# Curriculum and Syllabus for 3rd Semester, Aerospace Engineering

## B.E. AEROSPACE ENGINEERING

**III SEMESTER**

| Sl. No | Subject Code | Title | Teaching Dept. | Teaching Hours /Week | | Examination | | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory | Practical/ Drawing | Duration | Theory/ Practical Marks | I.A. Marks | Total Marks | |
| 1 | 17MAT31 | ENGINEERING MATHEMATICS-III | Mathematics | 04 | | 03 | 60 | 40 | 100 | 4 |
| 2 | 17AS32 | INTRODUCTION TO AEROSPACE ENGINEERING | AS | 04 | | 03 | 60 | 40 | 100 | 4 |
| 3 | 17AS33/ 17AE33 | AERO-THERMODYNAMICS | AS | 04 | | 03 | 60 | 40 | 100 | 4 |
| 4 | 17AS34/ 17AE34 | MECHANICS OF MATERIALS | AS | 04 | | 03 | 60 | 40 | 100 | 4 |
| 5 | 17AS35/ 17AE35 | MECHANICS OF FLUIDS | AS | 04 | | 03 | 60 | 40 | 100 | 4 |
| 6 | 17AS36 | AEROSPACE MATERIALS | AS | 03 | | 03 | 60 | 40 | 100 | 3 |
| 7 | 17ASL37 | MATERIAL TESTING & METROLOGY LAB | AS | | 1I+2P | 03 | 60 | 40 | 100 | 2 |
| 8 | 17ASL38 | FLUID MECHANICS LAB | AS | | 1I+2P | 03 | 60 | 40 | 100 | 2 |
| 9 | 17KL/CPH39/49 Core Course | Kannada/Constitution of India, Professional Ethics & Human Rights | Humanities | 01 | | 01 | 30 | 20 | 50 | 1 |
| **TOTAL** | | | | **24** | **6** | **25** | **510** | **340** | **850** | **28** |

**1. Core subject:** This is the course which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.

**2a. Foundation Course**: The courses based upon the content that leads to Knowledge enhancement.

**2b. Foundation Elective:** Elective Foundation courses are value-based and are aimed at man-making education

**3. Elective:** This is the course, which can be chosen from the pool of papers. It may be supportive to the discipline/providing extended scope/Enabling an Exposure to some other discipline/domain/nurturing student proficiency skills**.**

# VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

**B.E.SYLLABUS FOR 2017-2021**

# ENGINEERING MATHEMATICS-III

**(Common to all Branches)**

| | |
|---|---|
| **Course Code : 17MAT31** | **CIE Marks : 40** |
| **Contact Hours/Week : 04** | **SEE Marks: 60** |
| **Total Hours: 50** | **Exam Hours:03** |
| **Semester: III** | **Credits: 04(4:0:0)** |

**Course Objectives**:

The objectives of this course is to introduce students to the mostly used analytical and numerical methods in the different engineering fields by making them to learn Fourier series, Fourier transforms and Z-transforms, statistical methods, numerical methods to solve algebraic and transcendental equations, vector integration and calculus of variations.

