SEMESTER-VI

MATS UNIVERSITY, RAIPUR (C.G.)
SCHOOL OF ENGINEERING & I.T.

Semester: VI B.Tech Branch: Aeronautical
Subject: Aircraft Stability and Control Code: BT 650
Total Theory Periods: 48 Total Tutorial Periods: 00 Total Credits: 04

OBJECTIVES:
To make the students understand the static and dynamic longitudinal, lateral, directional stability and its control methods.

UNIT-I GENERAL
Degrees of freedom of a system, Static and dynamic stability Need for stability in an airplane, purpose of controls, inherently and marginally stable airplanes.

UNIT-II STATIC LONGITUDINAL STABILITY
Stick fixed: Basic equations of equilibrium, Stability criterion, Wing and tail moments, Effect of fuselage and nacelles, Effect of C.G. location, Power effects, Stabiliser setting and C.G. location, Elevator effects, stick fixed neutral point. Stick free: Hinge moment coefficients, Stick free neutral point symmetric maneuvers, stick force gradients and stick force per cg. Aerodynamic balancing of control surfaces.

UNIT-III STATIC LATERAL STABILITY AND STATIC DIRECTIONAL STABILITY
Dihedral effect, coupling between rolling moment and yawing moment, Adverse yaw, Aileron power, Aileron reversal. Weather cocking effect, rudder requirements. One engine inoperative conditions, rudder lock.

UNIT-IV DYNAMIC LONGITUDINAL STABILITY
Equation of motion, Stability derivatives, Routh's discriminant, solving the stability quadratic, Phugoid motion, factors affecting the period and damping.

UNIT-V DYNAMIC LATERAL AND DIRECTION STABILITY
Dutch roll and spiral instability Auto rotation and spin, two control airplane.

OUTCOMES:
Students will be able to understand the static and dynamic longitudinal, lateral, directional stability and its control methods.

TEXT BOOKS
1. Perkins, C.D., and Hage, R.E., "Airplane Performance stability and Control", John Wiley & Son, Inc, New York, 1988.

REFERENCES
1. Etkin, B., "Dynamics of Flight Stability and Control", Edn. 2, John Wiley, New York, 1982.
2. Babister, A.W., "Aircraft Dynamic Stability and Response", Pergamon Press, Oxford, 1980.
3. Dommasch, D.O., Shelby, S.S., and Connolly, T.F., "Aeroplane Aero dynamics", Third Edition, Issac Pitman, London, 1981.
4. Clancy, L.J., "Aerodynamics", Pitman, 1986
5. Nelson, R.C. "Flight Stability and Automatic Control", McGraw-Hill Book Co., 1998.

MATS UNIVERSITY, RAIPUR (C.G.)
SCHOOL OF ENGINEERING & I.T.

Semester: VI B.Tech | Branch: Aeronautical
Subject: Propulsion-II | Code: BT 651
Total Theory Periods: 48 | Total Tutorial Periods: 00 | Total Credits: 04

OBJECTIVES:
To impart knowledge in non air-breathing and hypersonic propulsion methods to students so that they are familiar with various propulsion technologies associated with space launch vehicles, missiles and space probes.

UNIT-I NOZZLES FOR JET ENGINES
Real flow in nozzles and nozzle efficiency – losses in nozzles – equilibrium flow and frozen flow in nozzles- two phase flow in nozzles – Ejector and variable area nozzles- Interaction of nozzle flow with adjacent surfaces – thrust reversal.

UNIT-II RAMJET PROPULSION
Operating principle of ramjet engine– various components of ramjet engines and their efficiencies – Combustion in ramjet engine – critical, subcritical and supercritical modes of operation - ramjet engine and its performance characteristics – sample ramjet design calculations – flame stability problems in ramjet combustors –integral ram rockets.

UNIT-III HYPERSONIC AIR BREATHING PROPULSION
Introduction to hypersonic air breathing propulsion, hypersonic vehicles and supersonic combustion- need for supersonic combustion for hypersonic propulsion –salient features of scramjet engine and its applications for hypersonic vehicles–problems associated with supersonic combustion – engine/airframe integrationaspects of hypersonic vehicles –various types scramjet combustors–fuel injection schemes in scramjet combustors–one dimensional models for supersonic combustion using method of influence coefficients.

