B.Tech. Aerospace Engineering (7th SEMESTER)

Course		Contact Hrs.			Marks			Credits
Code	**Name**	**L**	**T**	**P**	**Int.**	**Ext.**	**Total**	
BASES1-701	Finite element Analysis	3	1	0	40	60	100	4
BASES1-702	Hypersonic Aerodynamics	3	0	0	40	60	100	3
BASES1-703	**Project-I	0	0	8	60	40	100	4
BASES1-704	*Training-III	-	-	-				3
BASES1-705	Composite Materials and Structures	3	1	0	40	60	100	4
	Departmental Elective-IV(POOL-I, Select One)	3	1	0	40	60	100	4
BASED1-711	Rockets and Launch Vehicles							
BASED1-712	Space Missions							
	Departmental Elective-V(POOL-II, Select One) (Select One)	3	0	0	40	60	100	3
BANED1-721	Cryogenics							
BANED1-722	Spacecraft Systems Engineering							
BANED1-723	Power Systems in Spacecraft							
XXXX	**Open Elective***	3	0	0	40	60	100	3
Total		**-**	**-**	**-**	**300**	**400**	**700**	**28**

Project-I: A minor project for UG students to enable them applies knowledge to address the real world situations/problems to find solutions. The student will carry out minor project under the supervision of faculty advisor. A group of maximum three students can register for this minor project. The registered students will submit the project proposal in the prescribed format in the office of HOD within 10 days of semester registration. Faculty advisor of the group has to accept/reject proposals based on the merits and outcome of the project. The student will require developing and presenting a working prototype at the end of the semester to earn the credits of project.

*Open Elective Subjects may also be chosen from the list of Open Electives-I, II and III offered by other departments of university.

B.Tech. Aerospace Engineering (8th SEMESTER)

Course		Contact Hrs.			Marks			Credits
Code	**Name**	**L**	**T**	**P**	**Int.**	**Ext.**	**Total**	
	Departmental Elective-VI (POOL-I, Select One)	3	0	0	40	60	100	3
BASED1-811	Spacecraft Sensors and Instrumentation	-	-	-	-	-	-	-
BASED1-812	Mechatronics	-	-	-	-	-	-	-
	Departmental Elective-VII (POOL-II, Select One)	3	1	0	40	60	100	4
BASED1-821	Unmanned Aerial Systems	-	-	-	-	-	-	-
BASED1-822	Fatigue and Fracture Mechanics							
BASED1-823	Professional Ethics							
BANES1-801	Project-II	0	0	8	60	40	100	4
XXXX	**Open Elective***	3	0	0	40	60	100	3
XXXX	**Open Elective***	3	0	0	40	60	100	3
Total		**-**	**-**	**-**	**220**	**280**	**500**	**17**

Project-II: Student can do Project-2 either outside the institute or within the institute under a supervision of Faculty advisor. A group of maximum three can register for the project-II. The registered students will submit the project proposal in the prescribed format in the office of HOD within 10 days of semester registration. Faculty advisor of the group to accept/reject proposals based on the merits and outcome of the project.

*Open Elective Subjects may also be chosen from the list of Open Electives-I, II and III offered by other departments of university.

7th semester

Finite Element Analysis

BASES1-701 | **L T P Cr 3 1 0 4** | **Duration:60 Hours**

COURSE OBJECTIVES

- To give exposure to various solutions in Finite Element Method.
- To give insight about formulation and procedure of finite Element Method.
- Apply discretization techniques for domain decomposition

LEARNING OUTCOMES

After undergoing the subject, student will be able to:

- Apply finite element method to analyze airplane structures under various load conditions.
- Analyze formation of stress and strain matrix in 2D and 3D cases.
- Analyze various shape functions in higher order elements in 2D and 3D cases.
- Develop various codes of FEM to analyze structural loads on different aircraft components.

UNIT –I(14 Hrs.)