| MODULES | RBT Levels | No. of Hrs |
|---|---|---|
| **MODULE-I**<br>**Fourier Series**: Periodic functions, Dirichlet's condition, Fourier Series of periodic functions with period $2\pi$ and with arbitrary period $2c$. Fourier series of even and odd functions. Half range Fourier Series, practical harmonic analysis-Illustrative examples from engineering field. | **L1 & L2** | **10** |
| **MODULE-II**<br>**Fourier Transforms:** Infinite Fourier transforms, Fourier sine and cosine transforms. Inverse Fourier transform.<br>**Z-transform:** Difference equations, basic definition, z-transform-definition, Standard z-transforms, Damping rule, Shifting rule, Initial value and final value theorems (without proof) and problems, Inverse z-transform. Applications of z-transforms to solve difference equations. | **L1 & L2** | **10** |
| **MODULE- III**<br>**Statistical Methods:** Review of measures of central tendency and dispersion. Correlation-Karl Pearson's coefficient of correlation-problems. Regression analysis- lines of regression (without proof) –problems<br>**Curve Fitting:** Curve fitting by the method of least squares- fitting of the curves of the form, $y = ax + b$, $y = ax^2 + bx + c$ and $y = ae^{bx}$.<br>**Numerical Methods:** Numerical solution of algebraic and transcendental equations by Regula- Falsi Method and Newton-Raphson method. | **L1 & L2** | **10** |
| **MODULE IV**<br>**Finite differences**: Forward and backward differences, Newton's forward and backward interpolation formulae. Divided differences- Newton's divided difference formula. Lagrange's interpolation formula and inverse interpolation formula (all formulae without proof)-Problems.<br>**Numerical integration:** : Simpson's $(1/3)^{th}$ and $(3/8)^{th}$ rules, Weddle's rule (without proof ) –Problems. | **L1 & L2** | **10** |
| **MODULE-V**<br>**Vector integration:**<br>Line integrals-definition and problems, surface and volume integrals-definition, Green's theorem in a plane, Stokes and Gauss-divergence | **L2 & L3** | |

| | | |
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| theorem(without proof) and problems.<br>**Calculus of Variations:** Variation of function and Functional, variational problems. Euler's equation, Geodesics, hanging chain, problems. | **L2 & L3** | **10** |

**Course Outcomes:** On completion of this course, students are able to:

1. Know the use of periodic signals and Fourier series to analyze circuits and system communications.
2. Explain the general linear system theory for continuous-time signals and digital signal processing using the Fourier Transform and z-transform.
3. Employ appropriate numerical methods to solve algebraic and transcendental equations.
4. Apply Green's Theorem, Divergence Theorem and Stokes' theorem in various applications in the field of electro-magnetic and gravitational fields and fluid flow problems.
5. Determine the extremals of functionals and solve the simple problems of the calculus of variations.

**Question Paper Pattern:**

**Note:- The SEE question paper will be set for 100 marks and the marks will be proportionately reduced to 60.**

- The question paper will have **ten** full questions carrying equal marks.
- Each full question consisting of **20** marks.
- There will be **two** full questions (with a **maximum** of **four** sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer **five** full questions, selecting **one** full question from each module.

**Text Books:**

1. *B.S. Grewal: Higher Engineering Mathematics, Khanna Publishers, 43rd Ed., 2015.*
2. *E. Kreyszig: Advanced Engineering Mathematics, John Wiley & Sons, 10th Ed., 2015.*

1. *N.P.Bali and Manish Goyal: A Text Book of Engineering Mathematics, Laxmi Publishers, 7th Ed., 2010.*
2. *B.V.Ramana: "Higher Engineering M athematics" Tata McGraw-Hill, 2006.*
3. *H. K. Dass and Er. RajnishVerma: "Higher Engineerig Mathematics", S. Chand publishing, 1st edition, 2011.*

# INTRODUCTION TO AEROSPACE ENGINEERING

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

| | | | |
|---|---|---|---|
| Subject Code | **17AS32** | IA Marks | 40 |
| Number of Lecture Hours/Week | 04 | Exam Hours | 03 |
| Total Number of Lecture Hours | 50 | Exam Marks | 60 |

CREDITS – 04

**Course objectives:** This course will enable students to

1. Understand basic principles of aviation and the history of space vehicles.
2. Acquire the basic knowledge of aircraft structures, aerodynamics, propulsion, materials and aircraft systems & instrumentation.
3. Understand the basics of space propulsion, spacecrafts and their orbits.