UNIT-IV CHEMICAL ROCKET PROPULSION
Operating principle – specific impulse of a rocket – internal ballistics – rocket performance considerations – solid propellant rockets – selection criteria of solidpropellants – propellant grain design considerations – erosive burning in solid rockets– liquid propellant rockets – selection of liquid propellants–various feed systems for liquid rockets-thrust control in liquid rockets–cooling in liquid rockets and theassociated heat transfer problems – advantages of liquid rockets over solid rockets-introduction to hybrid propulsion –advantages and limitations of hybrid propulsion -static testing of rockets and safety considerations.

UNIT-V ADVANCED PROPULSION TECHNIQUES
Introduction to nozzle less propulsion and basic concepts - Electric rocket propulsion – Ion propulsion – Nuclear rocket – comparison of performance of these propulsionsystems with chemical rocket propulsion systems - Solar sail.

OUTCOMES:
- Understanding various propulsion systems
- Knowledge in rocket propulsion systems
- Knowing the applications and principles of liquid and solid-liquid propulsion systems
- Application of nuclear propulsion in rocketry.

TEXT BOOKS:
1. Sutton, G.P., “Rocket Propulsion Elements”, John Wiley & Sons Inc., New York, 5th Edition, 1993.

2. Mathur, M.L., & Sharma, R.P., “Gas Turbine, Jet & Rocket Propulsion”, Standard Publishers and Distributors, Delhi, 1988.

REFERENCES:

1**.** David H. Heiser and David T. Pratt., “Hypersonic Air breathing Propulsion”, AIAA Education Series, 1999.

MATS UNIVERSITY, RAIPUR (C.G.)
SCHOOL OF ENGINEERING & I.T.

Semester: VI B.Tech | Branch: Aeronautical
Subject: Civil Aviation Requirements | Code: BT 652
Total Theory Periods: 36 Total Tutorial Periods: 00 | Total Credits: 03

OBJECTIVES:
To make the students familiar with civil aviation rules and regulations and various amendments made in these rules and its implementation and importance in aviation sector.

UNIT-I C.A.R. SERIES 'A' AND 'B'
C.A.R. SERIES 'A' – Procedure for Civil Air Worthiness Requirements and Responsibility Operators Vis-À-Vis Air Worthiness Directorate
Responsibilities of operators / owners-Procedure of CAR issue, amendments etc., Objectives and targets of airworthiness directorate; Airworthiness regulations & safety oversight of engineering activities of operators.
C.A.R. SERIES 'B' – Issue Approval of Cockpit Check List, MEL, CDL:
Deficiency list (MEL & CDL); Preparation and use of cockpit checklist and emergency list.

UNIT-II C.A.R. SERIES 'C' AND 'D'
C.A.R. SERIES 'C' – Defect Recording, Monitoring, Investigation and Reporting
Defect recording, reporting, investigation, rectification and analysis; Flight report; Reporting and rectification of defects observed on aircraft; Analytical study of in-flight readings & recordings; Maintenance control by reliability Method.
C.A.R. SERIES 'D' – and aircraft maintenance programmes
Reliability Programmes (Engines); Aircraft maintenance programme & their approval; On condition maintenance of reciprocating engines; TBO–Revision programme; Maintenance of fuel and oil uplift and consumption records – Light aircraft engines; Fixing routine maintenance periods and component TBOs – Initial & revisions.

UNIT-III C.A.R. SERIES 'E' AND 'F'
C.A.R. SERIES 'E' – Approval of Organisations
Approval of organizations in categories A, B, C, D, E, F, & G - Requirements of infrastructure at stations other than parent base.
C.A.R. SERIES 'F' – Air Worthiness and Continued Air Worthiness:
Procedure relating to registration of aircraft; Procedure for issue/revalidation of Type Certificate of aircraft & its engines/propeller; Issue/revalidation of Certificate of Airworthiness; Requirements for renewal of Certificate of Airworthiness.

UNIT-IV C.A.R. SERIES 'L'&'M'
Issue of AME License, its classification and experience requirements, Mandatory Modifications /Inspections.

