M.TECH AEROSPACE ENGINEERING WITH SPECIALIZATION IN UAV PROGRAM

M.TECH AEROSPACE ENGINEERING WITH SPECIALIZATION IN UAV
w.e.f 2017

SEMESTER I			SEMESTER II		
Subject Code	Subject	Credits	Subject Code	Subject	Credits
ASEG 7007	Introduction to UAV	3	AVEG 7003	Mathematical Modeling & Simulation	3
ASEG 7008	Introduction to Flight	3	AVEG 7004	Flight Instrumentation & Data Acquisition System	3
ASEG 7009	Fundamental of Aerodynamics	3	ASEG 7017	Automatic Flight Control	3
AVEG 7001	Introduction to Avionics	3	ASEG 7018	Flight Stability & Control	3
ASEG 7010	Airplane Performance and Design	3	AVEG 7005	Path planning and Obstacle Avoidance for Unmanned Vehicles	3
AVEG 7002	Micro-controller & Embedded Systems	3	AVEG 7006	Actuators and Sensors for UAV	3
ASEG 7109	Aerodynamics Lab	1	ASEG 7117	Flight Control Lab	1
ASEG 7110	Aero-modeling & Design Lab	1	SEMI 7101	Seminar I	1
	TOTAL	20		TOTAL	20
SEMESTER III			SEMESTER IV		
Subject Code	Subject	Credits	Subject Code	Subject	Credits
AVEG 8001	UAV System Design	3	PROJ 8102	Project II	16
AVEG 8002	System Identification Methods	3			
AVEG 8003	Guidance & Navigation	3			
AVEG 8004	Remote Sensing and Surveillance	3			
AVEG 8005	Digital Image processing	3			
SIIB 8101	Summer Internship	2			
SEMI 8101	Seminar II	1			
PROJ 8101	Project I	2			
	TOTAL	20		TOTAL	16
Total Credits Points are		76			

Program Outcomes

PO1: Scholarship of Knowledge - Acquire in-depth knowledge of specific discipline and global perspective, with an ability to discriminate, evaluate, analyze and synthesize existing and new knowledge, and integration of the same for enhancement of knowledge pool.

PO2: Critical Thinking - Analyze complex engineering problems critically, apply independent judgement for synthesizing information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context.

PO3: Problem Solving - Think laterally and originally, conceptualize and solve engineering problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal and environmental factors in the core areas of expertise.

PO4: Research Skill - Extract information through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyze and interpret data, contribute individually/in group(s) to the development of scientific/technological knowledge in one or more domains of engineering.

PO5: Usage of modern tools - Create, select, learn and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering activities with an understanding of the limitations.

PO6: Collaborative and Multidisciplinary work – Demonstrate collaboration to foster multidisciplinary scientific research, also demonstrate decision-making abilities to achieve common goals.

PO7: Project Management and Finance - Demonstrate knowledge and understanding to manage projects efficiently in respective disciplines and multidisciplinary environments after consideration of economical and financial factors.

PO8: Communication - Communicate with the engineering community and with society, regarding complex engineering activities confidently and effectively and give and receive clear instructions.

PO9: Life-long Learning - Recognize the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.

PO10: Ethical Practices and Social Responsibility - Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.

PO11: Independent and Reflective Learning - Observe and examine critically the outcomes of one's actions and make corrective measures subsequently, and learn from mistakes without depending on external feedback.

Program Specific Outcomes (PSOs)

PSO1: Design and Control of Unmanned Aerial Vehicle.

PSO2: Develop content for research papers, technical Reports and research proposals with strict ethical standards.

SEMESTER I

Course Code	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
ASEG 7007	2.2	2.6	2.8	3	3	2.2	0	1	1	1	1	1.6	1.8
ASEG 7008	2.5	1.75	1.75	1.75	1.5	0	0	0	1	0	0	1	1
ASEG 7009	3	2.4	0	1.4	0	0	0	0	0	0	0	3	0
ASEG 7001	3	1.8	2	1.6	2	2	0	0	0	0	0	2.6	0
ASEG 7010	2	1	2.5	1	1.25	1	0	0	0	0	0	1.25	1
ASEG 7002	2	2	3	2	3	1	0	1	2	2	1	1.8	3

SEMESTER II													
Course Code	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PSO 1**	**PSO 2**
AVEG 7003	2.6	2	2.5	1.6	1.6	2	0	0	0	0	0	2.6	0
AVEG 7004	2.5	2	2	1.7 5	2	2	0	0	0	0	0	2.75	0
AVEG 7017	2	1.7 5	2	1.5	2	1	0	0	0	0	0	2	1
AVEG 7018	2	2	2	0	2	0	0	0	0	0	0	2	1
AVEG 7005	2.4	1.8	1	2.6	2.6	2.6	2	2	0	0	2	2	2.6
AVEG 7003	2.3	2	1.1	1.5	3	3	0	2	0	0	2	1.6	3
SEMESTER III													
Course Code	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PSO 1**	**PSO 2**
AVEG 8001	2.6	2	2	1.6	2.2	2	0	0	0	0	0	2.6	0
AVEG 8002	2	1.8	1.6	1.6	1.8	1	0	0	1.4	3	0	1.5	2
AVEG 8003	2.5	1.7	1.7	1.7	1.5	0	0	0	1	0	0	1	2.5
AVEG 8004	2.8	2.7	2	1	1.6	0	0	0	1	0	0	1.75	3
AVEG 8005	2	3	3	3	3	0	0	0	0	1	0	0	2

Model Question paper

Roll No: --------------------------

UNIVERSITY OF PETROLEUMAND ENERGY STUDIES

Semester Examination – September 20xx

Program/course: M.Tech (ASE+UAV)	**Semester : I**
Subject: Introduction to UAV	**Max. Marks : 100**
Code : MAEG 701	**Duration : 3Hrs**
No. of page/s: 02	

Note: 1) Mention Roll Number in the question paper.
2) No student will leave the room till one hour from the commencement of examination.

Section – A
(All the questions are compulsory)

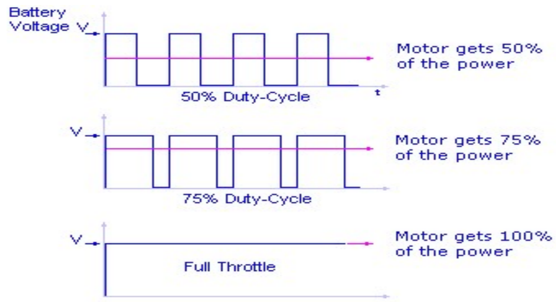
(4 * 5 = 20)

1. Discuss about the altitude and endurance of HALE, MALE and TUAV configurations.
2. How does the payload range varies for an UAV selected based on the performance of the payload, driven by the needs of the operational task.
3. List at least three properties of uplink and downlink communication used for UAVs.
4. Missiles have in build navigation and guidance system, also these systems are unmanned. Why missiles are not considered to be a UAV?

Section – B
(Answer all the questions)

(4* 10 = 40)

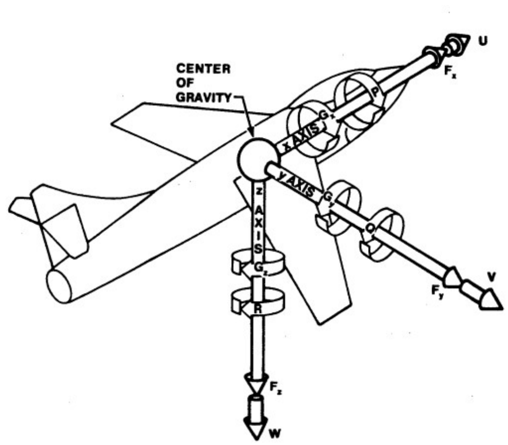
5. What are the *Launch, Recovery and Retrieval Equipment* generally used for an UAV?
6. Sensors for measuring tape height, that is height above ground, include those measuring distance by timing pulses of radio, laser or acoustic energy from transmission to return. Design an Altitude hold Autopilot for a fixed wing UAV using the sensors mentioned above.
7. How the sensor's analog values are converted to digital values for the autopilot in an UAV? Also explain the sampling and quantization process that occurs during the conversion process.
8. The Electronic Speed Controller is based on Pulse Width Modulation (PWM), which means that the motor's rpm is regulated by varying the pulses' duty-cycle according to the transmitter's throttle position (as given in the figure). Considering the battery voltage to be 22V develop an algorithm for a BLDC motor to run at full throttle



Section – C
(Answer all the Questions)

(2*20=40 Marks)

9. The performance of an aircraft can adequately be described by assuming the fixed wing UAV is a point mass concentrated at the aircraft's center of gravity (CG). The flying qualities of an UAV, on the other hand, cannot be described in such a simple manner. The flying qualities of an UAV must, instead, described analytically as motions of the aircraft's as well as motions of the airframe about the CG, both of which are caused by aerodynamic, thrust and other forces and moments. Derive the equations of motion for a fixed wing UAV.



10. Holding station in a hover or near hover is often a requirement for a VTOL aircraft for take-off or for landing and also for several types of operations, current or projected, where surveillance from a fixed-point is required. List and explain in detail about the sensors used for hover-position-hold sensing for a VTOL UAV.

SEMESTER I

AVEG 7007	Introduction to UAV	L	T	P	C
Version 1.0		3	0	0	3
Pre-requisites/Exposure	Basic Electronics, Introduction to Flight				
Co-requisites	--				

Course Objectives

Identify unmanned aircraft systems and the history.