| **Modules** | **Teaching Hours** | **Revised Bloom's Taxonomy (RBT) Level** |
|---|---|---|
| **Module -1**<br>**Introduction to Aircrafts:** History of aviation, International Standard atmosphere, Atmosphere and its properties, Temperature, pressure and altitude relationships, Classification of aircrafts, V/STOL machines, Modern developments in Aviation like UAV.<br>**Introduction to Space Flight:** History of Space Flight & spacecraft technologies Difference between space and atmosphere, upper atmosphere, Introduction to basic orbital mechanics, types of Orbits (LEO, MEO, Geosynchronous and Geostationary, Polar orbits), Kepler's Laws of planetary motion. | **10 Hours** | **L1, L2** |
| **Module -2**<br>**Basic principles of flight:** Significance of speed of sound, Propagation of sound, Mach number, subsonic, transonic, supersonic, hypersonic flows, Bernoulli's theorem, Aerodynamic forces and moments on an Airfoil, Lift and drag components, lift curve, drag curve, types of drag, factors affecting lift and drag; Centre of pressure and its significance, Aerodynamic centre, Aspect ratio, Airfoil nomenclature, Basic characteristics of airfoils, NACA nomenclature, Simple problems on lift and drag. | **10 Hours** | **L1, L2** |
| **Module -3**<br>**Aircraft Propulsion :** Introduction, Classification, Piston Engine & its application, Brayton cycle, Principle of operation of Turboprop, turbojet and turbofan engines, Introduction to ramjets and scramjets; performance characteristics,<br>**Rocket Propulsion :** Principles of operation of rocket, Classification of Rockets, Types of rockets and typical | **10 Hours** | **L1, L2** |

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| applications, Introduction to Space Exploration. | | |
| **Module -4**<br>**Aircraft Structures and Materials :** Introduction, General types of construction, Monocoque, Semi-Monocoque and Geodesic structures, Typical wing and fuselage structure; Metallic and non-metallic materials for aircraft application. Use of aluminum alloy, titanium, stainless steel and composite materials. | **10 Hours** | **L1, L2** |
| **Module -5**<br>**Aircraft Instruments:** Instrument Displays, Introduction to Navigation Instruments, Basic Air data systems & Probes, Mach meter, Air speed indicator, Vertical speed indicator, Altimeter, Gyro based instruments.<br>**Aircraft Systems :** Introduction to Hydraulic and pneumatic systems, Air Conditioning and Cockpit pressurization system, Generation and distribution of Electricity on board the airplane, Aircraft Fuel System, Fire Protection, Ice and Rain Protection System. | **10 Hours** | **L1, L2** |

**Course outcomes:**

At the end of this course the student will be able to:

1. Apply the basic knowledge & principles of aviation & spaceflight.
2. Apply the concepts of fundaments of flight, basics of aircraft structures, aircraft & rocket propulsion and aircraft materials during the development of an aircraft
3. Appreciate the complexities involved during development of flight vehicles.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Conduct Investigations.
- Life Long Learning

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**


1. John D. Anderson, "Introduction to Flight", McGraw-Hill Education, 8th edition, 2015, ISBN: 978-0078027673.
2. Lalit Gupta and O P Sharma, Fundamentals of Flight Vol-I to Vol-IV, Himalayan Books. 2006, ISBN: 9788170020752


**Reference Books:**


1. Ian Moir, Allan Seabridge, "Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration", John Wiley & Sons, 3rd edition, 2011, ISBN: 9781119965206
2. Sutton G.P., "Rocket Propulsion Elements", John Wiley, New York, 9th edition,2016,ISBN: 9781118753910

3. A.C. Kermode, “Flight without formulae”, Pearson Education India,5th edition,1989,ISBN: 9788131713891
4. Nelson R.C., “Flight stability and automatic control”, McGraw-Hill,2nd edition,1998,ISBN: 9780071158381

# AERO-THERMODYNAMICS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

| | | | |
|---|---|---|---|
| Subject Code | **17AS33/17AE33** | IA Marks | 40 |
| Number of Lecture Hours/Week | 04 | Exam Hours | 03 |
| Total Number of Lecture Hours | 50 | Exam Marks | 60 |