Introduction: Review of various approximate methods – variation approach and weighted residual approach- application to structural mechanics problems. Finite difference methods- governing equation and convergence criteria of finite element method and applications.

UNIT –II (16 Hrs.)

Finite Fundamentals: Construction of shape functions for bar element and beam element, Bar elements, uniform bar elements, uniform section, mechanical and thermal loading, varying section, truss analysis, Frame element, Beam element, problems for various loadings and boundary conditions.

UNIT –III (15 Hrs.)

Continuum Elements: Plane stress, plane strain and axisymmetric problems. Derivation of element matrices for constant and linear strain triangular elements and axisymmetric element.

UNIT –IV (15 Hrs.)

Isoparametric Elements: Definitions, Shape functions for 4,8 nodal quadrilateral elements, stiffness matrix and consistent load factor, numerical integration techniques for elemental matrix evaluation.

RECOMMENDED BOOKS

1. Reddy J.N., "An Introduction to Finite Element Method", McGraw Hill, third edition, 2005.
2. Bathe, K.J. and Wilson, E.L., "Numerical Methods in Finite Elements Analysis", Prentice Hall of India, 1985.
3. Rao. S.S., "Finite Element Methods in Engineering," Butterworth and Heinemann, 2001.
4. Tirupathi.R. Chandrapatha and Ashok D. Belegundu, "Introduction to Finite Elements in Engineering", Prentice Hall India, Fourth edition, 2012.
5. Chandrupatla T. R., "Finite Elements in engineering", PHI, 3rd edition, 2002, ISBN-13: 978- 8120321069

Hypersonic Aerodynamics

BASES1-702	**L T P Cr**	**Duration:45 Hours**
	3 0 0 3	

COURSE OBJECTIVES

- The course enables students to understand the basic concepts of hypersonic flow, boundary layer interaction.
- To understand surface inclination and approximation methods for hypersonic flows.

LEARNING OUTCOME

After undergoing the subject, the student will be able to:

- Analyze the trajectories of ballistic missiles, space planes, and air-breathing hypersonic vehicles.
- Perform perfect and real gas analyses of shock waves
- Determine the stagnation properties of a hypersonic vehicle.
- Have a basic understanding of real gas effects such as vibration activation, dissociation, ionization, and molecular transport phenomena.

UNIT – I (10hrs)

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

UNIT – II (12hrs)

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

UNIT – III (13hrs)

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

UNIT – IV (10hrs)

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

RECOMMENDED BOOKS

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

COMPOSITE MATERIALS AND STRUCTURES

BASE1-705	**L T P Cr** **3 0 0 3**	**Duration: 45 Hours**

COURSE OBJECTIVES

- This course will provide an understanding of the strength and stress behavior of the composite materials as explained by certain recent theories on the subject.
- The students are to be equipped with the knowledge of the composite material performance under fatigue, impact and other adverse conditions that an aircraft is subjected to.

LEARNING OUTCOMES

After undergoing the subject, student will be able to:

- Explain stress strain relation of composite material.
- Describe performance of composite components under fatigue, impact and other flight conditions.
- Differentiate and examine various types of aircraft composite materials
- Evaluate strength of composite materials.
- Explain composite materials, their applications to structure design, technology and calculate strength.
- Develop new solutions.

UNIT – I (10 hrs)

Introduction - advantages and application of composite materials – types of reinforcements and matrices - micro mechanics – mechanics of materials approach, elasticity approach-bounding techniques – fibre volume ratio – mass fraction – density of composites. effect of voids in composites

UNIT – II (12 hrs)

Generalized Hooke's Law - elastic constants for anisotropic, orthotropic and isotropic materials - macro mechanics – stress-strain relations with respect to natural axis, arbitrary axis – determination of in plane strengths of a lamina - experimental characterization of lamina. failure theories of a lamina. hygrothermal effects on lamina.

UNIT – III (10 hrs)

Governing differential equation for a laminate. stress – strain relations for a laminate. different types of laminates in plane and flexural constants of a laminate, hygrothermal stresses and strains in a laminate, failure analysis of a laminate, impact resistance and interlaminar stresses, netting analysis.

