SCHEME OF EXAMINATION
B.TECH. 4th Year Aeronautical Engineering -8th Semester

Course No.	Course Title	Teaching Schedule				Examination schedule			Total Marks	Duration of Exam
		L	T	P/D	Total	Theory	Sessional	Practical/ Viva		
----------	Department Elective -III	3	1	-	4	100	50	-	150	3
----------	Department Elective -IV	3	2	-	5	100	50	-	150	3
ARE-402E	Computational Fluid Dynamics	3	1	-	4	100	50	-	150	3
ARE-404E	Air Transportation and Aircraft Maintenance Management	3	1	-	4	100	50	-	150	3
ARE-406E	Rockets and Missiles	4	2	-	6	100	50	-	150	3
ARE-408E	Major Project	-	-	4	4	-	100	100	200	-
ARE-410E	Seminar		-	2	2	-	25	-	25	-
ARE-412E	Comprehensive Viva Voce	-	-	-	-	-	75	-	75	-
	TOTAL	16	7	6	29	500	450	100	1050	-

DEPARTMENT ELECTIVE-III

ARE-414E	Space Dynamics
ARE-416E	Modern Manufacturing Processes
ARE-418E	Boundary Layer Theory

DEPARTMENT ELECTIVE-IV

ARE-420E	Principles of Environmental Science and Engineering
ARE - 422 E	Management Information System
ARE-424E	Control Theory & Practice

B. Tech. (Eighth Semester) Aeronautical Engineering

Computational Fluid Dynamics

ARE -402 E

L	T	P
3	1	-

Sessional	:	50 Marks
Theory	:	100 Marks
Total	:	150 Marks
Duration of Exam.	:	3 Hrs.

NOTE: In the semester examination, the paper setter will set 8 questions in all, at least two questions from each unit, and students will be required to attempt only 5 questions, selecting at least one from each unit.

UNIT I

Methods of prediction: comparison of experimental investigation Vs theoretical calculation; Mathematical description of physical phenomena; significance of governing differential equations; the general form of governing differential equation. Classification of problems: Physical classification: Equilibrium problems and Marching problems; Mathematical classification: Elliptic, parabolic and hyperbolic partial differential equations; Nature of co-ordinates; one way and two-way co-ordinates; Proper choice of co-ordinates.

UNIT II

The concept of discretisation; Finite differences; Taylor series formulation; Finite difference discretisation of ordinary and partial derivatives; Truncation error, round-off error, discretisation error; Consistency and stability of numerical schemes; Variation formulation; Method of weighted Residuals, control volume formulation.

UNIT III

Steady one- dimensional Conduction, The inter-face conductivity, Non linearity, Source-Term Linearization, Types of Boundary Conditions. Unsteady one-dimensional Conduction: Explicit, Crank-Nicolson and Fully Implicit scheme's Discretisation of two and threedimensional problems, Stability analysis.

UNIT IV

Steady one dimensional convection and diffusion, The up wind scheme, Generalized Formulation, Discretisation equation for two and three dimensional problems, The outflow Boundary condition, false Diffusion. Basic difficulty, Vorticity Based methods, Representation of the continuity

equation, the staggered grid: the momentum equations, the pressure velocity corrections, and SIMPLE algorithm.

Text Books:

1. Computational Fluid Dynamics - By Anderson, McGraw-Hill
2. Numerical Heat Transfer and fluid flow- By Patankar, McGraw-Hill

B. Tech. (Eighth Semester) Aeronautical Engineering

Air Transportation and Aircraft Maintenance Management

ARE-404E

L	T	P
3	1	

Sessional	: 50 Marks
Theory	: 100 Marks
Total	: 150 Marks
Duration of Exam: 3 Hrs.	

NOTE: In the semester examination, the paper setter will set 8 questions in all, at least two questions from each unit, and students will be required to attempt only 5 questions, selecting at least one from each unit.

UNIT -I

Development of air transporation, comparison with other modes of transport - Role of IATA, ICAO – The general aviation industry airline - Factors affecting general aviation, use of aircraft, airport: airline management and organisation - levels of management, functions of management, Principles of organisation planning the organisation - chart, staff departments & line departments.

UNIT -II

Forecasting - Fleet size, Fleet planning, the aircraft selection process, operating cost, passenger capacity, load factor etc. - Passenger fare and traiffs - Infuence of geographical, economic & political factors on routes and route selection.