CREDITS – 04

**Course objectives:** This course will enable students to

1. Understand various concepts and definitions of thermodynamics.
2. Comprehend the I law and II law of thermodynamics.
3. Acquire the knowledge of various types of gas cycles

| Modules | Teaching Hours | Revised Bloom’s Taxonomy (RBT) Level |
|---|---|---|
| **Module -1**<br><br>**Fundamental Concepts & Definitions:** Thermodynamics definition and scope, Microscopic and Macroscopic approaches. Some practical applications of engineering thermodynamic Systems, Characteristics of system boundary and control surface, examples. Thermodynamic properties; definition and Modules, intensive and extensive properties. Thermodynamic state, state point, state diagram, path and process, quasi-static process, cyclic and non-cyclic processes; Thermodynamic equilibrium; definition, mechanical equilibrium; diathermic wall, thermal equilibrium, chemical equilibrium. Zeroth law of thermodynamics, Temperature; concepts, scales, fixed points and measurements.<br><br>**Work and Heat:** Mechanics-definition of work and its limitations. Thermodynamic definition of work; examples, sign convention. Displacement work; as a part of a system boundary, as a whole of a system boundary, expressions for displacement work in various processes through p-v diagrams. Shaft work; Electrical work. Other types of work. Heat. | **10 Hours** | **L1, L2** |

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| **Module -2**<br><br>**First Law of Thermodynamics:** Joules experiments, equivalence of heat and work. Statement of the First law of thermodynamics, extension of the First law to non - cyclic processes, energy, energy as a property, modes of energy, pure substance; definition, two-property rule, Specific heat at constant volume, enthalpy, specific heat at constant pressure. Extension of the First law to control volume; steady state-steady flow energy equation, important applications, analysis of unsteady processes such as film and evacuation of vessels with and without heat transfer. | **10 Hours** | **L1, L2, L3** |
| **Module -3**<br><br>**Second Law of Thermodynamics:** Devices converting heat to work; (a) in a thermodynamic cycle, (b) in a mechanical cycle. Thermal reservoir. Direct heat engine; schematic representation and efficiency. Devices converting work to heat in a thermodynamic cycle; reversed heat engine, schematic representation, coefficients of performance. Kelvin - Planck statement of the Second law of Thermodynamics; PMM I and PMM II, Clausius statement of Second law of Thermodynamics, Equivalence of the two statements; Reversible and Irreversible processes; factors that make a process irreversible, reversible heat engine, Carnot cycle, Carnot principles.<br><br>**Entropy:** Clasius inequality; Statement, proof, application to a reversible cycle. Entropy; definition, a property, change of entropy, principle of increase in entropy, entropy as a quantitative test for irreversibility, calculation of entropy using Tds relations, entropy as a coordinate. Available and unavailable energy. | **10 Hours** | **L1, L2** |
| **Module -4**<br><br>**Pure Substances & Ideal Gases**: Mixture of ideal gases and real gases, ideal gas equation, compressibility factor use of charts. P-T and P-V diagrams, triple point and critical points. Sub-cooled liquid, Saturated liquid, mixture of saturated liquid and vapour, saturated vapour and superheated vapour states of pure substance with water as example. Enthalpy of change of phase (Latent heat). Dryness fraction (quality), T-S and H-S diagrams, representation of various processes on these diagrams.<br><br>**Thermodynamic relations:** Maxwells equations, Tds relations, ratio of heat capacities, evaluation of thermodynamic properties from an equation of state. | **10 Hours** | **L1, L2, L3** |
| **Module -5**<br><br>**Gas Cycles:** Efficiency of air standard cycles, Carnot, Otto, | **10 Hours** | **L1, L2, L3** |

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| Diesel cycles, P-V & T-S diagram, calculation of efficiency; Carnot vapour power cycle, simple Rankine cycle, Analysis and performance of Rankine Cycle, Ideal and practical regenerative Rankine cycles – Reheat and Regenerative Cycles, Binary vapour cycle. | | |

**Course outcomes:**

After studying this course, students will be able to:

1. Apply the concepts and definitions of thermodynamics.
2. Differentiate thermodynamic work and heat and apply I law and II law of thermodynamics to different process.
3. Apply the principles of various gas cycles.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions.
- Interpretation of data.