UNIT – IV (13hrs)

Various open and closed mould processes, manufacture of fibers, importance of repair and different types of repair techniques in composites – autoclave and non-autoclave methods.

Basic design concepts of sandwich construction - materials used for sandwich construction - failure modes of sandwich panels - bending stress and shear flow in composite beams

RECOMMENDED BOOKS

1. Autar K Kaw, 'Mechanics of Composite Materials', CRC Press, 2 nd edition, 2005.
2. Isaac M. Daniel & Ori Ishai, "Mechanics of Composite Materials," OUP USA publishers, 2 ndedition, 2005.
3. Madhujit Mukhopadhyay, Mechanics of Composite Materials and Structures, University Press, 2004
4. Lalit Gupta , Advanced Composite Materials , 1998 ,Himalayan Books Publication
5. B. D. Aggarwal, L. J. Broutman and K. Chandrashekhara, Analysis and Performance of Fiber Composites, John Wiley & Sons
6. R.M. Jones ,Mechanics of Composite Materials , Taylor & Francis
7. Sabodh K. Garg, "Analysis of Structural Composite Materials".

Rockets and Launch Vehicles

BASED1-711	**L T P Cr** **3 1 0 4**	**Duration:60 Hours**

COURSE OBJECTIVES

Main objectives of this course are:

- Basic knowledge of rockets / missiles
- Guidance & navigation
- Performance, stability & control of rockets and missiles including maneuvering flights
- Launch operations & Re-entry

LEARNING OUTCOMES

After undergoing the subject, student will be able to:

- Describe different types of rockets and missiles.
- Differentiate between rockets and missiles.
- Calculate various stability aspects of various control configurations of space vehicles.
- Analyze problems related to launch and recovery of space vehicles.
- Predict various types of trajectories of space vehicles.

UNIT – I (15 hrs)

Introduction: Introduction to rockets and missiles, Difference between Rocket and missile, Type of Rockets and missiles, satellites, satellite launch vehicles.

Aerodynamic Characteristics of Airframe Components: Bodies of revolution, Different fore-body shapes, Summary of characteristics of bodies of revolution, Base pressure, Aerodynamic control, Jet control, various subsystems of missile & rockets

UNIT – II (15 hrs)

Performance and Propulsion of Missiles and Rockets Introduction of drag, various types of drags, Boost glide trajectory, Graphical solution, Boost sustainer trajectory, staging & stage separation, long range cruise trajectory, long range ballistic trajectory, Powered and un-powered flight, Brief description of Fin Stabilized, spin stabilized Rockets and their force systems, ramjet, scramjet, rocket (liquid/solid fuel based) engines, Thrust misalignment.

Guidance, Control & Navigation of Missiles and Rockets Introduction to guidance and navigation, various types of guidance schemes & their application. Types of Control and actuation systems, navigation systems for high accuracy & its suitability

UNIT –III (15 Hrs.)

Stability and Control Longitudinal: Two degrees of freedom Analysis, Complete Missile Aerodynamics with forward and rear control, Static stability margin.

Directional: Introduction, cruciform configuration, Body wing and Tail contribution on directional control.

Lateral: Induced roll, internal control and design consideration for cruciform and Monowing, Damping in roll.

UNIT IV (15 hours)

Maneuvering Flight: Introduction to maneuvering of missiles and rockets, Flat turn for cruciform and mono-wing, Pull-ups, Relationship of maneuverability and static stability margin.

Guidance, Control & Navigation of Missiles and Rockets Introduction to guidance and navigation, various types of guidance schemes & their application. Types of Control and actuation systems, navigation systems for high accuracy & its suitability

Advanced topics: Launching problems, Re-entry and recovery of space vehicles, Modern Concepts, Manned Missions, Current topics.