UNIT-V C.A.R. SERIES 'T'&'X'
Flight testing of (Series) aircraft for issue of C of A; Flight testing of aircraft for which C of A had been previously issued. Registration Markings of aircraft; Weight and balance control of an aircraft; Provision of first aid kits & Physician's kit in an aircraft; Use furnishing materials in an aircraft; Concessions; Aircraft log books; Document to be carried on board on Indian registered aircraft; Procedure for issue of tax permit; Procedure for issue of type approval of aircraft components and equipment including instruments.

OUTCOMES:
Students will become familiar with civil aviation rules and regulations and various amendments made in these rules and its implementation and importance in aviation sector.

TEXT BOOKS:

1. "Civil Aviation Requirements with latest Amendment (Section 2 Airworthiness)" – Published by DGCA, The English Book Store, 17-1, Connaught Circus, New Delhi 2000.
2. Aeronautical Information Circulars (relating to Airworthiness) from DGCA 2000.

REFERENCES:

1. "Aircraft Manual (India) Volume" – Latest Edition, the English Book Store, 17-1, Connaught Circus, New Delhi.
2. Advisory Circulars from DGCA 2003.

MATS UNIVERSITY, RAIPUR (C.G.)
SCHOOL OF ENGINEERING & I.T.

Semester: VI B.Tech | Branch: Aeronautical
Subject: Finite Element Analysis | Code: BT 653
Total Theory Periods: 48 Total Tutorial Periods: 00 | Total Credits: 04

OBJECTIVES:

- To give exposure various methods of solution and in particular the finite element method.
- Gives exposure to the formulation and the procedure of the finite element method and its application to varieties of problems.

UNIT-I INTRODUCTION

Review of various approximate methods –Raleigh Ritz's, Galerkin and finite difference methods- Governing equation and convergence criteria of finite element method.

UNIT-II DISCRETE ELEMENTS

Bar elements, uniform sections, mechanical and thermal loading, varying section, truss analysis. Beam element - problems for various loadings and boundary conditions - longitudinal and lateral vibration. Use of local and natural coordinates.

UNIT-III CONTINUUM ELEMENTS

Plane stress, Plane strain and axisymmetric problems, constant and linear strain, triangular elements, stiffness matrix, axisymmetric load vector,

UNIT-IV ISOPARAMETRIC ELEMENTS

Definitions, Shape function for 4, 8 and 9 nodal quadrilateral elements, Stiffness matrix and consistent load vector, Gaussian integration

UNIT-V FIELD PROBLEM

Heat transfer problems, Steady state fin problems, Derivation of element matrices for two dimensional problems, Torsion problems

OUTCOMES:

Upon completion of this course, the Students can able to understand different mathematical Techniques used in FEM analysis and use of them in Structural and thermal problem.

TEXT BOOKS:

1. Tirupathi R. Chandrapathala and Ashok D. Belegundu – Introduction to Finite Elements in Engineering – Prentice Hall India, Third Edition, 2003.
2. Rao. S.S., Finite Element Methods in Engineering, Butterworth and Heinemann, 2001

REFERENCES:

1. Reddy J.N. – An Introduction to Finite Element Method – McGraw Hill – 2000.
2. Krishnamurthy, C.S., Finite Element Analysis, Tata McGraw Hill, 2000.
3. Bathe, K. J. and Wilson, E. L., Numerical Methods in Finite Elements Analysis, Prentice Hall of India, 1985.
4. Robert D Cook, David S Malkus, Michael E Plesha, 'Concepts and Applications of Finite Element Analysis', 4th edition, John Wiley and Sons, Inc., 2003.
5. Larry J Segerlind, 'Applied Finite Element Analysis', Second Edition, John Wiley and Sons, Inc. 1984.

MATS UNIVERSITY, RAIPUR (C.G.)
SCHOOL OF ENGINEERING & I.T.

Semester: VI B.Tech | Branch: Aeronautical
Subject: Aircraft Design | Code: BT 654
Total Theory Periods: 36 | Total Tutorial Periods: 00 | Total Credits: 03

OBJECTIVES:
To impart knowledge to the students on various types of power plant types and also to expose them principles of aerodynamics and structural design aspects.