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**


1. A Venkatesh, "Basic Engineering Thermodynamics", Universities Press, India, 2007, ISBN 13: 9788173715877
2. P K Nag, "Basic and Applied Thermodynamics", Tata McGraw Hill Pub,2nd edition, 2002, ISBN 13: 9780070151314


**Reference Books:**


1. Yunus A.Cenegal and Michael A.Boles, "Thermodynamics: An Engineering Approach", TataMcGraw Hill publications,4th edition, 2002, ISBN 13: 9780071072540
2. J.B.Jones and G.A.Hawkins, John Wiley and Sons, "Engineering Thermodynamics", Wiley 1986, ISBN 13: 9780471812029
3. G.J.Van Wylen and R.E.Sonntag, "Fundamentals of Classical Thermodynamics", Wiley Eastern, 4th edition, 1994, ISBN 13: 978-0471593959
4. Y.V.C.Rao, "An Introduction to Thermodynamics", Universities Press, 2nd edition, 2003, ISBN 13: 978-8173714610.
5. B.K Venkanna, Swati B. Wadavadagi "Basic Thermodynamics", PHI, New Delhi, 2010, ISBN 13: 978-8120341128.

# MECHANICS OF MATERIALS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

| | | | |
|---|---|---|---|
| Subject Code | **17AS34/17AE34** | IA Marks | 40 |
| Number of Lecture Hours/Week | 04 | Exam Hours | 03 |
| Total Number of Lecture Hours | 50 | Exam Marks | 60 |

CREDITS – 04

**Course objectives:** This course will enable students to

1. Comprehend the basic concepts of strength of materials.
2. Acquire the knowledge of stress, strain under different loadings.
3. Understand the different failure theory.

| Modules | Teaching Hours | Revised Bloom's Taxonomy (RBT) Level |
|---|---|---|
| **Module -1**<br><br>**Basic equations of linear elasticity:** The concept of stress, Analysis of the state of stress at a point, Equilibrium equations, The state of plane stress, The concept of strain, Analysis of the state of strain at a point, Plane strain and plane stress in polar coordinates, Problem featuring cylindrical symmetry.<br><br>**Constitutive behaviour of materials:** Constitutive laws for isotropic materials, Allowable stress, Yielding under combined loading, Material selection for structural performance, Composite materials, Constitutive laws for anisotropic materials, Strength of a transversely isotropic lamina. **Engineering structural analysis**: Solution approaches, Bar under constant axial force, Pressure vessels. | **10 Hours** | **L1, L2** |
| **Module -2**<br><br>**Euler-Bernoulli beam theory:** The Euler-Bernoulli assumptions, Implications of the Euler-Bernoulli assumptions, Stress resultants Beams subjected to axial loads, Beams subjected to transverse loads, Beams subjected to combined axial and transverse loads.<br><br>**Three-dimensional beam theory:** Kinematic description, Sectional constitutive law, Sectional equilibrium equations, Governing equations, Decoupling the three-dimensional problem, The principal centroidal axes of bending. The neutral axis, Evaluation of sectional stiffness. | **10 Hours** | **L1, L2. L3** |
| **Module -3**<br>**Torsion:** Torsion of circular cylinders , Torsion combined with | **10 Hours** | **L1, L2, L3** |

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| axial force and bending moments, Torsion of bars with arbitrary cross-sections, Torsion of a thin rectangular cross-section, Torsion of thin-walled open sections.<br><br>**Thin-walled beams:** Basic equations for thin-walled beams, Bending of thin-walled beams, Shearing of thin-walled beams. The shear centre. Torsion of thin-walled beams, Coupled bending-torsion problems Warping of thin-walled beams under torsion. Equivalence of the shear and twist centres, Non-uniform torsion, Structural idealization. | | |
| **Module -4**<br><br>**Virtual work principles:** Introduction, Equilibrium and work fundamentals, Principle of virtual work, Principle of virtual work applied to mechanical systems, Principle of virtual work applied to truss structures. Principle of complementary virtual work, internal virtual work in beams and solids.<br><br>**Energy methods:** Conservative forces, Principle of minimum total potential energy, Strain energy in springs, Strain energy in beams, Strain energy in solids, Applications to trusses, Development of a finite element formulation for trusses, Principle of minimum complementary, Energy theorems, Reciprocity theorems, Saint-Venant's principle. | **10 Hours** | **L1, L2, L3, L4** |
| **Module -5**<br><br>**Yielding:** Yielding under combined loading, Applications of yield criteria to structural, Application to bars, trusses and beams. Buckling of beams: Rigid bar with root torsion spring, buckling of beams, buckling of sandwich beams. Shearing deformations in beams, Shear deformable beams: an energy approach.<br><br>**Kirchhoff plate theory:** Governing equations of Kirchhoff plate theory, The bending problem, Anisotropic plates, Solution techniques for rectangular plates, Circular, Energy formulation of Kirchhoff plate theory, Buckling of plates. | **10 Hours** | **L1, L2, L3** |
| **Course outcomes:**<br>After studying this course, students will be able to:<br>1. Apply the basic concepts of strength of materials.<br>2. Compute stress, strain under different loadings.<br>3. Distinguish the different failure theories. | | |
| **Graduate Attributes (as per NBA):**<br><br>• Engineering Knowledge.<br>• Problem Analysis.<br>• Design / development of solutions<br>• Interpretation of data. | | |