UNIT -III

FLEET PLANNING: The aircraft selection process - Fleet commonality, factors affecting choice of fleet, route selection and Capitol acquisition - Valuation & Depreciation - Budgeting, Cost planning - Aircrew evaluation - Route analysis - Aircraft evaluation.

Equipment maintenance, Flight operations and crew scheduling, Ground operations and facility limitations equipments and types of schedule - hub & spoke scheduling, advantages / disadvantages & preparing flight plans Aircraft scheduling in line with aircraft maintenance practices.Aircraft reliability - The maintenance schedule & its determinations - Condition monitoring maintenance - Extended range operations (EROPS) & ETOPS - Ageing aircraft maintenance production.

UNIT -IV

Airlines scheduling (with reference to engineering) - Product support and spares - Maintenance sharing - Equipments and tools for aircraft maintenance - Aircraft weight control - Budgetary control. On board maintenance systems - Engine monitoring - Turbine engine oil maintenance - Turbine engine vibration monitoring in aircraft - Life usage monitoring - Current capabilities of NDT - Helicopter maintenance - Future of aircraft maintenance.

Text Books:

1. Fedric J.H., " Airport Management ", English Book House, New Delhi-I.

2. Gene Krope, " Airline Procedures ", English Book House, New Delhi-I.

3. Wilson & Bryon, " Air Transportation ", English Book House, New Delhi-I.

4. Philip Lockin D, " Economics of Transporation ", English Book House, New Delhi-I.

5. " Indian Aircraft manual ", Published by DGGA, English Book House, New Delhi-I.

6. Alexander T Wells, " Air Transporation ", Wadsworth Publishing Company, California, 1993.

7. C.H. Friend, " Aircraft Maintenance Management ", English Book House, New Delhi.

B. Tech. (Eighth Semester) Aeronautical Engineering

Rockets and Missiles

ARE-406E

L	T	P
4	2	

Sessional : 50Marks
Theory : 100 Marks
Total : 150 Marks
Duration of Exam: 3 Hrs.

NOTE: In the semester examination, the paper setter will set 8 questions in all, at least two questions from each unit, and students will be required to attempt only 5 questions, selecting at least one from each unit.

UNIT-1

1. Classification of Rockets and Missiles-Differences-Uses-Advantages and Disadvantages.

Ignition system in Rockets - Types of igniters - Igniter design considerations – Design consideration of liquid rocket combustion chamber, injector propellant feed lines, valves, Propellant tanks outlet and helium Pressurized and turbine feed systems - Propellant slosh and propellant hammer - Elimination of geysering effect in missiles .

2. Combustion system of solid rockets.
Airframe components of rockets and missiles - Forces acting on a missile while passing through atmosphere -
- Method of describing aerodynamic forces and moments - Lateral aerodynamic moment - Lateral Damping moment and longitudinal moment of a rocket - Lift and drag forces – Drag

UNIT-1I

3. Estimation - body up wash and downwash in missiles - rocket dispersion – Numerical problems. One dimensional and two dimensional rocket motions in free space and homogeneous gravitational fields - Description of vertical, inclined and gravity turn trajectories - Determination of range and altitude Simple

4. Approximations to burnout velocity:-
Rocket vector control - Methods - Thrust termination - SITVC - Multistage of rockets – Vehicle optimization - Stage separation dynamics - Separation techniques.

UNIT-1II

5. Selection of materials - Special requirements of materials to perform under adverse conditions.

6. Solid Rocket Motors: General description, interior ballistics component design Techniques.

UNIT-1V

7. Liquid Rocket Engines: General description, engine cycles, power balance calculation , component design fundamentals.

8. Electric Propulsion : Classification of electric propulsion systems.

9. Trajectory Analysis : The rocket equation , vertical trajectories, multistage rockets, generalized 2D trajectory.

Text Books:

1. Sutton, G.P., et al., " Rocket Propulsion Elements " John Wiley & Sons Inc., NewYork, 1993.
2. Mathur, M., and Sharma, R.P., " Gas Turbines and Jet and Rocket Propulsion ", Standard Publishers, New Delhi, 1998.