1. Identify the different classes of UAS Systems and discuss the legal aspects of UAS Operations and the FAA regulations, describe the use of UAS within the National Air Space and describe the type of sensors and applications that can be used with unmanned aircraft systems.
2. Describe the payloads, data links, and ground support equipment, discuss mission planning, and control and recovery systems, Identify safety concerns and methodology for safe operations of UAS.

Course Outcomes

On completion of this course, the students will be able to

CO1: To classify the unmanned aerial vehicle types based on the design and application.
CO2: To analyze the different dispensable and non-dispensable payloads that can be carried over an UAV with respect to civil and military applications.
CO3: To apply the knowledge of flight mechanics in understanding the physics behind the flight.
CO4: To apply navigation and guidance techniques for unmanned aerial vehicle.
CO5: To apply and understand the different sensors that can be applied to UAV.

Catalog Description

This course covers the foundations of unmanned aerial systems, including history, UAS systems, payloads, data links, ground support equipment, classes of UAS systems, categories, applications, mission planning and control and recovery systems. This introductory course will also focus on the operation of Unmanned Aerial Vehicles/Unmanned Aircraft Systems (UAV/UAS). The topics include types of Unmanned Aerial Vehicles (UAVs), the Aviation Regulations related to UAV/UAS operations and associated safety measures, hazard risk assessment, roles and responsibilities, mission and/or operational planning.

Course Content

Unit I: **05 lecture hours**

Classification of Flight Vehicles along with prominent features of Design; Fixed wing and rotary wing UAVs along with examples.

Unit II: **06 lecture hours**

Nondispensable Payloads- Electro-optic Payload Systems, Radar Imaging Payloads - Other Nondispensable Payloads, Dispensable Payloads.

Unit III: **07 lecture hours**

Lift & Drag of Aerofoils, Stalling, Finite Span Wing, Induced Drag, Wing Planform Variations, use of Control Surfaces, Elementary Ideas about Stability & Control of UAVs

Unit IV: **08 lecture hours**

Aerodynamic models, equation of motion, dynamics modelling. Path and trajectory planning: continuous path and interpolated motion, elementary idea of guidance and navigation.

Unit V: **06 lecture hours**

UAV sensors and vision: sensors for UAV, position and motion sensors, proximity sensors, force and torque sensors, and vision controlled UAV system.

Unit VI: **04 lecture hours**

Sensors for UAV, position and motion sensors, proximity sensors, force and torque sensors, and vision controlled UAV system.

Unit VII: **04 lecture hours**

Open and close loop control, joint actuators, control schemes. Principles of UAV application, remote sensing and surveillance.

Text Books

1. Reg Austin ‘Unmanned Aircraft Systems’ Aerospace Series.

Reference Books

1. Spitzer, C.R. ‘Digital Avionics Systems’, Prentice Hall, Englewood Cliffs, N.J., U.S.A., 1987
2. Pallet, E.H.J. 'Aircraft Instruments & Integrated systems', Longman Scientific and Technical, McGraw-Hill, 1992.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	**IA**	**ESE**
Weightage (%)	50	50

Relationship between the Program Outcomes (POs), Program Specific Outcomes (PSOs) and Course Outcomes (COs)

PO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO1	1	1	2	3	3	3	0	0	0	0	0	2	1
CO2	1	3	3	3	3	1	0	0	1	0	0	2	1
CO3	3	3	3	3	3	2	0	0	0	0	1	2	1
CO4	3	3	3	3	3	2	0	0	1	0	0	1	3
CO5	3	3	3	3	3	3	0	1	0	1	0	1	3
Average	2.2	2.6	2.8	3	3	2.2	0	1	1	1	1	1.6	1.8

1 = WEEK 2 = MODERATE 3 = STRONG

		L	T	P	C
ASEG7008	**Introduction to Flight**	L	T	P	C
Version 1.0		3	0	0	3
Pre-requisites/Exposure	Basic Fluid mechanics, Fundamentals of thermos, electronics and systems				
Co-requisites	--				

Course Objectives

1. To introduce the concepts of flying, International standard atmosphere, structural aspects of airplanes, brief description of systems of instruments used in airplanes and power plants used.

Course Outcomes

On completion of this course, the students will be able to

CO1. To understand the basics of Aerospace and Avionics Engineering.
CO2. To calculate various aerodynamic parameters using the fundamental knowledge of aerodynamics theory.
CO3. To illustrate the basic understanding of thermodynamics in aircraft and spacecraft engineering for the propulsion.
CO4. To demonstrate the basic definitions and applications used in the avionics related to aeronautical and space domain technologies.

Catalog Description

The course will be divided in two parts: part one will cover aeronautics, part two space flight (astronautics). Part one will cover basic theory Lift and Drag in airfoil and wings, the aerodynamic coefficients and their use in aircraft aerodynamic performance, and basic principles of jet propulsion (Air breathing and Rocket). Part two will cover space vehicle-Satellite, Space probe, Launch Vehicle, with emphasis on system level synthesis of satellite subsystem.

Course Content

Unit I: 10 lecture hours

Standard Atmosphere, relation between Geopotential and Geometric Altitudes, Pressure, Temperature and Density Altitudes. Relation for Stratosphere and Troposphere. Stability of Atmosphere, Aero-Thermodynamics. Measurement of Air-speed: True Airspeed, Indicated Airspeed and Equivalent Airspeed, Airspeed Indicator, Cause of Drag, it's effects, Types of Drag and affecting factors. Drag Polar, Compressibility Drag, Design for Minimum Drag, Estimation of Drag of Complete Airplane, Terminal Velocity.

Unit II: 11 lecture hours

Force and Moments Coefficients from Dimensional Analysis. Pressure Distribution over 2D Airfoil, Variation with Angle of Attack, Center of Pressure, Aerodynamic Center, Problems connected with Them. Lift, Drag and Moment Coefficients; Relations between Lift and Drag. Estimation of these characteristics from Measured Pressure Distributions, Variation of Aerodynamic Coefficients with Reynold's Number and Mach number, Airfoil Stalling, Finite Span Wing, Induced Drag. Wing Planform Variations, Forward & Aft Swept Wings, High Coefficient of Lift Devices, use of Control Surfaces, Elementary Ideas about Stability & Control of Airplanes. Hovercraft,Helicopter & Space Vehicles

Unit III: **10 lecture hours**

Classification of Propulsive Units & their features; Fixed & Variable Pitch Air Screws, Piston Prop Engine, Turbo Prop Engine, Turbo Jet Engines & its Variations, Ramjet, Pulse Jet, Rockets Engines; Solid & liquid Propellant Engine, the concept of Staging of Rockets, Importance of Strength/Weight Ratio, Introduction to Loads on different parts of the Vehicle, detailed description of the Fuselage, Wing & Tail Surfaces, Wing Surfaces, Wing Fuselage Jointing Methods, different types of Under Carriages, Structural Design Philosophy of Manned & Unmanned Space Vehicles.

Unit IV: **05 lecture hours**

Different Navigation Methods, Dead Reckoning, Astronavigation, Ratio Aids, Positive Fixing, Related modern instruments. Instruments landing system, HF & vHF System, Simple Description of Communication Systems using Earth Station & Satellites, Networks Communication System

Text Books

1. Introduction to Flight (2015) 8th Edition, John D. Anderson, Mc Graw Hills.

Reference Books

1. Kermode, A.C. (2011) Flight without Formulae, Pearson Education; Eleven edition.
2. Stephen.A. Brandt (2004) Introduction to aeronautics: A design perspective, 2nd edition, AIAA
3. E W Somerset Maugham, Jet Engine Manual, BIP Publications
4. E H J Pallet, Aircraft Instruments, Himalayan Books.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	**IA**	**ESE**
Weightage (%)	50	50

Relationship between the Program Outcomes (POs), Program Specific Outcomes (PSOs) and Course Outcomes (COs)

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	3	2	0	0	0	1	0	0	1	1
CO2	3	1	2	1	2	0	0	0	1	0	0	1	1
CO3	2	2	2	1	1	0	0	0	1	0	0	1	0
CO4	2	2	1	2	1	0	0	0	1	0	0	1	0
Average	2.5	1.75	1.75	1.75	1.5	0	0	0	1	0	0	1	1

1 = WEEK 2 = MODERATE 3 = STRONG

ASEG 7009	Fundamentals of Aerodynamics	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	knowledge of Fluid Mechanics				
Co-requisites	--				

Course Objectives

1. To develop an understanding of low speed aerodynamics, potential flow and an introduction to compressible flows.
2. To introduce the concepts of mass, momentum and energy conservation relating to aerodynamics.
3. To make the student understand the concept of vorticity, irrotationality, theory of airfoils and wing sections.
4. To introduce the basics of viscous flow.

Course Outcomes

On completion of this course, the students will be able to understand the different types of flows and their properties – its effects.

CO1. Classify various fluid flow regimes and measure the flow parameters.
CO2. Apply potential flow theory to predict the velocity, pressure, and force distributions on simple aerodynamic bodies.
CO3. Solve simplified forms of the Navier-Stokes equations to obtain analytic solutions to selected fluid flow problems.
CO4. Analyze the effect of boundary layer and viscous flow on aerodynamics bodies.
CO5. Ability to apply principles of gas dynamics to solve compressible flow problems.

Catalog Description

This course builds on the student's background in Fluid Mechanics to deal primarily with internal and external flows (low-speed and high speed) relevant to aerospace applications. Students are expected to be able to analyse flows past airfoils, wings which form the basic building blocks of an airplane. Its objective is to present theoretical aerodynamics with basic numerical applications of potential flow over basic configurations, airfoil, fixed and rotating, and over body of revolution. Furthermore, compressibility effects are considered as well as elementary analysis of the boundary layer including boundary layer transition and turbulent layer.