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| **Question paper pattern:**<br><br>• The question paper will have ten questions.<br>• Each full question consists of 16 marks.<br>• There will be 2 full questions (with a maximum of four sub questions) from each module.<br>• Each full question will have sub questions covering all the topics under a module.<br>• The students will have to answer 5 full questions, selecting one full question from each module. |
| **Text Books:**<br><br>1. S.S. Bhavaikatii, "*Strength of Materials*", Vikas Publications House, New Delhi, 2013, ISBN- 978-9325971578.<br>2. Timoshenko and Young "*Elements of Strength of Materials*', East-West Press, 5th edition, 2003, ISBN-13: 978-8176710190. |
| **Reference Books:**<br>1. Beer.F.P. and Johnston.R, "*Mechanics of Materials*", McGraw Hill Publishers, 7th edition, 2016, ISBN-13: 978-9339217624.<br>2. S.Ramamrutham, R Narayanan, "*Strength of Materials*", Dhanapath Rai Publishing Company, New Delhi, 2012, ISBN 13: 9789384378264<br>3. Bao Shihua, Gong Yaoqing "*Structural Mechanics*" Wuhan University of Technology Press, 2005, ISBN: 7562924074 9787562924074<br>4. T.H.G Megson "*Introduction to Aircraft Structural Analysis*", Elsevier Exclusive Publications, 2nd edition, 2014, ISBN 13: 978-9351071860. |

## MECHANICS OF FLUIDS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

| | | | |
|---|---|---|---|
| Subject Code | **17AS35/17AE35** | IA Marks | 40 |
| Number of Lecture Hours/Week | 04 | Exam Hours | 03 |
| Total Number of Lecture Hours | 50 | Exam Marks | 60 |

CREDITS – 04

**Course objectives:** This course will enable students to

1. Understand the basic fluid properties.
2. Understand the governing laws of fluid flow.
3. Acquire the knowledge of types of fluid flows.

| **Modules** | **Teaching Hours** | **Revised Bloom's Taxonomy (RBT) Level** |
|---|---|---|