RECOMMENDED BOOKS

1. Seifert (Edited by), "Space Technology", John Wiley.
2. SR Mohan, "Fundamentals of Guided Missile" , DRDO
3. SK Ray, "Missile Control Systems", DRDO
4. EL Fleeman, "Tactical Missile Design", AIAA Education Series
5. EL Fleeman, "Missile Design and System Engineering", AIAA Education Series
6. Arthur L. Greensite, "Analysis and Design of Space Vehicle Flight Control Systems", ISBN:9780810491632, 081049163X, Spartan Books, 1970
7. SS Chin, "Missile configuration design", McGraw-Hill., New York,1961

Space Missions

BASED1-712	L T P Cr 3 1 0 4	Duration:60 Hours

COURSE OBJECTIVES

To understand the life support systems, mission logistics and planning.

- Fundamental laws of mechanics, orbital mechanics, and Orbital manoeuvres.
- Types of space missions and their objectives in the Space environment.
- General concepts of space vehicle architecture, Attitude determination, and control.

LEARNING OUTCOMES

After undergoing the subject, student will be able to:

- Understand the advanced concepts of manned space missions.
- Provide the necessary mathematical knowledge that are needed in understanding their significance and operation.
- Have an exposure on various topics such as missile space stations, space vs eartl environment, life support systems, mission logistics and planning.

UNIT – I (15 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 –II (15 Hrs.)

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

UNIT –III (15 Hrs.)

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

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

UNIT –IV (15 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.

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

CRYOGENICS

BASED1-721	**L**	**T**	**P**	**Cr**	**Duration:45 Hours**
	3	**0**	**0**	**3**	

COURSE OBJECTIVES

The aim of the course is

- To analyze cryogenic systems
- To calculate the efficiency of cryogenic systems
- To know cryogenic applications in aerospace engineering

LEARNING OUTCOMES

After undergoing the subject, student will be able to:

- Describe various methods to produce low temperature and phenomena at cryogenic temperature.
- Understand the working principle of different cryogenic refrigeration and liquification system.
- Understand the functions and working principles of insulations and various low temperature measuring and storage devices.
- Understand the application of Cryogenic technology in engineering research and Industry.

UNIT I:(10 Hrs.)

Introduction: Historical Background - Introduction to Cryogens and Cryogenic propellants - Liquid hydrogen, liquid helium, liquid nitrogen and liquid oxygen and their properties

UNIT II: (12 Hrs.)

Production Of Low Temperature: Theory behind the production of low temperature - Expansion engine heat exchangers - Cascade Process Joule Thompson Effect - Magnetic effect - Ortho and H2 - Helium4 and Helium3

Cryogenic Systems Efficiencies: Types of losses and efficiency of cycles - specific amount of cooling - The fraction liquefied Cooling coefficient of performance - Thermodynamic efficiency – energy balance Method.

UNIT III: (10 Hrs.)

Cryogenic plants cycle: Classification of cryogenic cycles - structure of cycles - Throttle expansion cycles - Expander cycles - Thermodynamic analysis - Numerical problems

UNIT IV: (13 Hrs.)

Cyrogenics applications in aerospace: Cryogenic liquids in Rocket launching and space simulation Storage of cryogenic liquids - Effect of cryogenic liquids on properties of aerospace materials – Cryogenic loading problems - Zero gravity problems associated with cryogenic propellants - Phenomenon of tank collapse - Elimination of Geysering effect in missiles

RECOMMENDED BOOKS

Barron, R. F., “Cryogenic Systems”, Oxford University, 1985.
Haselden, G., “Cryogenic Fundamentals”, Academic Press, 1971.
Parner, S. F., “Propellant Chemistry”, Reinhold Publishing Corp., New York 1985.
Weisend, J. G., “The Handbook of Cryogenic Engineering”, Taylor & Francis, 1998

SPACECRAFT SYSTEMS ENGINEERING

BASED1-722	**L T P Cr** **3 0 0 3**	**Duration:45 Hours**

COURSE OBJECTIVES

- To understand the concept of space system design and engineering.
- To describe the various subsystems involved in the design of a satellite and Launch Vehicle.
- To describe the techniques of systems engineering that are used to obtain a coherent satellite design.