Course Content

Unit I: **5 lecture hours**

Introduction: Continuum and free molecular flows, inviscid and viscous flows, incompressible and compressible flows. Newtonian and non-Newtonian flows. Pitot static tube, measurement of air-speed, pressure coefficient. Aerodynamic force and moments. Dimensional analysis, non-dimensional parameters, M, Re, Fr etc., flow similarity.

Unit II: **6 lecture hours**

Description of fluid Motion: Lagrangian and Eulerian methods, description of properties in a moving fluid, local and material rate of change. Equation of conservation of mass for control volume, special form of equation of conservation of mass, differential form of equation of conservation of mass. Streamlines, pathlines, streaklines, vorticity and circulation. Laws of vortex motion. Translation, rotation and rate of deformation of fluid particles. Euler's and Navier-Stokes equations. Derivation of Bernoulli's equation for inviscid and viscous flow fields. Momentum equation and angular momentum equation in integral form.

Unit III: **8 lecture hours**

Inviscid Incompressible Flow: Condition on velocity for incompressible flow. Laplace's equations. Potential function, stream function. Basic elementary flows: uniform flows, source flow, doublet flow and vortex flow. Superimposition of elementary flows. Non-lifting and lifting flow over a circular cylinder, comparison with real flow over circular cylinder. Kutta-Jaukowski theorem, generation of lift.

Unit IV: **6 lecture hours**

Introduction to Viscous Flow: Qualitative aspects of viscous flows, viscosity and thermal conductivity. Phenomenon of separation. Navier-Stokes equation; viscous flow energy equation. Some exact solutions to Navier-Stokes equations: Couette flow, Poiseuille flow.

Unit V: **5 lecture hours**

Introduction to Incompressible Boundary Layer: BL concept, BL Properties, Derivation of Prandtl's BL Equations, Blasius Solution, Karman's Integral Equation. Turbulent BL over a Plate, Skin Friction Drag, BL Control.

Unit VI: **6 lecture hours**

Elements of Compressible flow: Compressible Flow Properties: Total Enthalpy, Total Temperature, Temperature and Pressure Ratios as a function of Mach No., Mass Flow Parameter (MFP). Isentropic Area Ratio (A/A*), Velocity-Area variations, 2D Small Amplitude Wave Propagation. Adiabatic Steady Flow Ellipse, description of Flow Regimes. Introduction to Normal and Oblique Shock Waves. Working out solutions through Gas Tables/Charts.

Text Books

1. Anderson, John D. “fundamental of Aerodynamics” Tata McGraw Hill Publishing Company, New Delhi
2. Laurence Joseph Clancy. “Aerodynamics” Sterling Book House, Mumbai

Reference Books

1. E L Houghton and P W Carpenter. “Aerodynamics for Engineering Students” Butterworth Heinemann

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	IA	ESE
Weightage (%)	50	50

Relationship between the Program Outcomes (POs), Program Specific Outcomes (PSOs) and Course Outcomes (COs)

PO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PS01	PS02
CO1	3	1	0	1	0	0	0	0	0	0	0	3	0
CO2	3	3	0	1	0	0	0	0	0	0	0	3	0
CO3	3	3	0	1	0	0	0	0	0	0	0	3	0
CO4	3	3	0	1	0	0	0	0	0	0	0	3	0
CO5	3	2	0	3	0	0	0	0	0	0	0	3	0
Average	3	2.4	0	1.4	0	0	0	0	0	0	0	3	0

1 = WEEK 2 = MODERATE 3 = STRONG

AVEG 7001	**Introduction to Avionics**	L	T	P	C
Version 1.0		3	1	0	3
Pre-requisites/Exposure	Basic knowledge of communication and navigation equipment.				
Co-requisites	--				

Course Objectives

1. To understand the avionics system design development and integration using simulation tools
2. To know modular avionics packaging and EMI/EMC requirements in avionics
3. To introduce role of avionics system and its architecture
4. To study system assessment, validation, certification and maintenance of avionics system

Course Outcomes

On completion of this course, the students will be able to

CO1. Demonstrate ability to identify and explain the major components of aircraft navigation systems and aircraft display and communications system and their functions.
CO2. Understand the different requirements and design parameters for flight control systems of aircraft of different types.
CO3. Understand the concept of military and civil standard to design avionics system and ability to analyze the performance of data buses in civil and military aircraft.
CO4. Understand the electromagnetic compatibility issues that arise with the integration of multiple electronic and electromagnetic systems into modern aircraft and the design and implementation strategies that are used to minimize them.
CO5: Understand the different requirements System Assessment, Validation and Certification.

Catalog Description

Avionics systems can automatically perform many tasks that pilots and navigators previously did by hand. For example, an area navigation (RNAV) or flight management system (FMS) unit accepts a list of points that define a flight route, and automatically performs most of the course, distance, time, and fuel calculations. The FMS or RNAV unit can continually track the position of the aircraft with respect to the flight route, and display the course, time, and distance remaining to each point along the planned route Advanced avionics perform many functions and replace the navigator and pilot in most procedures. However, with the possibility of failure in any given system, the pilot must be able to perform the necessary functions in the event of an equipment failure. Pilot ability to perform in the event of equipment failure(s) means remaining current and proficient in accomplishing the manual tasks, maintaining control of the aircraft manually (referring only to standby or backup instrumentation), and adhering to the air traffic control (ATC) clearance received or requested.

Course Content

Unit I: 8 lecture hours

Role for Avionics in Civil and Military Aircraft systems, Mathematical modeling of electrical system (force-voltage and Force current) Time Domain specification for Flight control system, Avionics sub-systems and design, Communication, Navigation system, defining avionics System/subsystem requirements.

Unit II: 7 lecture hours

Man-Machine Interface, CRT, monochrome and color CRT, IFOV, TFOV, NVG, FLIR, K-map simplification, Binary codes, Binary number conversion ,Binary Hexa, octal, Multiplexer and De-Multiplexer, Synchronous and Asynchronous, Duplex, Half-Duplex communication, Encoding: RZ, NRZ, Master/Slave configuration, Digital logic.

Unit III: 7 lecture hours

Phugoid oscillation and Short period Approximation using Synthetic division method. Avionics system architectures MIL-STD-1553B, ARINC-429, ARINC-629, CSDB, AFDX and its Elements, Avionics system design, Development and integration-Use of simulation tools, stand alone and integrated Verification and Validation 14.

Unit IV: 7 lecture hours

Modular Avionics Packaging, Trade-off studies, ARINC and DOD types, system cooling, EMI/EMC requirements BIT and CFDS, Automatic Test Equipment, Speeds maintenance, ATLAS, Remote diagnostics and maintenance support-Life Cycle Costs for Military and Civil Avionics, Cash flow analysis, Software costs, Establishing spares level Civil and Military Electrical Power requirement standards, comparing the Military and Civil Requirements and Tips for Power System Design.

Unit V: 7 lecture hours

Fault tolerant systems and Hardware and Software, Evaluating system design and Future architecture Hardware assessment-FARs guide certification requirements-Fault Tree analysis – Failure mode and effects analysis, Criticality and damaging modes and effects analysis, Software development process models, Software Assessment and Validation -Civil and Military standards, Certification of Civil Avionics.

Text Books

1. Spitzer, C.R. "Digital Avionics Systems‟, Prentice Hall, Englewood Cliffs, N.J., U.S.A., 1987.
2. R.P.G Collinson, "Introduction to Avionics" .

Reference Books

1. Cary R .Spitzer, The Avionics Handbook, Crc Press, 2000.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	IA	ESE
Weightage (%)	50	50

Relationship between the Program Outcomes (POs), Program Specific Outcomes (PSOs) and Course Outcomes (COs)

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	1	0	1	2	0	0	0	0	0	0	2	0
CO2	3	2	2	2	2	2	0	0	0	0	0	3	0
CO3	3	2	2	2	2	2	0	0	0	0	0	3	0
CO4	3	2	2	2	2	2	0	0	0	0	0	3	0
CO5	3	2	0	1	2	2	0	0	0	0	0	2	0
Average	3	1.8	2	1.6	2	2	0	0	0	0	0	2.6	0

1 = WEEK 2 = MODERATE 3 = STRONG

ASEG 7010	Airplane Performance and Design	L	T	P	C
Version 1.0		3	0	0	3
Pre-requisites/Exposure	Engineering Mechanics				
Co-requisites					

Course Objectives

1. To make the students to understand various airplane flight modes
2. To enable the students to derive relations for airplane performance analyses
3. To introduce the student philosophy of airplane design
4. To make the student apply the concept of airplane performance for airplane design

Course Outcomes

On completion of this course, the students will be able to

CO1. Apply engineering mechanics theory to evaluate airplane performance in level flight.

CO2. Apply engineering mechanics theory to evaluate airplane performance in gliding and climbing flights.

CO3. Calculate airplane performance parameter in accelerated flights.

CO4. Apply principles of airplane performance for conceptual design of airplanes.

Catalog Description

This course builds on the student's background in Flight Mechanics and Airplane Design to deal primarily with performance analysis of airplane in flight (steady and accelerated) relevant to airplane conceptual design. Students are expected to be able to analyse flight performance in various flight modes, which forms the basis of building blocks of an airplane design. Its objective is to apply engineering mechanics concepts along with basic numerical applications in level, gliding, climbing, take-off and landing flights. Furthermore, application of flight mechanics concepts are considered for conceptual design of propeller driven and jet propelled airplane.