References:

1. Cornelisse, J.W.., " Rocket Propulsion and Space Dynamics ", J.W., Freeman & Co., Ltd., London, 1982.
2. Parket, E.R., " Materials for Missiles and Spacecraft ", McGraw Hill Book Co., Inc., 1982

B. Tech. (Eight Semester) Aeronautical Engineering
Major Project
ARE 408 E

P/D	Total
4	4

Practical Viva : 100 Marks
Sessional : 100 Marks
Total : 200 Marks
Duration of Exams. : 03 hours

The students expected to take up a project under the guidance of teacher from the college. The project must be based on mechanical engineering problems, which can be extended up to the full academic session. The students may be asked to work individually or in a group not more than four students in a group. Viva- voce must be based on the preliminary report submitted by students related to the project.

B. Tech. (Eighth Semester) Aeronautical Engineering
Seminar
ARE 410 E

P/D	Total	
2	2	**Sessional: 25 marks**

Student will give a talk on some technical topics.

Note: The seminar will continue in eighth semester and will be evaluated in eighth semester.

Electives III and IV Eighth Semester
(Aeronautical Engineering)

ELECTIVE – III
(For Aeronautical Engineering Students)

DEPARTMENT ELECTIVE-III

ARE-414E	Space Dynamics
ARE-416E	Modern Manufacturing Processes
ARE-418E	Boundary Layer Theory

DEPARTMENT ELECTIVE-IV

ARE-420E	Principles of Environmental Science and Engineering
ARE - 422 E	Management Information System
ARE-424E	Control Theory & Practice

Elective - III & IV will be offered as departmental elective for Aeronautical Engineering Students.

DEPARTMENT ELECTIVE-III

B. Tech. (Eighth Semester) Aeronautical Engineering

Space Dynamics

ARE-414E

L	T	P
3	1	-

Sessional	:	50 Marks
Theory	:	100 Marks
Total	:	150 Marks
Duration of Exam.	:	3 Hrs.

NOTE: In the semester examination, the paper setter will set 8 questions in all, at least two questions from each unit, and students will be required to attempt only 5 questions, selecting at least one from each unit.

UNIT- I

INTRODUCTION

Initial works in Germany for space travel.russian and American campaigns, man in space, profile of flight from earth to a destination in space and back. The space shuttle.

PARTICLE DYNAMICS

Introduction, Newton's laws, velocity and acceleration, coordinates and rotation, the spherical pendulum, energy for one particle, angular momentum, energy for systems of particles, angular momentum , the N-body problem.

UNIT-II

THE TWO–BODY PROBLEM

Introduction , the two body problem, energy and angular momentum, orbit equation, Kepler's laws, orbit determination and satellite tracking.

THE EARTH SATELLITE OPERATIONS

The Hohmann transfer, inclination-change maneuver, launch to rendezvous, decay life time, earth oblations effect

UNIT-III

RIGID BODY DYNAMICS Introduction, choice of origin, angular momentum and energy, principal-body-axis frame, particle axis theorem, Euler's equations, Orientational angle, the simple Top.

SATELLITE ATTITUDE DYNAMICS

Torque –Free-axisymmetric Rigid body, The general torque free rigid body, semi-rigid space craft, attitude control: Spinning and Non spinning space craft. The Yo-Yo mechanism, gravity gradient satellite, the dual spin spacecraft.

UNIT-IV

RE-ENTRY

Introduction, ballistic re-entry, skip re-entry, double dip re-entry, Aero braking, lifting re-entry.

THE SPACE ENVIRONMENT

Introduction, The atmosphere, Light and space craft temperature, charged particle motion, magnetic mirrors, The van-atten Belts, radiation effects, Meteors, Meteorites and impact. Our local neighborhood

BOOK:

1. Space Flight Dynamics : William E. Wiesel , Mcgraw Hill 1989

B. Tech. (Eighth Semester) Aeronautical Engineering

Modern Manufacturing Processes

ARE-416E

L	T	P
3	1	-

Sessional	:	50 Marks
Theory	:	100 Marks
Total	:	150 Marks
Duration of Exam.	:	3 Hrs.

NOTE: In the semester examination, the paper setter will set 8 questions in all, at least two questions from each unit, and students will be required to attempt only 5 questions, selecting at least one from each unit.

UNIT- I

Mechanical Processes: Ultrasonic Machining- Elements of process, cutting tool system design, effect of parameters, economic considerations, applications, limitations of the process, advantages and disadvantages. Abrasive Jet Machining- Variables in AJM, metal removal rate in AJM. Water Jet Machining- Jet cutting equipments, process details, advantages and applications.