UNIT-I REVIEW OF DEVELOPMENTS IN AVIATION
Categories and types of aircrafts –various configurations –Layouts and their relative merits – strength, stiffness, fail safe and fatigue requirements –Manoeuvering load factors –Gust and manoeuverability envelopes –Balancing and maneuvering loads on tail planes.

UNIT-II POWER PLANT TYPES AND CHARACTERISTICS
Characteristics of different types of power plants –Propeller characteristics and selection – Relative merits of location of power plant.

UNIT-III PRELIMINARY DESIGN
Selection of geometric and aerodynamic parameters –Weight estimation and balance diagram– Drag estimation of complete aircraft – Level flight, climb, take – off and landing calculations – range and endurance – static and dynamic stability estimates – control requirements.

UNIT-IV SPECIAL PROBLEMS
Layout peculiarities of subsonic and supersonic aircraft – optimization – of wing loading to achieve desired performance – loads on undercarriages and design requirements.

UNIT-V STRUCTURAL DESIGN
Estimation of loads on complete aircraft and components – Structural design of fuselage, wings and undercarriages, controls, connections and joints. Materials for modern aircraft – Methods of analysis, testing and fabrication.

OUTCOMES:
Upon completion of the course, students will get the basic concept of aircraft design.

TEXT BOOKS:

1. D.P. Raymer, "Aircraft Conceptual design", AIAA Series, 1988.
2. G. Corning, "Supersonic & Subsonic Airplane Design", II Edition, Edwards Brothers Inc., Michigan, 1953.
3. E.F. Bruhn, "Analysis and Design of Flight Vehicle Structures", Tristate Offset Co., U.S.A., 1980.

REFERENCES:

1. E. Torenbeek, "Synthesis of Subsonic Airplane Design", Delft University Press, London, 1976.
2. H.N.Kota, Integrated design approach to Design fly by wire" Lecture notes Interline Pub. Bangalore, 1992.
3. A.A. Lebedenski, "Notes on airplane design", Part-I, I.I.Sc., Bangalore

MATS UNIVERSITY, RAIPUR (C.G.)
SCHOOL OF ENGINEERING & I.T.

Semester: VI B.Tech | Branch: Aeronautical
Subject: Minor Project | Code: BT 656
Total Practical Periods: 42 | Total Credits: 02

OBJECTIVES:

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
- To train the students in preparing project reports and to face reviews and viva voce examination.

SUMMARY/ PROCEDURE OF MINOR PROJECT

1. The objective of the Minor Project is to make use of the knowledge gained by the student at various stages of the degree course.
2. Students are permitted to form group of likeminded colleagues (not more than 4 members) for working on a particular project/topic.
3. Students will also be permitted to undertake industrial/consultancy project Work, outside the department, in industries/Research labs.
4. There shall be four assessments during the semester by a review committee.
5. The student shall make four presentations on the progress made before the committee at various stages of the Project work.
6. The Head of the Department shall constitute the review committee for each branch of study.
7. The total marks obtained in the four reviews, shall be taken in to account.
8. There will be a viva-voce examination at the end of the Project work, conducted by one internal examiner and one external examiner.
9. The total marks secured will be the sum of marks secured in the Project reviews and Viva Voce Examination.
10. Each student is required to submit a Project report on the project assigned to him/group by the department.
11. The report should be based on the information available in the literature or data obtained by the student by way of experiments conducted in the laboratory/industry.

OUTCOMES:

- On Completion of the project work students will be in a position to take up any challenging practical problems and find solution by formulating proper methodology.

MATS UNIVERSITY, RAIPUR (C.G.)
SCHOOL OF ENGINEERING & I.T.

Semester: VI B.Tech | Branch: Aeronautical
Subject: Propulsion-II Lab | Code: BT 657
Total Practical Periods: 28 | Total Credits: 01

OBJECTIVES:

- To familiarize students and to expose them practically to various aircraft piston and gas turbine engines.
- To give practical exposure to various testing methods of variable area ducts, propellants, jet engine components and rockets.
- To practically determine the flow behaviour of jets.

LIST OF EXPERIMENTS

1. Cascade testing of a model of axial compressor blade row.
2. Study of performance of a propeller.
3. Determination of heat of combustion of aviation fuel.
4. Combustion performance studies in a jet engine combustion chamber.
5. Study of free jet.
6. Study of wall jet.