Course Content

Unit I: **8 lecture hours**

Airplane Performance in Steady level Flight: Straight and Level Flight, Stalling Speed; Variation of Drag with Flight. Speed conditions for Minimum Drag, Minimum Power Conditions; Power at other Speeds.

Unit II: **8 lecture hours**

Airplane Performance in Gliding and Climbing Flight: Gliding Flight, Shallow and Steep Angles of Glide; Sinking Speed, Minimum Sinking Speed, Time of Descent. Climbing Flight at Shallow Angles, Correction for Steep Angles, Time to Flight, and Maximum Rate of Climb.

Unit III: **8 lecture hours**

Airplane Performance in Accelerated Flight: Take-off and Landing, Calculations of Take-off Ground Run, Take off Distances. Minimum Ground Run, Assisted Take-off, Calculation of Landing Ground Run. Range and Endurance and Problems connected with them.

Unit IV: **12 lecture hours**

Airplane Design: Philosophy of Airplane Design, Phases of Airplane design, Points for conceptual design. Design of propeller Driven Airplane. Design of Jet Propelled airplane.

Text Books

1. Anderson, John D. "Aircraft Performance & Design" McGraw Hill(1999)

Reference Books

1. Anderson, John D. "Introduction to Flight" McGraw Hill(1999).
2. Bandu N. Pamadi, "Performance, Stability, Dynamics, and Control of Airplanes" Second Edition (AIAA Education).
3. Laurence Joseph Clancy. "Aerodynamics" Sterling Book House, Mumbai.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	**IA**	**ESE**
Weightage (%)	50	50

Relationship between the Program Outcomes (POs), Program Specific Outcomes (PSOs) and Course Outcomes (COs)

PO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PS0 1	PS0 2
CO1	2	1	2	0	1	0	0	0	0	0	0	1	1
CO2	2	1	2	0	1	0	0	0	0	0	0	1	1
CO3	2	1	3	0	1	0	0	0	0	0	0	1	0
CO4	2	1	3	1	2	1	0	0	0	0	0	3	0
Averag e	2	1	2.5	1	1.2 5	1	0	0	0	0	0	1.25	1

1 = WEEK 2 = MODERATE 3 = STRONG

AVEG 7002	**Micro-controller & Embedded Systems**	L	T	P	C
Version 1.0		3	0	0	3
Pre-requisites/Exposure	Basic Electronics, Digital Electronics, C Programming				
Co-requisites	--				

Course Objectives

1. Demonstrate a working knowledge of microcontroller busses and the flow of data within a microcontroller system.
2. Develop and demonstrate how to accomplish a given task using Assembly and "C" language on a microcontroller.

Course Outcomes

On completion of this course, the students will be able to

CO1. Understand the basic concepts of Digital Electronics, Number Systems.
CO2. Understand the working of different Microcontrollers, their architectures and their limitations for different applications. Discussion on I/O ports, which allows the students who are working on a project to start experimenting with 8051 microcontrollers.
CO3. Develop and understand the working of basic loop instructions like jump and loops.
CO4. Develop embedded codes for input and output devices interfaced to the micro controller.
CO5. Embedded code will explain the students how to store the data and Interfacing and testing of components like LED's, Motors, Display Devices, switches and sensors to the microcontroller. Interfacing PCs and Laptops with the microcontrollers and controlling external devices using PCs and Laptops.

Catalog Description

Basic architecture and assembly language of a microcontroller. Principles of microprocessor serial and parallel interfacing. Timers, A/D and D/A relevant chips. Software and hardware interrupt handling routines. Application of top-down design to microcontroller software development in assembly language and a high level language. Evaluation of hardware and software trade-offs.

Course Content

Unit I: **05 lecture hours**
Numbering and coding systems, Digital Electronics, Memory, CPU Architecture.
Unit II: **04 lecture hours**
Microcontrollers and Embedded Processors, Overview of AVR, GPRS, Data Memory, Status Registers, Data Format and Directives, Assembling in AVR, Viewing registers and Memory with AVR Studio.
Unit III: **06 lecture hours**
Branching Instructions and Looping, Call Instructions, Time Delay Instructions, I/O Port Programming, Bit Manipulation.

Unit IV: **07 lecture hours**

Embedded C: Data Types and time delay in ATmega 16, IO Programming, Logic Operations, Data Conversions, Data Serializations, Memory Allocation.

Unit V: **08 lecture hours**

Data types and Time delays, I/O Programming, Logic Operations, Data Conversions in C, Data Serialization, Memory Allocation in C.

Unit VI: **06 lecture hours**

PIN connections, Fuse Bits, Hex File, AVR Development Board, Timer, Counter, Serial Port Programming, ADC, LCD, Key Board, Sensor, Motor (DC).

Text Books

1. The AVR Microcontroller and Embedded Systems, Using Assembly and C, Muhammad Ali Mazidi.

Reference Books

1. AVR Microcontroller-Internals, Instructions, Programming & Interfacing by Subrata Ghoshal.
2. The AVR Microcontroller by Kenneth Ayala.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	IA	ESE
Weightage (%)	50	50

Relationship between the Program Outcomes (POs), Program Specific Outcomes (PSOs) and Course Outcomes (COs)

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	1	1	1	1	0	0	0	0	0	0	1	2
CO2	1	1	2	2	3	0	0	0	0	0	0	1	2
CO3	2	2	3	2	3	0	0	1	2	0	1	3	2
CO4	3	2	3	2	3	0	0	1	2	2	0	3	3
CO5	2	3	3	2	3	1	0	0	2	2	1	2	3
Average	2	1.8	2.4	1.8	2.6	1	0	1	2	2	1	2	2.4

1 = WEEK 2 = MODERATE 3 = STRONG

SEMESTER II

AVEG 7003	Mathematical Modelling & Simulation	L	T	P	C
Version 1.0		3	0	0	3
Pre-requisites/Exposure	Basic knowledge of modeling and simulation of aircraft systems				
Co-requisites	--				

Course Objectives

1. To introduce the concepts of aircraft mathematical model and simulation of aircraft systems.
2. To introduce the knowledge about various types of flight simulators and Probability concepts in simulation.

Course Outcomes

On completion of this course, the students will be able to
CO1. Students will explain the advanced concepts of Mathematical Modeling and Simulation to the engineers and to provide the necessary mathematical knowledge that are needed in modeling physical processes.
CO2. The students will have an exposure on various topics such as System Models, probability concepts in simulation and flight simulators.
CO3. Students will be able to deploy the skills effectively in demonstrating the concepts and working of a flight simulator.

Catalog Description

Modeling and simulation (M&S) in aircraft system development, for example of fuel, hydraulic and electrical power systems, is today an important part of the design process. Through M&S a problem in a function or system is found early on in the process. An increasing part of the end system verification relies on results from simulation models rather than expensive testing in flight tests. Consequently, the need for integrated models of complex systems, and their validation, is increasing. The development of computer performance and modeling and simulation tools has enabled large-scale simulation In aircraft development, it is crucial to understand and evaluate behavior, performance, safety and other aspects of systems before and after they are physically available for testing. Simulation models are used to gain knowledge in order to make decisions at all development stages. This realization has led to an increase in modeling and simulation (M&S) activity in early development phases. Another reason is the relationship between market requests for products with high functionality, which often results in complex system interactions that M&S can describe/develop. Added to this is also the financial incentive to minimize product development time and cost which M&S supports.

Course Content

Unit I: 8 lecture hours

Physical setup and system equations: governing the motion of an aircraft with six non-linear coupled differential equations, linearized into the longitudinal and lateral equations, Design requirements-to design a feedback controller, Transfer function and the state-space-numerical values to simplify the modeling equations, MATLAB representation and open-loop response.

Unit II: **7 lecture hours**
Bode plot and open-loop response, Lag controller, Lag or Phase-Lag Compensator using Frequency Response, Designing Cruise Control using Root-Locus method, Discrete transfer function, Root-Locus in z-plane, Compensation using a digital controller.

Unit III: **7 lecture hours**
Proportional control- decreases the rise time, PI control- eliminates the steady-state error, PID control-obtained the system with no overshoot, fast rise time, and no steady-state error.

Unit IV: **7 lecture hours**
State-space equations (K=Control matrix, U=Kv=input, R=Reference) Control design using pole placement ,Introducing the reference input, Observer design.

Unit V: **7 lecture hours**
Designing Pitch Controller using State-Space method, Discrete state-space, Controllability and observability, Control design via pole placement, Linear Quadratic Regulator (LQR), Performance index matrix (R), state-cost matrix (Q), and weighting factor (p).

Text Books

1. Gordon. G., ―System Simulation‖ , Prentice – Hall Inc., 1992.
2. Dr. Kai Velten - Mathematical Modeling and Simulation: Introduction for Scientists and Engineers.

Reference Books

1. Stables, K.J. and Rolfe, J.M. ―Flight Simulation‖, Cambridge University Press, 1986.
2. Moller, Dietmar P.F - Mathematical and Computational Modeling and Simulation.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	IA	ESE
Weightage (%)	50	50

Relationship between the Program Outcomes (POs), Program Specific Outcomes (PSOs) and Course Outcomes (COs)

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	1	0	1	2	0	0	0	0	0	0	2	0
CO2	3	3	3	2	2	2	0	0	0	0	0	3	0
CO3	3	2	2	2	2	2	0	0	0	0	0	3	0
Average	2.6	2	2.5	1.6	1.6	2	0	0	0	0	0	2.6	0

1 = WEEK 2 = MODERATE 3 = STRONG

AVEG 7004	**Flight Instrumentation and Data Acquisition System**	L	T	P	C
Version 1.0		3	1	0	3
Pre-requisites/Exposure	Basic knowledge of communication and navigation equipment.				
Co-requisites	--				

Course Objectives

1. To learn the concept of measurement, error estimation and classification of aircraft instrumentation and displays
2. To study air data instruments and synchronous data transmissions systems
3. To study gyroscope and its purposes, aircraft compass system and flight management system
4. To study Data acquisition and handling systems.