| | | |
|---|---|---|
| **Module -1**<br>**Basic Considerations:** Introduction, Dimensions- Modules and physical quantities, Continuum view of gases and liquids, Pressure and Temperature scales, Physical properties of fluids.<br>**Fluid Statics:** Pressure distribution in a static fluid, Pressure and its measurement, hydrostatic forces on plane and curved surfaces, buoyancy, illustration by examples. | **10 Hours** | **L1, L2** |
| **Module -2**<br><br>**Fluids in motion:** Methods of describing fluid motion, types of fluid flow, continuity equation in 3 dimensions, velocity potential function and stream function. Types of motion, Source sink, doublet, plotting of streamlines and potential lines Numerical problems.<br><br>**Fluid Kinematics:** Kinematics of fluid motion and the constitutive equations, Integral (global) form of conservation equations (mass, momentum, energy) and applications, Differential form of conservation equations (continuity, Navier-Stokes equations, energy equation). | **10 Hours** | **L1, L2** |
| **Module -3**<br><br>**Fluid Dynamics:** Equations of motion: Euler's and Bernoulli's equation of motion for ideal and real fluids. Momentum equation, Fluid flow measurements. Numerical problems.<br><br>**Dimensional analysis and similarity:** Dimensional homogeneity, methods of dimensional analysis, model analysis, types of similarity and similitude. Dimensionless numbers. Model laws. Numerical problems. | **10 Hours** | **L1, L2** |
| **Module -4**<br><br>**Flow past Immersed bodies:** Introduction to boundary layer, boundary layer thickness, karman's integral momentum theory, drag on a flat plate for laminar and turbulent flow, Drag on immersed bodies. Expression for drag and lift. Kutta – joukowsky theorem; Fundamentals of aerofoil theory Numerical problems. | **10 Hours** | **L1, L2, L3** |
| **Module -5**<br><br>**Compressible flow and Boundary Layers theory**: Steady, one-dimensional gas dynamics, Propagation of pressure waves in a compressible medium, velocity of sound , Mach number, Mach cone, Stagnation properties , Bernoulli's eqn for isentropic flow, normal shock waves . Numerical Problem; Laminar and turbulent boundary layers. | **10 Hours** | **L1, L2, L3. L4** |
| **Course outcomes:**<br>After studying this course, students will be able to: | | |

1. Evaluate the effect of fluid properties.
2. Apply the governing laws of fluid flow.
3. Classify different types of fluid flows.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions.
- Interpretation of data.

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**


1. Bansal, R.K, "Fluid Mechanics and Hydraulics Machines", Laxmi Publications (P) Ltd., New Delhi, 9th edition, 2017, ISBN-13: 978-8131808153.
2. Rathakrishnan. E, "Fluid Mechanics", Prentice-Hall of India Pvt.Ltd,3rd edition,2012, ISBN 13: 978-8120345935.


**Reference Books:**


1. Yunus A. Cengel & John M Cimbala, Fluid Mechanics and Applications, McGraw Hill Education; 3rd edition, 2013, ISBN-13: 978-0073380322.
2. Ramamritham. S "Hydraulic Fluid Mechanics and Fluid Machines", DhanpatRai& Sons, Delhi, 1988, ISBN 13: 9788187433804.
3. Kumar. K.L., "Engineering Fluid Mechanics" (VII Ed.) Eurasia Publishing House (P) Ltd., New Delhi, 1995, ISBN 13: 9788121901000.
4. Streeter. V. L., and Wylie, E.B., "Fluid Mechanics", McGraw Hill,9th edition,2010, ISBN 13: 978-0070701403.


## AEROSPACE MATERIALS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

| | | | |
|---|---|---|---|
| Subject Code | **17AS36** | IA Marks | 40 |
| Number of Lecture Hours/Week | 03 | Exam Hours | 03 |
| Total Number of Lecture Hours | 40 | Exam Marks | 60 |
| CREDITS – 03 | | | |

**Course objectives:** This course will enable students to

1. Acquire knowledge of different aerospace materials & their properties.
2. Understand the Heat Treatment processes of aircraft metals and alloys
3. Characteristics and Applications of Aluminum alloys, Ceramics, Composites and High Temperature Materials.