LIST OF EQUIPMENTS

(For a batch of 30 students)

S. No.	Details of Equipments	Qty Req.	Expt. No.
1	Axial compressor blade row model with pressure tapping	1	1
2	Water tube manometers (20 tubes)	2	5,6,1,2
3	Subsonic wind tunnel	1	1,2
4	Propeller model static and total pressure probes	4	2
5	2-D travers in mechanism	2	5,6
6	Free jet test setup	1	5
7	Wall jet test setup	1	6

OUTCOMES

- Ability to understand details of piston and gas turbine engine.
- Ability to perform various testing on ducts, propellants, jet engine components.

MATS UNIVERSITY, RAIPUR (C.G.)
SCHOOL OF ENGINEERING & I.T.

Semester: VI B.Tech | Branch: Aeronautical
Subject: Aero Engine Repair and Maintenance Lab | Code: BT 658
Total Practical Periods: 28 | Total Credits: 01

OBJECTIVES:

To introduce the knowledge of the maintenance and repair procedures followed for overhaul of aero engines.

LIST OF EXPERIMENTS

1. Stripping of a piston engine.
2. Engine (Piston Engine) - cleaning, visual inspection, NDT checks.
3. Piston Engine Components - dimensional checks.
4. Piston – Engine reassembly.
5. Propeller Pitch Setting.
6. Stripping of a jet engine.
7. Jet Engine – identification of components & defects.
8. Jet Engine – NDT checks and dimensional checks
9. Jet Engine – reassembly.
10. Engine starting procedures.

LIST OF EQUIPMENTS

(For a batch of 30 students)

S. No.	Details of Equipments	Qty Req.	Expt. No.
1	Piston Engines	2	1,2,3,4
2	Jet Engines	2	6,7,1,9
3	Propeller pitch setting stand	1	5
4	Aircraft with serviceable stand	1	1 to 10
5	Precision instruments (Vernier Caliper, Micro meter, Cylinder bore gauge, depth gauge, Bevel Protector and DTI)	2 each	3,5,1
6	NDT Equipments (Defectoscope, Dye Penetrant method, Hot oil Chalk Method	1 each	2,1

OUTCOMES:

Ability to maintain and repair the areo engines.

MATS UNIVERSITY, RAIPUR (C.G.)
SCHOOL OF ENGINEERING & I.T.

Semester: VI B.Tech | Branch: Aeronautical
Subject: Aircraft Design Lab-I | Code: BT 659
Total Practical Periods: 28 | Total Credits: 01

OBJECTIVES:

To make the students prepare their own aircraft design by following various design processes and calculations.

LIST OF EXPERIMENTS

1. Comparative configuration study of different types of airplanes.
2. Comparative study on specification and performance details of aircraft.
3. Preparation of comparative data sheets.
4. Work sheet layout procedures.
5. Comparative graphs preparation and selection of main parameters for the design.
6. Preliminary weight estimations, selection of main parameters.
7. Power plant selection, Aerofoil selection, Wing tail and control surfaces.
8. Preparation of layouts of balance diagram and three view drawings.
9. Estimation of various Drags.
10. Detailed performance calculations and stability estimates.

LIST OF EQUIPMENTS

(For a batch of 30 students)

S. No.	Details of Equipments	Qty Req.	Expt. No.
1	Engineering Drawing Board	30	3,4,5
2	Engineering Drawing Instruments	30	3,4,5

OUTCOMES:

Students will be able to prepare their own aircraft design by following various design processes and calculations.

MATS UNIVERSITY, RAIPUR (C.G.)
SCHOOL OF ENGINEERING & I.T.

Semester: VI B.Tech | Branch: Aeronautical
Subject: Missile Aerodynamics | Code: BT 6551
Total Theory Periods: 36 Total Tutorial Periods: 00 | Total Credits: 03

OBJECTIVES:

To make the students familiar with hypersonic aerodynamics, its solution methods, viscous hypersonic flow theory and its interactions and high temperature effects in hypersonic flow.