Course Outcomes

On completion of this course, the students will be able to

CO1. The learners will able to measure the error and can find the error estimation in the aircraft instruments.
CO2.Students will be able know about the various air data systems and synchronous data transmissions systems.
CO3. The learners will be able to know the principle of gyroscope and its property, principle of DGU, RMI, FMS and its operation mode in 4D flight management.
CO4 The students will also have an exposure to various topics such as measurement concepts, air data sensors and measurements, Flight Management Systems, and other instruments pertaining to Gyroscopic measurements and Engine data measurements.

Catalog Description

Flight Test Data Acquisition System and Instrumentation is self-contained, lightweight, easily calibrated and reliable in the flight test environment. In addition to a basic airborne data acquisition system, a pilot control force measurement system, differential GPS, air data measurement system and trailing cone system. The instrumentation is designed to interface with a variety of transducers (many of which the company keeps in stock) and record data from all types of aircraft. KSR also provides the ability to monitor selected key parameters in real time during the flight. Flight test instrumentation (FTI) is monitoring and recording equipment fitted to aircraft during flight test. It is mainly used on experimental aircraft, prototype aircraft and development aircraft - both military and civil, and can monitor various parameters from the temperatures of specific components to the speed of the engines.

Course Content

Unit I: **8 lecture hours**
Airspeed, altitude, Vertical speed indicators. Static Air temperature, Angle of attack measurement.

Unit II: **7 lecture hours**

Gyroscope and its properties, gyro system, Vertical gyroscope-Horizon, Direction gyro-direction indicator, Rate gyro-rate of turn and slip indicator, acceleration and turning errors.

Unit III: **7 lecture hours**

Direct reading compass, magnetic heading reference system-detector element, monitored gyroscope system, DGU, RMI, deviation compensator, FMS- Flight planning-flight path optimization-operational modes-4D flight management.

Unit IV: **7 lecture hours**

Pressure measurement, temperature measurement, fuel quantity measurement, engine power and control instruments-measurement of RPM, manifold pressure, Engine torque, fuel flow.

Unit V: **7 lecture hours**

Data acquisition and Handling systems: Introduction-signal conditioners-Instrumentation amplifiers-filters. Data conversion -multiplexers-A/D-D/A conversion. Telemetry-Airborne and ground system-PC based telemetry system. Introduction to telemetry flight data testing. Application of telemetry in UAVs and Satellites.

Text Books

1. Pallet, E.H.J. ―Aircraft Instruments & Integrated systems‖, Longman Scientific and Technical, McGraw-Hill, 1992.
2. Murthy, D.V.S., ―Transducers and Measurements‖, McGraw-Hill, 1995.

Reference Books

1. Doeblin.E.O, ―Measurement Systems Application and Design‖, McGraw-Hill, New York, 1999.
2. HarryL.Stilz, ―Aerospace Telemetry‖, Vol I to IV, Prentice-Hall Space Technology Series.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	IA	ESE
Weightage (%)	50	50

Relationship between the Program Outcomes (POs), Program Specific Outcomes (PSOs) and Course Outcomes (COs)

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2	0	1	2	0	0	0	0	0	0	2	1
CO2	2	2	0	2	2	2	0	0	0	0	0	3	1
CO3	3	2	2	2	2	2	0	0	0	0	0	3	0
CO4	3	2	2	2	2	2	0	0	0	0	0	3	0
Average	2.5	2	2	1.75	2	2	0	0	0	0	0	2.75	1

1 = WEEK 2 = MODERATE 3 = STRONG

ASEG 7017	Automatic Flight Control	L	T	P	C
Version 1.0		3	0	0	3
Pre-requisites/Exposure	Airplane Stability and Control				
Co-requisites					

Course Objectives

1. To make the students to understand dynamics of aircraft flight modes.
2. To enable the students to understand the aircraft handling qualities requirements.
3. To introduce the student the concepts of automatic control system.
4. To make the student apply principles of automatic control for conceptual design of autopilots.

Course Outcomes

On completion of this course, the students will be able to

CO1. Derive equation of motion of aircraft to analyse handling qualities.

CO2. Linearize equations of motion of aircraft for stability analysis.

CO3. Analyse the stability of automatic control system.

CO4. Analyse autopilots for various flight conditions.

Catalog Description

This course builds on the student's background in Flight dynamics and Automatic control system design to deal primarily with handling qualities analysis of airplane in flight (longitudinal and lateral) relevant to airplane conceptual autopilot design. Students are expected to be able to analyse airplane dynamics stability in various flight modes, which forms the basis of building blocks of an airplane autopilot design. Its objective is to apply automatic control concepts along with basic aircraft dynamics in longitudinal and lateral motion. Furthermore, application of automatic flight control concepts are considered for conceptual design of autopilots and Instrument Landing System.

Course Content

Unit I: 12 lecture hours
Flight Dynamics: Linearized equations of aircraft motion for small perturbations in stability axes. Stability analysis of linearized equations of motion. Derivation of Airplane longitudinal motion. Airplane lateral motion. Airplane handling qualities.

Unit II: 8 lecture hours
Automatic Control: Feedback Control system, analysis of feedback control system.

Unit III: 8 lecture hours
System Stability: Control system stability, Routh-Hurwitz Criterion, Root Locus Method.

Unit IV: 8 lecture hours
Autopilots: Autopilots, Fly-By-Wire control system, Instrument Landing System.

Text Books

1. R. C. Nelson, “Flight Stability and Automatic Control “(Second Edition), McGraw Hill Book Company.
2. K. Ogata, “Modern Control Engineering” Prentice Hall, 2010.

Reference Books

1. Bernard Etkins, “Dynamics of Flight: Stability and Control”, Wiley.
2. Anderson, John D. “Introduction to Flight” McGraw Hill(1999).
3. Bandu N. Pamadi, Performance, Stability Dynamics and Control of Airplanes, AIAA Education Series.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	**IA**	**ESE**
Weightage (%)	50	50

Relationship between the Program Outcomes (POs), Program Specific Outcomes (PSOs) and Course Outcomes (COs)

PO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PS0 1	PS0 2
CO1	2	1	0	0	0	0	0	0	0	0	0	2	1
CO2	2	1	0	0	0	0	0	0	0	0	0	2	1
CO3	2	2	2	1	2	1	0	0	0	0	0	2	0
CO4	2	3	2	2	2	1	0	0	0	0	0	2	0
Averag e	2	1.7 5	2	1.5	2	1	0	0	0	0	0	2	1

1 = WEEK 2 = MODERATE 3 = STRONG

ASEG 7018	**Flight Stability & Control**	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	Introduction to Flight, Airplane Performance and Design				
Co-requisites	--				

Course Objectives

1. To help the students understand the fundamentals and relevance of stability and control in the broader context of engineering sciences in general, and Aerospace engineering in particular
2. To enable students to understand theory of flight, apply laws of flight mechanics, and analyse aircraft stability through different aircraft configurations along with the measurement of stability parameters.
3. To empower students with the expertise of experimentation and the fundamental concepts that are required to translate a novel engineering idea to reality through Flight test and Root Locus analysis.
4. To expose students to a wide variety of research areas and concerns in and around flight mechanics such as ILS, UAVs, etc. across multidisciplinary domains.
5. To equip students with necessary engineering skills such as solving engineering problems in a professional way, using commercial software packages such as MATLAB for data analysis, numerical simulations etc.

Course Outcomes

On completion of this course, the students will be able to

CO1. Apply laws of engineering mechanics to calculate moments about aircraft cg.

CO2. Estimate stick free aircraft longitudinal stability parameters.

CO3. Understand and formulate the manoeuvring stability equations.

CO4. Analyse directional and lateral stability and control characteristics of aircraft.

CO5. Apply system vibration concepts on aircraft dynamics.

Catalog Description

Flight stability and control is an important aspect of aircraft handling qualities for aircraft design and development. The estimation of aircraft neutral point for longitudinal stick fixed and stick free is very important parameter to judge the level of aircraft stability. The directional and lateral stability and control are equally important aspects of aircraft handling qualities. Finally, knowledge of dynamic stability such as short period motion and phugoid motion, ducth roll motion, etc. The students will learn the fundamental laws of flight mechanics and then flight dynamics of aircraft. The student will also learn the art of engineering approximations, and the fundamental concepts of stability and control analysis, that are involved in translating a novel idea to a real-world application.

Course Content

Unit I: **10 lecture hours**

Stick Fixed Static Longitudinal Stability: Introduction to Stability of Airplane, Stick Fixed Longitudinal Stability, Effect of Power, Neutral Point, and Center of Gravity Limits. In Flight Measurement of Stick Fixed Neutral Point.

Unit II: **10 lecture hours**

Stick Free Static Longitudinal Stability: Control Surface Hinge Moments, Floating and Restoring Tendencies, different types of Tabs used on Airplanes. Frise Aileron, Spoiler Controls. Effect of Free Elevator on Airplane stability, Elevator Control Force, Stick Force Gradients, Neutral Point, Controls Free Center of Gravity Limit. In Flight Measurement of Stick Free Neutral Point. Effect of Acceleration on Airplane Balancing, Elevator Angle per g, and Stick Force per g, Maneuver Margins.