LEARNING OUTCOMES

After undergoing the subject, student will be able to:

- Analyse the issues in the spacecraft structures.
- Understand the functions of spacecraft power systems.
- Detect the error and correct in the spacecraft computer systems.
- Learn system engineering by designing, building, and testing a small satellite in laboratory

UNIT – I (10 hours)

Deployment and Geometry Maintenance – Deployment for Aperture Maintenance - Origins Telescope Dynamics and Controls - SIM Dynamics and Control Block Diagram - Dynamic Disturbance Sources - Disturbance Analysis

UNIT – II (10 hours)

Modal Sensitivity Analysis - Thermal Issues with Structures - Impedance Matched Tether Termination - Control-Structure Interaction - SPECS Geometry - Tether Vibration Control.

UNIT – III (12 hours)

Computer system specification - Estimating throughput and processor speed requirements - Computer selection – Memory - Mass storage - Input/Output - Radiation hardness - Fault tolerance - Error detection and correction - Integration and test

UNIT – IV (13 hours)

Satellite Communications Architecture - Advantages of Digital Communication - Data Collection Mission - Link Design Process - Power Flux Density - Received Power - System Noise Temperature - Modulation Techniques - Bit Error Rate - Convolutional Coding with Viterbi Decoding – Attenuation - Frequency Selection Drivers - Multiple Access Strategies - Antijam Techniques - Differential Pulse Code Modulation (DPCM).

RECOMMENDED BOOKS

1. James R. Wertz, Wiley Larson, "Space Mission Analysis and Design", 3 rd Ed., Springer Netherlands, 1999.

2. Peter Fortescue, Graham Swinerd, John Stark, “Spacecraft Systems Engineering”, 4th Ed., Willey, 2011.
3. Vincent L. Piscane, “Fundamentals of Space Systems”, Oxford University Press, 2 nd Ed., 2005.
4. James R. Wertz, “Spacecraft Attitude Determination and Control”, Springer, 1978.
5. Kaplan, M. H., “Modern Spacecraft Dynamics and Control”, Wiley India Pvt Ltd, 2011.
6. Maral G., and Vousquet M., “Satellite Communications Systems: Systems, Techniques, and Technology”, 5th Ed., 2010.
7. Steven R. Hirshorn, “NASA System Engineering Handbook Revision 2”, NASA SP-2016-6105 Rev2, 2016

POWER SYSTEMS IN SPACECRAFT

BASED1-723	L	T	P	Cr	Duration: 45 Hours
	3	0	0	3	

COURSE OBJECTIVE

- This course is aimed to provide To understand the various Power system elements, energy storage technology and power converters in a spacecraft.
- Design driving requirements for a space power system.
- Solar cell technology and environmental susceptibility.
- Battery technologies, including battery selection and sizing.
- Design Example: Sample power system concept design of a LEO mission.

LEARNING OUTCOMES

After undergoing this course, the student should

- Understand the advanced concepts of Spacecraft power systems.
- Provide the necessary mathematical knowledge that are needed in modeling the power systems.
- Have an exposure on various Power system elements, energy storage technology and power converters.

UNIT – I (10 hrs)

IPO with respect to Power Generation – Power System Elements - Solar aspect angle Variations

UNIT – II (10 hrs)

Study of Solar spectrum - Solar cells - Solar Panel design - Solar Panel Realization – Solar Panel testing - Effects of Solar cells and panels (IR, UV, Particles), MPPT(Maximum Power Point Tracking).

UNIT – III (13 hrs)

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

UNIT-IV (12 Hrs.)