UNIT-I FUNDAMENTALS OF HYPERSONIC AERODYNAMICS
Introduction to hypersonic aerodynamics – differences between hypersonic aerodynamics and supersonic aerodynamics - concept of thin shock layers and entropy layers – hypersonic flight paths – hypersonic similarity parameters – shock wave and expansion wave relations of inviscid hypersonic flows.

UNIT-II SIMPLE SOLUTION METHODS FOR HYPERSONIC INVISCID FLOWS
Local surface inclination methods – Newtonian theory – modified Newtonian law –tangent wedge and tangent cone and shock expansion methods – approximate methods - hypersonic small disturbance theory – thin shock layer theory.

UNIT-III VISCOUS HYPERSONIC FLOW THEORY
Boundary layer equations for hypersonic flow – hypersonic boundary layers – self similar and non self similar boundary layers – solution methods for non self similar boundary layers – aerodynamic heating.

UNIT IV VISCOUS INTERACTIONS IN HYPERSONIC FLOWS
Introduction to the concept of viscous interaction in hypersonic flows - Strong and weak viscous interactions - hypersonic viscous interaction similarity parameter –introduction to shock wave boundary layer interactions.

UNIT-V INTRODUCTION TO HIGH TEMPERATURE EFFECTS
Nature of high temperature flows – chemical effects in air – real and perfect gases –Gibb's free energy and entropy - chemically reacting mixtures – recombination and dissociation.

OUTCOMES:

Students will becomes familiar with hypersonic aerodynamics, its solution methods, viscous hypersonic flow theory and its interactions and high temperature effects in hypersonic flow.

TEXT BOOKS:

1. John D. Anderson. Jr., "Hypersonic and High Temperature Gas Dynamics", Mc.Graw hill Series, New York, 1996.

REFERENCES:

1. John D. Anderson. Jr., "Modern Compressible flow with historical Perspective", Mc. Graw Hill Publishing Company, New York, 1996.
2. John T. Bertin, "Hypersonic Aerothermodynamics", Published by AIAA Inc., Washington. D. C., 1994.

MATS UNIVERSITY, RAIPUR (C.G.)
SCHOOL OF ENGINEERING & I.T.

Semester: VI B.Tech | Branch: Aeronautical
Subject: Space Mechanics | Code: BT 6552
Total Theory Periods: 36 | Total Tutorial Periods: 00 | Total Credits: 03

OBJECTIVES:

To introduce concepts of satellite injection and satellite perturbations, trajectory computation for interplanetary travel and flight of ballistic missiles based on the fundamental concepts of orbital mechanics.

UNIT-I BASIC CONCEPTS AND THE GENERAL N- BODYPROBLEM

The solar system – reference frames and coordinate systems – terminology relatedto the celestial sphere and its associated concepts – Kepler's laws of planetary motion and proof of the laws – Newton's universal law of gravitation - the many bodyproblem - Lagrange-Jacobi identity – the circular restricted three body problem –liberation points – the general N-body problem – two body problem – relationsbetween position and time.

UNIT-II SATELLITE INJECTION AND SATELLITE PERTURBATIONS

General aspects of satellite injection – satellite orbit transfer – various cases – orbitdeviations due to injection errors – special and general perturbations – Cowell's method and Encke's method – method of variations of orbital elements – generalperturbations approach.

UNIT-III INTERPLANETARY TRAJECTORIES

Two-dimensional interplanetary trajectories – fast interplanetary trajectories – threedimensional interplanetary trajectories – launch of interplanetary spacecraft –trajectory estimation about the target planet – concept of sphere of influence –Lambert's theorem

UNIT-IV BALLISTIC MISSILE TRAJECTORIES

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

UNIT-V MATERIALS FOR SPACECRAFT

Space environment – peculiarities of space environment – effect of space environment on materials of spacecraft structure – materials required for the construction of space craft – TPS for re-entry space vehicles.

OUTCOMES:

- Ability to perform satellite injection, satellite perturbations and trajectory control.
- Apply orbital mechanics to control ballistic missile.

TEXT BOOKS:

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

REFERENCES:

1. Sutton, G.P., "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 5th Edition, 1993.

MATS UNIVERSITY, RAIPUR (C.G.)
SCHOOL OF ENGINEERING & I.T.