Unit III: **8 lecture hours**

Directional Stability and Controls: Asymmetric Flight, Weather Cock Stability, contribution of different parts of Airplane, Rudder Fixed and Rudder Free Static Directional Stability, Rudder Lock. Lateral Stability and Control: Dihedral Effect. Contribution of different. Parts of Airplane Controls in Roll, Aileron Control Power, Cross coupling of Lateral and Directional Effects.

Unit IV: **8 lecture hours**

Longitudinal Dynamic Stability: Simple Analysis of Short Period and Phugoid Modes, Stick-Fixed and Stick-Free. Lateral and Directional Dynamic Stability: Simple Analysis of Roll Subsdience Spiral Mode and Dutch Roll.

Text Books

1. R. C Nelson, Flight Stability and Automatic Control (Second Edition); Mc-Graw Hill.
2. Bandu N. Pamadi; Performance, Stability Dynamics and Control of Airplanes, AIAA Education Series.
3. Perkins & Hedge; Airplane Performance Stability & Control; John Wiley & Sons.

Reference Books

1. Thomus R Yechout, Introduction to Aircraft Flight Mechanics, AIAA Education Series
2. McCormick, B. W.; Aerodynamics, Aeronautics, and Flight Mechanics, John Wiley & Sons, Inc.1995
3. Clancy, L. J. ; Aerodynamics: Sterling Book House, 2006

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	IA	ESE
Weightage (%)	50	50

Relationship between the Program Outcomes (POs), Program Specific Outcomes (PSOs) and Course Outcomes (COs)

PO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PS0 1	PS0 2
CO1	2	2	2	0	0	0	0	0	0	0	0	2	1
CO2	2	2	2	0	0	0	0	0	0	0	0	2	1
CO3	2	2	2	0	0	0	0	0	0	0	0	2	0
CO4	2	2	2	0	0	0	0	0	0	0	0	2	0
CO5	2	2	2	0	2	0	0	0	0	0	0	2	0
Averag e	2	2	2	0	2	0	0	0	0	0	0	2	1

1 = WEEK 2 = MODERATE 3 = STRONG

AVEG 7005	Path Planning and Obstacle Avoidance for Unmanned Aerial Vehicles	L	T	P	C
Version 1.0		3	0	0	3
Pre-requisites/Exposure	Basic Electronics, Mathematics, C Programming, Data Structures				
Co-requisites	--				

Course Objectives

1. Demonstrate a working knowledge of basic path planning algorithms used in UAVs.
2. Develop and demonstrate how to accomplish a given task using a Plan and avoid obstacles while UAV is performing a mission.

Course Outcomes

On completion of this course, the students will be able to

CO1. Understand the basic concepts of Digital Electronics, Number Systems Digital signal conditioning which will allow the students to understand the converters and data acquisition systems.

CO2. Understand the Discrete Planning Methods.

CO3. Understand the Discrete Optimal Planning Methods.

CO4. Understand the Optimal Fixed/Unspecified Length Plans.

CO5. Understand the State Space Representation of Plans and Interfacing and testing of Obstacle Avoidance Sensors with Microcontroller

Catalog Description

This course addresses the planning part of UAVs, which includes motion-planning, trajectory planning, and planning under uncertainty. This is only one part of the big picture in UAV, which includes issues not directly covered, such as mechanism design, dynamical system modeling, feedback control, sensor design, computer vision.

Course Content

Unit I: 03 lecture hours

covers number systems (Binary, Decimal and Hex) and provides introduction to basic logic gates and computer terminology. (This is for the students who have not taken a digital logic course), Basic Ingredients of planning, Algorithms, Planners and Plans

Unit II: **8 lecture hours**
Introduction to discrete feasible planning, searching for feasible plans: General Forward Search, Breadth First Search, Depth First Search, Dijkstra's algorithm, A-Star, Best First, Iterative Deepening

Unit III: **6 lecture hours**
Other General Search Schemes, Backward Search, Bidirectional Search Discrete Optimal Planning, Logic to formulate discrete planning, Logic based planning methods.

Unit IV: **8 lecture hours**
Backward Value Iteration, Forward Value Iteration, Dijkstra Revisited, Using Logic to Formulate Discrete Planning, A STRIPS- Like Representation.

Unit V: **6 lecture hours**
Converting to State Space Representation: Logic Based Planning Methods, Building a Planning Graph

Text Books

1. Planning Algorithms by Steven M. LaValle, University of Illinois.

Reference Books

1. Optimal Path Planning for Unmanned Aerial Systems by Erik Johannes Forsmo

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	**IA**	**ESE**
Weightage (%)	50	50

Relationship between the Program Outcomes (POs), Program Specific Outcomes (PSOs) and Course Outcomes (COs)

PO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2
CO1	2	1	1	1	1	1	0	0	0	0	0	2	1
CO2	2	1	1	3	3	3	0	0	0	0	0	2	3
CO3	2	2	1	3	3	3	0	2	0	0	2	2	3
CO4	3	2	1	3	3	3	0	0	0	0	0	2	3
CO5	3	3	1	3	3	3	2	0	0	0	0	2	3
Average	2.4	1.8	1	2.6	2.6	2.6	2	2	0	0	2	2	2.6

1 = WEEK 2 = MODERATE 3 = STRONG

AVEG 7006	Actuators and Sensors for UAV	L	T	P	C
Version 1.0		3	0	0	3
Pre-requisites/Exposure	Basic Electronics, Mathematics, Signals and Systems				
Co-requisites	--				

Course Objectives

1. Understanding basic laws and phenomena on which operation of sensors and actuators-transformation of energy is based.
2. Develop and demonstrate how to accomplish a given task using sensors and actuate the motors in an UAV.

Course Outcomes

On completion of this course, the students will be able to

CO1. Understand the basic concepts of Digital Electronics, Number Systems Digital signal conditioning which will allow the students to understand the converters and data acquisition systems.
.
CO2. Understand the working of ADC, DAC, DAQ.

CO3. Understand the working of thermal sensors.

CO4. Understand the working of Mechanical sensors.

CO5. Understand the working of Optical sensors and Interfacing and testing of components like LED's, Motors, Display Devices, switches and sensors to the microcontroller

Catalog Description

This course addresses the planning part of UAVs, which includes motion-planning, trajectory planning, and planning under uncertainty. This is only one part of the big picture in UAV, which includes issues not directly covered, such as mechanism design, dynamical system modeling, feedback control, sensor design, and computer vision.

Course Content

Unit I: **04 lecture hours**

Measurements, significance of Measurements, Methods of Measurements, Direct Methods, Indirect Methods, Instruments and Measurements Systems- Mechanical, Electrical and Electronics Instruments, Classification of Instruments, Deflection type, Null Type, Analog and Digital Modes of Operation, Measurement system performance, Static Calibrations, Static Characteristics, Errors in Measurements, True Value, Static Error , Noise, Accuracy, Precision, Transducers, Primary sensing elements, Secondary elements

Unit II: **08 lecture hours**
Logic gates, Operational Amplifiers, Signal Processing, Signal Conditioning, Analog to Digital Converters, Digital to Analog Converters, Sample and Hold Circuits, Data Acquisition Systems

Unit III: **08 lecture hours**
LVDT, RVDT, Strain Gauges and Measurement of Strain, Ballast Circuit, Wheatstone Bridges, Null type Wheatstone bridge, Displacement, Location and Position Sensors, Strain Sensors, Flow Sensor, Motion Sensors, Pressure sensors, Optical Sensors: Photo Detectors, Pyrometry Optical Sources

Unit IV: **06 lecture hours**
Measurement of temperature, Metal resistance Vs Temperature devices, Thermistors, Thermocouples, Other thermal sensors like Bimetal Strips, Gas Thermometers, Vapor Pressure Thermometers, Measurement of Flow, Measurement of thickness, Measurement of humidity

Unit V: **06 lecture hours**
Electrical Actuators- DC Motor, Servo Motors, Stepper Motors, Pneumatic Actuators and Hydraulic Actuators, Introduction to Control Systems, Micro Processors, Data Acquisition Systems

Text Books

1. Electronic Measurements & Instruments by A.K.Sawhney.

Reference Books

1. Process Control Instrumentation Technology by Curtis D. Johnson.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	IA	ESE
Weightage (%)	50	50

Relationship between the Program Outcomes (POs), Program Specific Outcomes (PSOs) and Course Outcomes (COs)

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	1	1	1	1	3	0	0	0	0	0	3	3
CO2	2	1	1	0	3	3	0	0	0	0	0	2	3
CO3	2	2	1	0	3	3	0	2	0	0	2	2	3
CO4	3	2	1	0	3	3	0	0	0	0	0	1	3
CO5	3	3	1	0	3	3	0	0	0	0	0	1	3
Avg.	2.4	1.8	1	1	2.6	3	0	2	0	0	2	1.8	3

1 = WEEK 2 = MODERATE 3 = STRONG

SEMESTER III

		L	T	P	C
AVEG 8001	**UAV System Design**	L	T	P	C
Version 1.0		3	1	0	3
Pre-requisites/Exposure	Basic knowledge of UAV System Design & Automatic flight control.				
Co-requisites	--				

Course Objectives

1. To understand the UAV system design development and integration using simulation tools
2. To know modular avionics subsystem and analyse the performance of the sub-system
3. To introduce the integration of multiple electronic and electromagnetic systems

Course Outcomes

On completion of this course, the students will be able to

CO1. Demonstrate ability to identify and explain the complete system for UAV requirement and performance and their functions.