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

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

RECOMMENDED BOOKS

1. Anspaugh B.E., “GaAs Solar Cell Radiation Handbook”, NASA, 2014.
2. Chetty P. R. K., “Spacecraft Power Systems”, 1988.
3. Patel, Mukund R, “Spacecraft Power Systems”, CRC Press Boca Raton, 2005.
4. Ned Mohan, et al, “Power Electronics, convertors Applications and Design”, John Wiley & Sons, 1989
5. Bauer P., “Batteries for Space Power Systems”, NASA SP-172, 1968.

8th semester

SPACECRAFT SENSORS AND INSTRUMENTATION

BASED1-811 **L T P Cr 3 0 0 3** **Duration: 45 Hours**

COURSE OBJECTIVES

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

LEARNING OUTCOMES

After undergoing the subject, student will be able to:

- Discusses essential topics such as cost estimation, signal processing, noise reduction, filters, phased arrays, radars, optics, and radiometers used in space operation.
- Covers a range of typical sensors used in the spacecraft industry such as infrared, passive microwave, radars and space-based GPS sensors.
- Spacecraft Sensors is an invaluable resource for engineers, technical consultants, those in the business division, and research scientists associated with spacecraft projects.

UNIT – I (12hrs)

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

UNIT – II (13 hrs)

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

UNIT – III (10 hrs)

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

UNIT – IV(10 hrs)

Auroral imagers: Optical, UV, X-ray – X-ray sensors and imagers - Detection techniques, Grazingincidence optics – Charged Coupled Devices – Other imaging techniques – tomography.
Subsystems – Testing and Qualifications – Trade-offs – Role of orbit to investigation – Unusual orbital techniques: L1 orbit, double lunar swing-by.

RECOMMENDED BOOKS

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

MECHATRONICS

BASED1-812 **L T P Cr** **3 0 0 3** **Duration:45 Hours**

COURSE OBJECTIVES

- This course will provide knowledge of basic concepts of momentum and thermal boundary layers, formulation of equations and solutions given by different investigators in case of flat surface and axi-symmetric bodies.
- The study involves the analysis and understanding of empirical results for laminar boundary layer, transition and turbulent boundary layer.

LEARNING OUTCOMES

After undergoing the subject, student will be able to:

- Describe and formulate momentum and thermal boundary layers equations in respect of flat surface and axi-symmetric bodies.
- Analyze empirical results obtained for laminar, transition and turbulent boundary layers.

UNIT – I (10 hrs)

Mechatronic Systems: Measurement and control systems. Their elements and functions, Microprocessor based controllers.

Electrical Actuation Systems. Electrical systems, Mechanical switches, solid-state switches, solenoids, DC & AC motors, Stepper motors and their merits and demerits

UNIT – II (10 hrs)

Review of Transducers and Sensors: Definition and classification of transducers. Definition and classification of sensors. Principle of working and applications of light sensors, proximity sensors and Hall effect sensors.

Signal Conditioning: Introduction to signal conditioning. The operational amplifier, Protection, Filtering, Wheatstone bridge, and Digital signals Multiplexers, Data acquisition.

UNIT – III (12 hrs.)

Introduction to Microprocessors: Evolution of Microprocessor, Organization of Microprocessors (Preliminary concepts), basic concepts of programming of microprocessors. Review of concepts - Boolean algebra, Logic Gates and Gate Networks Binary & Decimal number systems, memory representation of positive and negative integers, maximum and minimum integers. Conversion of real, numbers, floating point notation, representation of floating point numbers, accuracy and range in floating point representation, overflow and underflow, addition of floating point numbers, character representation. Introduction to Digital system. Processing Pulse- modulation.

UNIT – IV (13 hrs.)