UNIT- II

Electrochemical and Chemical Metal Removal Processes: Electrochemical Machining- Elements of ECM process, tool work gap, chemistry of the process, metal removal rate, accuracy, surface finish and other work material characteristics, economics, advantages, applications, limitations. Electrochemical Grinding - Material removal, surface finish, accuracy, advantages, applications.

UNIT- III

Thermal Metal Removal Processes: Electric Discharge Machining (EDM) or spark erosion machining processes, mechanism of metal removal, spark erosion generators, electrode feed control, dielectric fluids, flushing, electrodes for spark erosion, selection of electrode material, tool electrode design, surface finish, machining accuracy, machine tool selection, applications. Wire cut EDM. Laser beam machining (LBM)- Apparatus, material removal, cutting speed and accuracy of cut, metallurgical effects, advantages and limitations.

UNIT- IV

Plasma Arc Machining (PAM): Plasma, non thermal generation of plasma, mechanism of metal removal, PAM parameters, equipments for D.C. plasma torch unit, safety precautions, economics, other applications of plasma jets. Electron Beam Machining (EBM) - Generation and control of electron beam, theory of electron beam machining, process capabilities and limitations.

Text Books:
1. Modern Machining Processes – P.C.Pandey, H.S.Shan, Tata McGraw Hill
2. Machining Science- Ghosh and Malik, Affiliated East-West Press

References:
1. Non Traditional Manufacturing Processes- Benedict G.F, Marcel Dekker
2. Advanced Methods of Machining- Mc Geongh J.A, Chapman and Hall

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B. Tech. (Eighth Semester) Aeronautical Engineering

Boundary Layer Theory

ARE-418E

L	T	P
3	1	-

Sessional	:	50 Marks
Theory	:	100 Marks
Total	:	150 Marks
Duration of Exam.	:	3 Hrs.

NOTE: In the semester examination, the paper setter will set 8 questions in all, at least two questions from each unit, and students will be required to attempt only 5 questions, selecting at least one from each unit.

UNIT-I

BASICS

Basic laws of fluid flow- Continuity, momentum and energy equations as applied to system and control volume –Concept of flow fields- Viscous fluid flow with historical out lines of viscous flow, Boundary conditions for viscous flow problems, Development of boundary layer- Prandtl's hypothesis, Estimation of boundary layer thickness- Displacement thickness, momentum and energy thickness for two-dimensional flows. Viscosity and thermal conductivity, thermodynamic properties.

UNIT-II

DERIVATION OF THE NAVIER-STOKES EQUATIONS

General stress system in a deformable body, the rate at which the fluid element is strained in a flow, Relation between stress and rate of deformation, Stoke's hypothesis, bulk viscosity and thermodynamic properties, The Navier – Stokes Equation (N-S) –General properties of Navier – Stokes Equation.

SOLUTIONS OF THE NAVIER-STOKES EQUATIONS

Two dimensional flow through a straight channel. Hagen- Poiseulle flow, Suddenly accelerated plane wall, Stagnation in plane flow (Hiemenz problem), Flow near a rotating disk, Very slow motion, Parallel flow past a sphere.

UNIT-III

LAMINAR BOUNDARY LAYER

Analysis of flow past a flat plate and a cylinder, Integral relation of Karman, Integral analysis of energy equation, Laminar boundary layer equations, Flow separation. Similarity solutions for steady two dimensional flows; Blasius solution for flat- plate flow, Boundary layer temperature profiles for constant wall temperature, Falkner-Skan Wedge flows, Free shear flows- plane laminar jet, plane laminar wake. Integral equation of Boundary layer, Karman-Pohlhausen method.Digital computer solutions. Thermal boundary layer calculations- One parameter (Uo) and two parameters (U0 and □T) integral methods. Stability of laminar flows.

UNIT-IV

TURBULENT BOUNDARY LAYER:
Two dimensional turbulent boundary layer equations, Integral relations, Eddy-Viscosity theories, Velocity profiles; The law of the wall, The law of the wake. Turbulent flow in pipes and channels.- Turbulent boundary layer on a flat pate, Boundary layers with pressure gradient.

COMPRESSIBLE BOUNDARY LAYER FLOWS
Introduction to the compressible boundary layer on a flat plate, shock wave boundary layer interaction.