CO2. Understand the UAV sub-system and input/output device & power requirement system and ability to analyze the performance of the sub-system.

CO3. Understand the concept of autopilot design and integration of multiple electronic and electromagnetic systems into modern UAV system.

CO4. To design and analyses the auto-pilot system and Fly-By Wire control system.

CO5: To design the UAV Architecture with consideration to Systems performance and EMC/EMI, Maintainability, Redundancy, Testability, Weapon Delivery and Man-Machine Interface.

Catalog Description

A UAV will have some greater or lesser degree of 'automatic intelligence'. It will be able to communicate with its controller and to return payload data such as electro-optic or thermal TV images, together with its primary state information – position, airspeed, heading and altitude. It will also transmit information as to its condition, which is often referred to as 'housekeeping data', covering aspects such as the amount of fuel it has, temperatures of components, e.g. engines or electronics. If a fault occurs in any of the sub-systems or components, the UAV may be designed automatically to take corrective action and/or alert its operator to the event. In the event, for example, that the radio communication between the operator and the UAV is broken, then the UAV may be programmed to search for the radio beam and re-establish contact or to switch to a different radio frequency band if the radio-link is duplexed. The initials RPV (remotely piloted vehicle) were originally used for unmanned aircraft, but with the appearance of systems deploying land-based or underwater vehicles, other acronyms or initials have been adopted to clarify the reference to airborne vehicle systems.

Course Content

Unit I: **8 lecture hours**

Design of a complete system - example, a UAV system and its elements, The mission system software must must employ an open system architecture, Requirements include performance, cost, schedule and risk, layers of subsystems, Top-Down Aapproach, High Altitude Endurance (HAE) UAV top-level system requirement.

Unit II: **7 lecture hours**

Trends in display technology, Alphanumeric displays, character displays etc., Civil and Military aircraft cockpits, MFDs, MFK, HUD, HDD, HMD, DVI, HOTAS, Synthetic and enhanced vision, situation awareness, Panoramic/big picture display, virtual cockpit.

Unit III: **7 lecture hours**

UAV Longitudinal Autopilot Design: Autopilot-Pitch Orientation Control system, Acceleration Control System, Glide Slope Coupler and Automatic Flare Control and Flight path stabilization, longitudinal control law design.

Unit IV: **7 lecture hours**

UAV lateral Autopilot Design: Damping of the Dutch Roll, Methods of Obtaining Coordination, Yaw Orientation Control system, turn compensation, Automatic lateral Beam Guidance. Introduction to Fly-by-wire flight control systems, Lateral control law.

Unit V: **7 lecture hours**

Determination of Sub-System Specifications, Selection of Sub-Systems and Design of UAV Architecture with consideration to Systems performance, Power Consumption, Layout, Cost, EMC/EMI, Maintainability, Redundancy, Testability, Weapon Delivery and Man-Machine Interface.

Text Books

1. Reg Austin, "Unmanned Aircraft Systems: UAVS Design, Development and Deployment"
2. John H. Blakelock, "Automatic Control of Aircraft and Missiles", 2nd Edition.

Reference Books

1. Douglas M. Marshall**,** Richard K. Barnhart **, "**Introduction to Unmanned Aircraft Systems" 1st Edition.
2. Cary R .Spitzer, The Avionics Handbook, Crc Press, 2000.
3. Spitzer, C.R. "Digital Avionics Systems‟, Prentice Hall, Englewood Cliffs, N.J., U.S.A., 1987.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	IA	ESE
Weightage (%)	50	50

Relationship between the Program Outcomes (POs), Program Specific Outcomes (PSOs) and Course Outcomes (COs)

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2	1	1	2	0	0	0	0	0	0	2	0
CO2	2	2	2	1	2	0	0	0	0	0	0	2	0
CO3	3	2	2	2	2	2	0	0	0	0	0	3	0
CO4	3	2	2	2	2	2	0	0	0	0	0	3	0
CO5	3	2	3	2	3	2	0	0	0	0	0	3	0
Average	2.6	2	2	1.6	2.2	2	0	0	0	0	0	2.6	0

1 = WEEK 2 = MODERATE 3 = STRONG

AVEG 8002	System Identification Methods	L	T	P	C
Version 1.0		3	0	0	0
Pre-requisites/Exposure	Basic Knowledge of Flight Mechanics. Good understanding of Stability and control and statistics.				
Co-requisites	--				

Course Objectives

1. To help the students understand the fundamentals of stability and controls in the broader context of engineering sciences in general.
2. To enable students to understand Mathematics some basics of Matrices ,statistics and flight Mechanics.
3. To empower students with the expertise of experimentation, simulation and the fundamental concepts that is required to translate a novel engineering idea to reality.
4. To expose students to a wide variety of research areas and applications in Aircraft System Identification.

Course Outcomes

On completion of this course, the students will be able to

CO1. Understand about concept of Sensors and Measurements.
CO2. Carryout detailed description of flight Data analysis.
CO3. Classification of flight Parameter Estimation.
CO4. Carryout detailed description of System Identification Methods.
CO5. Fully equipped with concepts, methodologies and applications of flight Parameter Estimation.

Catalog Description

Aircraft parameter estimation is probably the most outstanding example of the system identification methodology. The process of estimation of parameters (aerodynamic derivatives) is the determination of the best possible estimates occurring in the model used to represent a system. It is a branch of Statistics which deals with estimating the value of Parameters based on measure empirical data. The major application of parameter estimation is designing controls and autopilots, flight envelopes can be Expanded, comparison with results from wind tunnel tests and analytic methods such as CFD, dynamic analysis, simulation, flying qualities assessments, accident investigation and verification of overall aircraft performances.

Course Content

Unit I: 12 lecture hours

Flight data analysis and system Identification Methods of data analysis and modelling. Sensors and measurements concepts. Time and frequency data analysis, statistical and spectral concepts. Linear regression and identification of time series models.

Unit II: **11 lecture hours**

Flight parameter Estimation using optimization.Basis –function expansion and nonlinear time series identification..

Unit III: **12 lecture hours**

Output Error Method, Filter Error Method, Equation Error Method, Recursive parameter Estimation, Neural Networks. Data compatibility check, Filtering,Smoothing, Model Validation.

Text Books

1. Jategaonkar,R.V. " Flight vehicle system identification- ATime Domain Methodology", AIAA Progress in Aeronautics and Astronautics.Vol 216 .AIAA.Reston,VA August, 2006
2. Klein V. and Morelli, E.A, 'Aircraft system identification-Theory and practices' AIAA Education Series,Reston,Virgina,2006

Reference Books

1. **"**Flight Stability and control" , Robert Nelson

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	**IA**	**ESE**
Weightage (%)	50	50

Relationship between the Program Outcomes (POs), Program Specific Outcomes (PSOs) and Course Outcomes (COs)

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	1	2	1	1	1	0	0	1	1	0	0	1
CO2	2	2	1	2	2	1	0	0	1	0	0	1	2
CO3	2	2	1	2	2	1	0	0	2	1	0	1	2
CO4	2	1	2	1	2	1	0	0	1	0	0	2	2
CO5	2	3	2	2	2	1	0	0	2	1	0	2	3
Average	2	1.8	1.6	1.6	1.8	1	0	0	1.4	3	0	1.5	2

1 = WEEK 2 = MODERATE 3 = STRONG

AVEG8003	**Guidance & Navigation**	L	T	P	C
Version 1.0		3	0	0	3
Pre-requisites/Exposure	Introduction to Avionics, RADAR Fundamentals				
Co-requisites	--				

Course Objectives

1. Understand observation techniques and limitations, and how navigation data is collected and assimilated.
2. Compute initial orbits based on observation data.
3. Understand sources of errors, how errors are treated, and their effect on navigation solutions.
4. Compute GPS position solutions.

Course Outcomes

On completion of this course, the students will be able to

CO1. Understand the basic concepts of guidance and navigational tools.
CO2. Formulate and design the INS.
CO3. Compute the Kalman filter problems used in satellite technologies.
CO4. Solve the problem related to missile launch guidance and navigation.

Catalog Description

Aircraft, spacecraft and satellites guidance and navigation is an integral part of the Aerospace engineering and technologies. The subject deals with the mathematics and physics of the navigational techniques involved in guiding and navigating the aircrafts, drones, spacecraft's and satellites. Basic latitude and longitude information can also be formulated and investigated using the traditional tools such as DR methods and would further be validated with the modern techniques such as LORAN, TACAN, DECCA and OMEGA systems. The various methods of missile navigation and guidance systems can also be used to investigate the recent trends and developments in the defense technologies.

Course Content

Unit I: **09 lecture hours**

Radio Navigation- Different types of radio navigation- ADF, VOR/DME- Doppler -LORAN and Omega

Approach and Landing Aids- ILS, MLS, GLS - Ground controlled approach system - surveillance systems-radio altimeter. Inertial Sensors- Gyroscopes-Mechanical-electromechanical-Ring Laser gyro- Fibre optic gyro, Accelerometers.

Unit II: **09 lecture hours**

Inertial Navigation System- Introduction to navigation, Guidance and control - definition, Historical background, INS components: transfer function and errors-The earth in inertial space, the coriolis effect-Mechanisation. Platform and Strap down, INS system block diagram, Different co-ordinate systems, Schuler loop, compensation errors, Cross coupling, Gimbal lock, Alignment.

