaus Schwab, "Fourth Industrial Revolution", Random House USA Inc, New York, USA, 2017.
5. Oliver Grunow, "SMART FACTORY AND INDUSTRY 4.0. The current state of Application Technologies", Studylab Publications, 2016
6. Alasdair Gilchrist, "INDUSTRY 4.0: Industrial Internet of Things", Apress, 2016
7. Sang C. Suh, U. John Tanik, John N Carbone, Abdullah Eroglu, "Applied Cyber-Physical Systems", Springer Publications, New York, 2013.

SAEA2604	AIRCRAFT ENGINE MAINTENANCE	L	T	P	Credits	Total

	AND REPAIR LAB					**Marks**
		0	**0**	**4**	**2**	**100**

COURSE OBJECTIVE

- To make the students to understand the Airframe components and the tools used to maintain the components.

SUGGESTED LIST OF EXPERIMENTS

1. Performing the stripping of a piston Engine procedures.
2. Engine(Piston Engine) – cleaning, visual inspection, NDT checks.
3. Piston Engine Components – dimensional checks.
4. Piston Engine reassembly procedures.
5. Estimation of the propeller pitch setting.
6. Performing the stripping of a Jet Engine.
7. Jet Engine – Identification of components & defects, NDT checks and dimensional checks.
8. Performing the Jet Engine – reassembly.
9. Training and Performing the ground run engine of propeller powered aircraft.
10. Perform the startup procedure for a piston powered aircraft.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Perform the study of Aircraft Piston and its components.
CO2 – Examine the damages through Inspection checks.
CO3 – Demonstrate the procedure for Engine stripping
CO4 – Evaluate the propeller pitch and twist.
CO5 – Perform the propeller efficiency of the piston engine aircraft.
CO6 – Elucidate the engine startup procedures.