Logic Function: Data word representation. Basic elements of control systems 8085A processor architecture terminology such as CPU, memory and address, ALU, assembler data registers, Fetch cycle, write cycle, state, bus, interrupts. Micro Controllers. Difference between microprocessor and micro controllers. Requirements for control and their implementation in microcontrollers. Classification of micro controllers. Organization & Programming of Microprocessors: Introduction to organization of INTEL 8085-Data and Address buses

Central Processing Unit of Microprocessors: Introduction, timing and control unit basic concepts, Instruction and data flow, system timing, examples of INTEL 8085 and INTEL 4004 register organization. Instruction set of 8085, programming the 8085, assembly language programming

RECOMMENDED BOOKS

1. Bolton, "Mechatronics", Pearson Education,4th edition,2010,ISBN-13: 978-8131732533
2. Ramesh S Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085", Penram International Publishing, 6th Edition, 2013,ISBN-13: 978-8187972884
3. K.P.Ramchandran, G.K.Vijayraghavan, M.S.Balasundran, Mechatronics and Microprocessors,Wiley, 1st Ed, 2009,ISBN-13: 978-8126519859
4. Nitaigour and PremchandMahilik, Mechatronics - Principles, Concepts and applications–- Tata McGraw Hill- 2003,ISBN-13: 978-0070483743
5. Godfrey C. Onwubolu.Mechatronics Principles & applications, Elsevier,1st edition,2006,ISBN13: 978-8131205235.
6. David. G. Aliciatore& Michael. B. Bihistaned, Introduction Mechatronics & Measurement systems,Tata McGraw Hill,4th edition,2014,ISBN-13: 978-9339204365.

UNMANNED AERIAL SYSTEMS

BASED1-821 **L T P Cr 3 1 0 4** **Duration:60 Hours**

COURSE OBJECTIVES

This course will enable student to :

- Comprehend the basic aviation history and UAS systems.
- Acquire the knowledge of basic aerodynamics, performance, stability and control.
- Understand the propulsion, loads and structures.

LEARNING OUTCOMES

After undergoing the subject, student will be able to:

- Apply the basic concepts of UAS systems.
- Explain the basic aerodynamics, performance, stability and control required for UAV.
- Select the propulsion system.

UNIT – I (13 hrs.)

Introduction: UAV systems definition, Historical overview, Coverage and scope

Overview of UAV systems: Aerial vehicle, Mission planning, Launch and recovery, Payloads and sensors, Data links. Ground support equipment, Classes of UAV systems.

UNIT – II (13 hrs)

Aerodynamic Considerations: Review of aerodynamics, Aerodynamic considerations for various UAV types, Determination of Aerodynamic Parameters.

Propulsion: Propulsion Systems for UAV. IC engines. Gas turbines. Other propulsive techniques: e.g., flapping wings.

UNIT – III (16 hrs)

Flight Modeling & Simulations The need for UAV flight modeling. Modeling approaches. Simulation of UAV flights.

Performance: Performance measures for various UAV. Flight performance considerations: speed, range, endurance, maneuverability. Launch and recovery performance. Unconventional maneuvers.

UNIT – IV(18 hrs)

Flight Control Systems. Review of static and dynamic stability. Control surfaces on UAV. Control hierarchy in UAV. Autonomous feature. Control of unconventional maneuvers

Payload and Sensors Mission planning. Flight operations. Navigation systems. Antennas. Reconnaissance and surveillance payloads. Other payloads. Data links. Common sensors for autonomy.

Technical Considerations of Some UAV Types Rotorcraft UAV. Micro Air Vehicles (MAV).

RECOMMENDED BOOKS

1. Paul Gerin Fahlstrom, Thomas James Gleason, Introduction to UAV Systems, 4th Edition, Wiley Publication, 2012 John Wiley & Sons, Ltd
2. P. Castillo et al., Modelling and Control of Mini-Flying Machines, Springer-Verlag, 2005. 2. T. Mueller et al., Introduction to the Design of Fixed-Wing Micro Air Vehicles, AIAA Education Series, 2007.
3. T. Mueller et al., Introduction to the Design of Fixed-Wing Micro Air Vehicles, AIAA Education Series, 2007
4. Landen Rosen, Unmanned Aerial Vehicle, Publisher: Alpha Editions, ISBN13: 9789385505034.
5. Unmanned Aerial Vehicles: DOD's Acquisition Efforts, Publisher: Alpha Editions, ISBN13: 9781297017544.
6. Valavanis, Kimon P., Unmanned Aerial Vehicles, Springer, 2011.