Semester: VI B.Tech — Branch: Aeronautical
Subject: Satellite Technology — Code: BT 6553
Total Theory Periods: 36 Total Tutorial Periods: 00 — Total Credits: 03

OBJECTIVES:
To make the students aware about satellite systems, orbital mechanics, satellite structures and thermal control, spacecraft controls and power systems.

UNIT-I INTRODUCTION TO SATELLITE SYSTEMS
Common satellite applications and missions – Typical spacecraft orbits – Definitions of spin the three axis stabilization-Space environment – Launch vehicles – Satellite system and their functions (structure, thermal, mechanisms, power, propulsion, guidance and control, bus electronics).

UNIT-II ORBITAL MECHANICS
Fundamental of flight dynamics – Time and coordinate systems – Orbit determination and prediction – Orbital maneuvers – GPS systems and application for satellite/orbit determination – Ground station network requirements.

UNIT-III SATELLITE STRUCTURES & THERMAL CONTROL
Satellite mechanical and structural configuration: Satellite configuration choices, launch loads, separation induced loads, deployment requirements – Design and analysis of satellite structures – Structural materials and fabrication – The need of thermal control: externally induced thermal environment – Internally induced thermal environment - Heat transfer mechanism: internal to the spacecraft and external heat load variations – Thermal control systems: active and passive methods.

UNIT-IV SPACECRAFT CONTROL
Control requirements: attitude control and station keeping functions, type of control maneuvers – Stabilization schemes: spin stabilization, gravity gradient methods, 3 axis stabilization – Commonly used control systems: mass expulsion systems, momentum exchange systems, gyro and magnetic torquer - Sensors star and sun sensors, earth sensor, magnetometers and inertial sensors.

UNIT-V POWER SYSTEM AND BUS ELECTRONICS
Solar panels: Silicon and Ga-As cells, power generation capacity, efficiency – Space battery systems – battery types, characteristics and efficiency parameters – Power electronics. Telemetry and tele command systems: Tm & TC functions, generally employed communication bands (UHF/VHF, S, L, Ku, Ka etc), their characteristics and applications-Coding Systems – Onboard computer- Ground checkout Systems.

OUTCOMES:
Students will become familiar with satellite systems, orbital mechanics, satellite structures and thermal control, spacecraft controls and power systems.

TEXT BOOKS:

1. Analysis and Design of Flight Vehicle Structures, Tri-State off set company, USA, 1980.
2. Space Systems Engineering Rilay, FF, McGraw Hill, 1982.
3. Principles of Astronautics Vertregt.M., Elsvier Publishing Company, 1985.
4. Introduction Space Flight, Francis J. Hale Prentice Hall, 1994.
5. Space Vehicle Design, Michael D. Griffin and James R. French, AIAA Education Series, 1991.

REFERENCES:

1. Spacecraft Thermal Control, Hand Book, Aerospace Press, 2002.
2. Structural Design of Missiles & Space Craft Lewis H. Abraham, McGrawHill, 1992.
3. Space Communications Systems, Richard.F, Filipowsky Eugen I Muehllorf, Prenctice Hall, 1995.
4. Hughes, P.C. Space Craft Altitude Dynamics, Wiley, 1986.
5. Gebmart, Heat Transfer, McGraw Hill, Martin J. Communication Satellite Systems, McGraw Hill, 1978.

MATS UNIVERSITY, RAIPUR (C.G.)
SCHOOL OF ENGINEERING & I.T.

Semester: VI B.Tech — Branch: Aeronautical
Subject: Wind Tunnel Techniques — Code: BT 6554
Total Theory Periods: 36 Total Tutorial Periods: 00 — Total Credits: 03

OBJECTIVES:
The students are exposed to various types and techniques of Aerodynamic data generation on aerospace vehicle configurations in the aerospace industry.

UNIT-I PRINCIPLES OF MODEL TESTING
Buckingham Theorem – Non dimensional numbers – Scale effect – Geometric Kinematic and Dynamic similarities.

UNIT-II WIND TUNNELS
Classification – special problems of testing in subsonic, transonic, supersonic and hypersonic speed regions – Layouts – sizing and design parameters.

UNIT-III CALIBRATION OF WIND TUNNELS
Test section speed – Horizontal buoyancy – Flow angularities – Turbulence measurements – Associated instrumentation – Calibration of supersonic tunnels.