Text Books:
1. Viscous Fluid Flow 3rd Ed. Frank M White McGraw Hill 2006
2. Boundary Layer theory 6th Ed. H. Schlichting McGraw Hill 1968

REFERENCES:
1 Aerodynamics for Engineers 4th Ed. John Bertin Pearson 2004

DEPARTMENT ELECTIVE-IV

B. Tech. (Eighth Semester) Aeronautical Engineering

Principles of Environmental Science and Engineering

ARE 420 E

L	T	P
3	2	-

Sessional	:	50 Marks
Theory	:	100 Marks
Total	:	150 Marks
Duration of Exam.	:	3 Hrs.

NOTE: In the semester examination, the paper setter will set 8 questions in all, at least two questions from each unit, and students will be required to attempt only 5 questions, selecting at least one from each unit.

UNIT-I

INTRODUCTION TO ENVIRONMENTAL STUDIES AND NATURAL RESOURCES

Definition, scope and importance – need for public awareness – forest resources: use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their ground water, floods, drought, conflicts over water, dams-benefits and problems – mineral resources: use effects on forests and tribal people – water resources: use and over-utilization of surface and exploitation, environmental effects of extracting and using mineral resources, case studies – food resources: world food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – energy resources: growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. Case_studies – land resources: land as a resource, land degradation, man induced landslides, soil erosion and desertification – role of an individual in conservation of natural resources – equitable use of resources for sustainable lifestyles.

UNIT-II

ECOSYSTEMS AND BIODIVERSITY

Concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers – energy flow in the ecosystem – ecological succession – food chains, food webs and ecological pyramids – introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – introduction to biodiversity – definition: genetic, species and ecosystem diversity – biogeographical classification of India – value of biodiversity:

consumptive use, productive use, social, ethical, aesthetic and option values – biodiversity at global, national and local levels – India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: in-situ and ex-situ conservation of biodiversity.

UNIT-III

ENVIRONMENTAL POLLUTION

Definition – causes, effects and control measures of: (a) air pollution (b) water pollution (c) soil pollution (d) marine pollution (e) noise pollution (f) thermal pollution (g) nuclear hazards – solid waste management: causes, effects and control measures of urban and industrial wastes – role of an individual in prevention of pollution – pollution case studies – disaster management: floods, earthquake, cyclone and landslides. Field study of local polluted site – urban / rural / industrial / agricultural

UNIT-IV

SOCIAL ISSUES AND THE ENVIRONMENT

From unsustainable to sustainable development – urban problems related to energy – water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns, case studies – environmental ethics: issues and possible solutions – climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies – wasteland reclamation – consumerism and waste products – environment protection act – air (prevention and control of pollution) act – water (prevention and control of pollution) act – wildlife protection act – forest conservation act – issues involved in enforcement of environmental legislation – public awareness

Text Books:-

1. Gilbert M.Masters, "Introduction to Environmental Engineering and Science", pearson education Pvt., Ltd., second edition, ISBN 81-297-0277-0, 2004.
2. Miller T.G. jr., "Environmental Science", Wadsworth publishing co.
3. Townsend C., Harper J and Michael Begon, "Essentials of Ecology", Blackwell science.
4. Trivedi R.K. and P.K. Goel, "Introduction to air pollution", techno-science publications.
5. Bharucha erach, "The Biodiversity of India", mapin publishing Pvt. Ltd., Ahmedabad India,
6. Trivedi R.K., "Handbook of Environmental Laws", Rules, Guidelines, Compliances and Standards, Vol. I and II, Enviro media.
7. Cunningham, W.P.Cooper, T.H.Gorhani, "Environmental Encyclopedia", Jaico Publ., House, Mumbai, 2001.

8. Wager K.D., "Environmental Management", W.B. Saunders Co., Philadelphia, USA, 1998

B. Tech. (Eighth Semester) Aeronautical Engineering

Management Information System
ARE 422 E

L	T	P			
			Sessional	:	50 Marks
3	2	-	Theory	:	100 Marks
			Total	:	150 Marks
			Duration of Exam.	:	3 Hrs.

NOTE: In the semester examination, the paper setter will set 8 questions in all, at least two questions from each unit, and students will be required to attempt only 5 questions, selecting at least one from each unit.