FATIGUE AND FRACTURE MECHANICS

BASED1-822	L T P Cr	Duration:60 Hours
	3 1 0 4	

COURSE OBJECTIVES

This course will enable students to

- Understand the basics of fatigue of structures.
- Comprehend the fracture mechanics.
- Acquire the knowledge of fatigue design and testing.

LEARNING OUTCOMES

After undergoing the subject, student will be able to:

- Evaluate the fatigue of structures.
- Determine the strength of cracked bodies.
- Distinguish the safe life and fail safe design.

UNIT – I (15 hrs)

Fatigue of Structures: S.N. curves, Endurance limit, Effect of mean stress, Goodman, Gerber and Soderberg relations and diagrams, Notches and stress concentrations, Neuber's stress concentration factors, plastic stress concentration factors – Notched S-N curve

UNIT – II (18 hrs)

Statistical Aspects Of Fatigue Behavior: Low cycle and high cycle fatigue, Coffin-Manson's relation, Transition life, Cyclic Strain hardening and softening, Analysis of load histories, Cycle counting techniques, Cumulative damage, Miner's theory, other theories.

Phase in fatigue life, Crack initiation, Crack growth, Final fracture, Dislocations, Fatigue fracture surfaces

UNIT – III(12 hrs)

Fracture Mechanics: Strength of cracked bodies, potential energy and surface energy, Griffith's theory, Modes of fracture, Irwin – Orwin extension of Griffith's theory to ductile materials, Stress analysis of cracked bodies, Effect of thickness on fracture toughness, Stress intensity factors for typical geometries.

UNIT – IV(15 hrs)

Fatigue Design And Testing: Safe life and fail safe design philosophies, Importance of Fracture Mechanics in aerospace structure, Application to composite materials and structures.

RECOMMENDED BOOKS

1. D.Brock, "Elementary Engineering Fracture Mechanics", Noordhoff International Publishing Co., London, 1994.
2. J.F.Knott, "Fundamentals of Fracture Mechanics", Butterworth & Co., (Publishers) Ltd., London,1983.
3. W.Barrois and L.Ripley, "Fatigue of Aircraft Structures", Pergamon Press, Oxford, 1983.
4. C.G.Sih, "Mechanics of Fracture", Vol.1 Sijthoff and Noordhoff International Publishing Co.,Netherland, 1989

PROFFESSIONAL ETHICS

BASED1-823 **L T P Cr** **Duration:60 Hours**
3 1 0 4

COURSE OBJECTIVES

The course on to enable the students to create an awareness on Engineering Ethics to instill Moral and Social Values and Loyalty and to appreciate the rights of others

After learning the course, the students should be able to: -

- the student should be able to apply ethics in society
- discuss the ethical issues related to engineering and realize the responsibilities and rights in the society.

UNIT-I (15 hrs)

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self-confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management

UNIT-II (15 hrs)

Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories.

UNIT-III (15 hrs)

Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination

UNIT-IV (15 hrs)

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility.

RECOMMENDED BOOKS

1. Charles B. Fleddermann, “Engineering Ethics”, Pearson Prentice Hall, New Jersey, 2004.
2. Engineering Ethics by C.G.K. Nair
3. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, “Engineering Ethics – Concepts and Cases”, Cengage Learning, 2009.
4. Edmund G Seebauer and Robert L Barry, “Fundamentals of Ethics for Scientists and Engineers”, Oxford University Press, Oxford, 2001.
5. John R Boatright, “Ethics and the Conduct of Business”, Pearson Education, New Delhi, 2003
6. Laura P. Hartman and Joe Desjardins, “Business Ethics: Decision Making for Personal Integrity and Social Responsibility” Mc Graw Hill education, India Pvt. Ltd., New Delhi, 2013.
7. World Community Service Centre, ‘Value Education’, Vethathiri publications, Erode, 2011