UNIT-IV WIND TUNNEL MEASUREMENTS
Steady and Unsteady Pressure and velocity measurements – Force measurements –Three component and six component balances – Internal balances – Principles of Hotwire Anemometer.

UNIT-V FLOW VISUALIZAITON
Smoke and Tuft grid techniques – Dye injection special techniques – Optical methods of flow visualization.

OUTCOMES
Ability to use various techniques of Aerodynamic data generation.

TEXT BOOKS:

1. Rae, W.H. and Pope, A., Low Speed Wind Tunnel Testing, John Wiley Publication, 1984.
2. R. C. Pankhurst, Douglas William Holder, Wind-tunnel technique: an account of experimental methods in low- and high-speed wind tunnels, Pitman, 1952.

REFERENCES:

1. Pope, A., and Goin, L., High Speed Wind Tunnel Testing, John Wiley, 1985.
2. Wind Tunnels and Wind Tunnel Test Techniques, The Royal Aeronautical Society, London, 1992.

MATS UNIVERSITY, RAIPUR (C.G.)
SCHOOL OF ENGINEERING & I.T.

Semester: VI B.Tech | Branch: Aeronautical
Subject: Unmanned Aircraft Systems | Code: BT 6555
Total Theory Periods: 36 Total Tutorial Periods: 00 | Total Credits: 03

OBJECTIVES:
To make students familiar with unmanned aircraft systems, its design, modelling, control and deployment techniques.

UNIT-I INTRODUCTION TO UAS
History of unmanned aerial vehicles- types- Introduction to Unmanned aircraft systems- Unmanned aerial vehicles–Micro aerial vehicles definitions, history, classification- applications-recent research and development in civil and defense applications – autonomous vehicles -future research in autonomous vehicles – design standards and regulatory aspects introduction to design and selection of systems.

UNIT-II ASPECTS OF UAS SYSTEMS
Involvement of different aspects in the development of UAV-aerodynamic configurations - Aspects of airframe design- Stealth design, payload types, communication, navigations & guidance systems, control & stability, launch, recovery and support systems, reliability design.

UNIT III MODELING AND CONTROL HELICOPTER MODEL
Modeling and control of small and miniature unmanned helicopters –single rotor helicopter design – coaxial rotor helicopter design - autonomous control of a mini quadrotor vehicle using LQG controllers – linearization and identification of helicopter model.

UNIT-IV UAV DESIGN MODELING & CONTROL
Development of autonomous quad tilt wing – advanced flight control systems for rotorcraft UAV and MAV –mathematical modeling and non linear control of VTOL aerial vehicles.

UNIT-V DEPLOYMENT OF UAS/UAV SYSTEMS
Only application point of view of various UAS roles played in civil, defense applications - vision based navigation company trails- certification of UAS/UAV/MAV systems.

OBJECTIVES:
The students will gain the knowledge on unmanned aircraft systems, its design, modelling, control and deployment techniques.

TEXT BOOKS:

1. Reg Austin, Unmanned Aircraft Systems: UAVS Design, Development and Deployment John Wiley, UK, 2010.
2. Elizabeth Bone, Christopher Bolkcom, Unmanned aerial vehicles, Novinka Books, United Kingdom, 2004.
3. Kimon Valavanis, Advances in unmanned aerial vehicles, Springer, Netherlands, 2007.

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1. K. Nonami, F. Kendoul, S. Suzuki, W. Wang, Daisuke Nakazawa, Modeling and Control of Unmanned Small Scale Rotorcraft UAVS & MAVS, Springer, New York, 2010.
2. Laurence R. Newcome, Unmanned aviation: a brief history of unmanned aerial vehicles, American Institute of Aeronautics and Astronautics, New York, 2004.

4. Rogelio Lozano, Unmanned Aerial Vehicles Embedded Control, John Wiley & Sons, 2010.
5. Pedro Castillo, Rogelio Lozano, Alejandro E. Dzul, Modelling and control of mini-flying machines, Advances in industrial control (AIC), Springer-Verlag, London, 2005.
6. Bernard Mettler, Identification modeling and characteristics of miniature rotorcraft, Kluwer Publishers, USA, 2003.