UNIT I

What is MIS? Decision support systems, systems approach, the systems view of business, MIS, MIS organization within the company management organizational theory and the systems approach. Development of organizational theory, management and organizational behavior, management information and the system approach. Evolution of an information systems, basic information systems, decision making and MIS, MIS as a technique for making programmed decision assisting information systems (r) strategic and project planning for MIS : General business planning, appropriate MIS Planning-general, MIS planning -details.

UNIT II

Define the problems, set system objectives, establish system constraints, determine information needs, determine information sources, develop alternative conceptual; designs and select one document the system concept, prepare the conceptual ;design report.

UNIT III

Inform and involve the organization, aim of detailed design, project management of MIS detailed design, identify dominant and trade off criteria, define the subsystems, Sketch the detailed operating subsystems and information flow. Determine the degree of automation of each operation, inform and involve the organization again, inputs, and processing, early system testing, software, hardware and tools, propose an organization to operate the system, document the detailed design, revisit the manager -user.

UNIT IV

Plan the Implementation , acquire floor space and plan space layouts, organize for implementation, develop, procedures for implementation, train (ho operating personnel, computer related acquisitions, develop forms for data collection and information dissemination, develop the files, test the system, cutover, document the system, evaluate the MIS control and maintain the

system (r). Pitfalls in MIS development: Fundamental weakness, soft spots in planning, design problems, implementation: The TARPIT.

Text Books:

1. Management Information system by W.S. JawadeKar - Tata McGraw Hill.

B. Tech. (Eighth Semester) Aeronautical Engineering

Control Theory & Practice

ARE-424E

L	T	P
3	2	-

Sessional	:	50 Marks
Theory	:	100 Marks
Total	:	150 Marks
Duration of Exam.	:	3 Hrs.

NOTE: In the semester examination, the paper setter will set 8 questions in all, at least two questions from each unit, and students will be required to attempt only 5 questions, selecting at least one from each unit.

UNIT-I

Introduction to Laplace transform, Fourier transforms, Definition of feedback terms, symbols to represent feedback control variables, characteristics of basic feedback loop.

UNIT-II

Introduction to dynamics of stable and unstable vehicles. Definition of Aerodynamic coefficients, force and moment equations, definition of relaxed static stability , CCV concept in modern flight control system. .

UNIT-III

Models of Components and Systems : Its variables and equations, modeling of passive electrical components and systems, static and dynamic variables, modeling of DC motors and servo systems, transducer, sensors and actuators, transport delay.
Frequency response analysis :

a) Open loop and closed loop poles and zeros
b) Nyquist diagram
c) Nyquist stability criterion
d) Stability margins, illustration of phase margin and gain margins

The BODE magnitude plot: Studies on BODE phase plot, stability margins on the BODE plot, Time delay effects. The root locus method: the locus equations, properties and sketching rules, loci for systems.

UNIT-IV

Time Response: Steady state error, transient response to a input, performance measures. System design: (a) Signal conversion and processing: Digital signals and coding, data conversions and quatization sample and hold devices, digital to analog conversion, analog to digital conversion, the sampling theorem, reconstruction of sampled signals. (b)Compensation networks, system effects of offset and noise. (c) Servo components: Synchros, Sensors, actuators, computers (d) Electronic design aspects: rating, time delays, reasonable values, etc. proportional controller, proportional integral controller, proportional integral differential controller (PID) The Z-Transform: (a) Definition of Z Transform (b) Evaluation of Z Transform (c) Mappling between s-plane and the z-plane (d) the inverse Z transform (e) Theorems of Z transform. The State Variable Technique : (a) State equations and state transition equations of continuous data system (b) State transition equations of digital systems (c) Relation between state equation and transfer function (d) Characteristic equation, eigen values and eigen vectors (e) Diagonalisation of A matrix (f) Methods of computing the state transition of A matrix. Stability of digital control system, time domain analysis, frequency domain analysis.

Text Books:

1. Katsuhiko Ogata, Modern Control Engineering, Prentice Hall of India
2. Robert C Nelson, Flight Stability and Automatic Control, McGrawHill, New York.
3. B Etkin, Dynamics of Aircraft, McGraw Hill, New York

References:

1. Duglas B Miron, Design of Feed Back Systems, Harcourt Brace Jovanovic Publications, and NY
2. Benjamin C Kuo, Digital Control Systems
3. Mc Ruer, Ashkenaus and Graham, Aircraft Dynamics and Controls, Prinston Univ.Press, NJ