Unit III: **09 lecture hours**

Satellite Navigation and Hybrid Navigation- Introduction to GPS -system description -basic principles -position and velocity determination-signal structure-DGPS, Introduction to Kalman filtering-Estimation and mixed mode navigation-Integration of GPS and INS-utilization of navigation systems in aircraft

Unit IV: **09 lecture hours**

Missile and Launch Vehicle Guidance- Operating principles and design of guidance laws, Homing guidance laws- short range, Medium range and BVR missiles, Launch Vehicle-Introduction, Mission requirements, Implicit guidance schemes, Explicit guidance, Q guidance schemes

Text Books

1. Ching-Fang Lin (1991) Modern Navigation, Guidance and Control Processing, Prentice Hall Inc., Englewood Cliffs, New Jersey.

Reference Books

1. George, M.S. (1993) Aerospace Avionics System - A Modern Synthesis, Academic Press Inc.
2. Kaplan M. (1976), Modern Space Craft Dynamics and Control, Wiley.
3. Garnele, P. (1980) Guided Weapon Control Systems, Pergamon.
4. Blaklock J. H. (1990) ‘Automatic Control of Aircraft and Missiles, Wiley.
5. Skolnik R. E. (1982) Introduction to Radar Systems, McGraw Hill.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	**IA**	**ESE**
Weightage (%)	50	50

Relationship between the Program Outcomes (POs), Program Specific Outcomes (PSOs) and Course Outcomes (COs)

PO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2
CO1	3	2	2	3	2	0	0	0	1	0	0	1	2
CO2	3	1	2	1	2	0	0	0	1	0	0	1	3
CO3	2	2	2	1	1	0	0	0	1	0	0	1	2
CO4	2	2	1	2	1	0	0	0	1	0	0	1	3
Averag e	2.5	1.7 5	1.7 5	1.7 5	1.5	0	0	0	1	0	0	1	2.5

1 = WEEK 2 = MODERATE 3 = STRONG

AVEG 8004	Remote Sensing and Surveillance	L	T	P	C
Version 1.0		3	0	0	3
Pre-requisites/Exposure	EMW Propagation Principles, Basic sensors				
Co-requisites	--				

Course Objectives

1. To provide exposure to students in gaining knowledge on concepts and applications leading to modelling of earth resources management using Remote Sensing
2. To acquire skills in storing, managing digital data for planning and development.
3. To acquire skills in advance techniques such as hyper spectral, thermal and LiDAR Scanning for mapping, modelling and monitoring.

Course Outcomes

On completion of this course, the students will be able to

CO1. Fully equipped with concepts, methodologies and applications of Remote Sensing Technology.
CO2. Understand the concept of Earth feature remote sensing.
CO3. Acquire skills in handling instruments, tools, techniques and modelling while using Remote Sensing Technology.
CO4. It empowers the candidate to apply the remote sensing knowledge in surveillance.

Catalog Description

This course emphasizes basic remote sensing concepts and aerial photographic data collection and analysis. The Remote Sensing Fundamentals course is focused on understanding the basic principles on which remote sensing is based in general, and how aerial photographic data are acquired and analyzed in particular. Included is treatment of: electromagnetic radiation principles; energy interaction with the atmosphere and earth surface features; analog vs. digital imagery; ground truth considerations; films, analog and digital cameras; basic principles of photogrammetry; mapping from aerial photographs and digital orthophoto production; and an introduction to aerial photographic interpretation.

Course Content

Unit I: **09 lecture hours**
Introduction of Remote Sensing, Electro Magnetic Spectrum, Physics of Remote Sensing, Effects of Atmosphere, Scattering, Different types, Absorption-Atmospheric window.

Unit II: **09 lecture hours**
Energy interaction with surface features, Spectral reflectance of vegetation, soil, and water, atmospheric influence on spectral response patterns- multi concept in Remote sensing.

Unit III: **09 lecture hours**
Surveillance for Resource mapping, monitoring and management, Preparation of thematic layers, Integration of all relevant primary and secondary data using GIS in Surface and groundwater studies

Unit IV: **09 lecture hours**
Engineering Geology, Mineral exploration and Petroleum exploration – Disaster Management studies like Droughts, Floods-Case studies.

Text Books

1. Cracknell, A.P. (1991) Introduction to Remote Sensing, (2nd Ed.), Tylor & Francis, London.

Reference Books

1. James B. Campbell and Randolph H. Wynne (2012) Introduction to Remote Sensing, (5th Ed.), The Guildford Press, New York.
2. Lillesand, T.M., Kiefer, R.W. and Chapman, J.W. (2007) Remote Sensing and Image Interpretation by (5th Ed.), John Wiley & Sons.
3. Gupta, R. P. (2003) Remote Sensing Geology 2nd Ed., Springer.
4. Drury, S. A. (1993) Image Interpretation in Geology, 2nd Ed, Allen & Unwin.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	**IA**	**ESE**
Weightage (%)	50	50

Relationship between the Program Outcomes (POs), Program Specific Outcomes (PSOs) and Course Outcomes (COs)

PO/CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2
CO1	2	2	2	1	2	0	0	0	1	0	0	2	3
CO2	3	3	2	1	0	0	0	0	1	0	0	2	3
CO3	3	3	2	1	2	0	0	0	1	0	0	2	3
CO4	3	2	2	1	1	0	0	0	1	0	0	1	3
Average	2.8	2.75	2	1	1.67	0	0	0	1	0	0	1.75	3

1 = WEEK 2 = MODERATE 3 = STRONG

AVEG 8005	**Digital Image Processing**	L	T	P	C
Version 1.0		3	0	0	3
Pre-requisites/Exposure	Basic Electronics, Digital Electronics, Mathematical Morphology				
Co-requisites	--				

Course Objectives

1. To provide an introduction to basic concepts and methodologies for digital image processing.
2. To develop a foundation that can be used as the basis for further study and research in this field.
3. To expose students to current applications in the field of digital image processing.

Course Outcomes

On completion of this course, the students will be able to

CO1: To analyze a scene and understand the objectives of each stage.

CO2: To apply the basics of mathematical morphology on various images.

CO3: To analyze the ability of human visual system with perceptual characteristics and pattern discrimination ability.

CO4: To understand the geometric model and photometric model.

CO5: To convert analog images to the digital images suitable for processing by digital computers and improve the quality of image by image enhancement techniques.

Catalog Description

This course is focused on the fundamentals whose scope is not limited to the solution of specialized problems. The mathematical complexity of the course remains at a level well within the grasp of postgraduate students who have introductory preparation in mathematical analysis, vectors, matrices, probability statistics, linear systems and computer programming.

Course Content

Unit I: **05 lecture hours**

Motivation and Perspective, Scenes and Images, Applications, Components of Image processing, image sensors, image file formats, digitizer, processor, display unit, Image Acquisition and sampling, Images and digital images, Some applications, Aspects of image processing, Vector Algebra, Linear Operations, Orthogonal Transforms, Electro Magnetic Spectrum

Unit II: **06 lecture hours**

Types of digital images Image File Sizes, Image perception, Greyscale images, RGB Images, Indexed colour images Data types and conversions, Basics of image display, The Imshow function, Bit planes Spatial Resolution, Arithmetic operations, Elements of Visual Perception, Image sensing and Acquisition, Image Sampling and Quantization, Some basic Relationship between pixels, An introduction to mathematical tools used in Image Processing

Unit III: **07 lecture hours**

Basic Intensity transformation functions, Histogram Processing (Histogram Equalization, Histogram Matching, Local Histogram Processing, Using Histogram Statistics for Image Enhancement), Fundamentals of spatial filtering (Mechanics of spatial Filtering, Spatial Correlation and Convolution, Vector Representation of Linear Filtering, Generating Spatial Filter Mark),

Unit IV: **08 lecture hours**

Smoothing Spatial Filters (Ideal Low Pass Filters, Butterworth Low Pass Filter, Gaussian Low Pass filter, Additional Examples of Low Pass Filtering), Sharpening Spatial Filters (Ideal High Pass Filters, Butterworth High Pass Filter, Gaussian High Pass filter, Laplacian in frequency domain, Unsharp Masking, High Boost Filtering, Homo Morphic Filtering).

Unit V: **06 lecture hours**

Properties of Noise, Mean Filters, Order Static Filters, Adaptive Filters, Band Reject Filter, Band Pass Filter, Notch Filter, Optimum Notch Filtering, Estimation by Image Observation, Estimation by Experimentation, Estimation by Modelling

Unit VI: **04 lecture hours**

Introduction to Image reconstruction from Projections, Principals of computed tomography, Projections and the Random Transform, The Fourier Slice Theorem

Text Books

1. Rafael C. Gonzalez, Richard E. Woods, “Digital Image Processing” Third Edition, Pearson

Reference Books

1. B. Chanda , D. Dutta Majumdar, “Digital Image Processing and Analysis” second edition, PHI Learning Private Limited, 2013
2. An Introduction to Digital Image Processing with MATLAB by Alasdair MacAndrew. (download from www.ino.it/home/mazzeo/downloads/)

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	**IA**	**ESE**
Weightage (%)	50	50

Relationship between the Program Outcomes (POs), Program Specific Outcomes (PSOs) and Course Outcomes (COs)

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	1	1	2	3	3	0	0	0	0	0	0	2	2
CO2	1	3	3	3	3	0	0	0	0	0	0	2	2
CO3	2	3	3	3	3	0	0	0	0	0	0	1	1
CO4	3	3	3	3	3	0	0	0	0	1	0	1	2
CO5	3	3	3	3	3	0	0	0	0	0	0	0	0
Avg	2	2.6	2.8	3	3	0	0	0	0	1	0	1.5	1.75

1 = WEEK 2 = MODERATE 3 = STRONG