| Modules | Teaching Hours | Revised Bloom's Taxonomy (RBT) Level |
| --- | --- | --- |
| **Module -1**<br>**Mechanical Behaviour of Engineering Materials:** Introduction to aerospace materials and their classification, Linear and non-linear elastic properties - Stress and Strain Curves - Yielding and strain Hardening, Toughness - Modules of resilience -- Bauchinger's effect - Effect of notches - Testing and flaw detection of materials and components, knowledge of various material testing machines | **09 Hours** | **L1, L2** |
| **Module -2**<br>**Non-ferrous materials in aircraft construction :** Aluminium and its alloys: Types and identification. Properties - Castings - Heat treatment processes - Surface treatments.<br>Magnesium and its alloys: Cast and Wrought alloys - Aircraft application, features specification, fabrication problems, Special treatments.<br>Titanium and its alloys: Applications, machining, forming, welding and heat treatment, Copper Alloys.<br>Wood and fabric in aircraft construction and specifications - Glues Use of glass, plastics & rubber in aircraft, Introduction to glass & carbon composite. | **09 Hours** | **L1, L2** |
| **Module -3**<br>**Ferrous materials in aircraft construction:** Steels : Plain and low carbon steels , various low alloy steels, aircraft steel specifications, corrosion and heat resistant steels, structural applications.<br>Maraging Steels: Properties and Applications.<br>Super Alloys: Use - Nickel base - Cobalt base - Iron base - Forging and Casting of Super alloys - Welding, Heat treatment. | **08 Hours** | **L1, L2, L3** |
| **Module -4**<br>**Ceramics and Composites:** Introduction, modern ceramic materials, cermets, glass ceramic, production of semi fabricated forms, Carbon/Carbon composites, Fabrication processes involved in metal matrix composites, polymer composites, applications in aerospace vehicle design. | **08 Hours** | **L1, L2** |
| **Module -5**<br>**High Temperature Materials Characterization:** Classification, production and characteristics, Methods and testing, | **08 Hours** | **L1, L2** |

| | | |
|---|---|---|
| Determination of mechanical and thermal properties of materials at elevated temperatures, Application of these materials in Thermal protection systems of Aerospace vehicles, High temperature material characterization. | | |

**Course outcomes:**

At the end of this course the student will be able to :

1. Apply the knowledge about the mechanical behaviour of different aircraft & aerospace materials.
2. Explain the applications of Aluminum alloys, Ceramics and Composites Materials.
3. Appreciate the importance of high temperature materials and their characterization.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Environment and Sustainability.
- Life long learning.

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

1. Titterton G F, Aircraft Material and Processes, English Book Store, New Delhi, 5th edition, 1998, ISBN-13: 978-8175980136
2. H Buhl, Advanced Aerospace Materials, Springer, Berlin 1992, ISBN-13: 978-3540558880.

**Reference Books:**

1. Balram Gupta, Aerospace material Vol. 1,2,3,4 ARDB, S Chand & Co ,2009, ISBN-13: 978-8121922005.
2. Parker E R, Materials for Missiles and Space, McGraw-Hill Inc., US, 1963, ISBN-13: 978 - 0070485013
3. Hill E T, The Materials of Aircraft Construction, Pitman London.
4. C G Krishnadas Nair, Handbook of Aircraft materials, Interline publishers, Bangalore, 1993

## MATERIAL TESTING AND METROLOGY LAB

[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – III

| Subject Code | **17ASL37** | IA Marks | 40 |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Number of Lecture Hours/Week | 03 | Exam Hours | 03 |
| Total Number of Lecture Hours | 42 | Exam Marks | 60 |
| CREDITS – 02 | | | |

**Course objectives:** This course will enable students to

1. Understand the relations among materials and their properties.
2. Learn the concepts of mechanical measurements and metrology
3. Use the concept of accuracy, error, calibration.

| Modules | Revised Bloom's Taxonomy (RBT) Level |
|---|---|
| 1. Hardness Testing – Vicker's, Brinell, Rockwel | L1, L2, L3, L4 |
| 2. Tensile Test & Torsional Test | L1, L2, L3, L4 |
| 3. Impact Test | L1, L2, L3, L4 |
| 4. Fatigue Test | L1, L2, L3, L4 |
| 5. Heat treatment: Annealing, normalizing, hardening and tempering of steel. Hardness studies of heat-treated samples. | L1, L2, L3, L4, L5 |
| 6. To study the wear characteristics of ferrous, non-ferrous and composite materials for different parameters. | L1, L2, L3, L4 |
| 7. Measurement of vibration parameters using vibration setup. | L1, L2, L3, L4 |
| 8. Measurements using Optical Projector / Toolmaker Microscope. | L1, L2, L3 |
| 9. Measurement of angle using Sine Center / Sine bar / bevel protractor | L1, L2, L3 |
| 10. Measurement of alignment using Autocollimator / Roller set | L1, L2, L3 |
| 11. Measurement of Screw thread Parameters using Two-wire or Three-wire method. | L1, L2, L3 |
| 12. Measurements of Surface roughness, Using Tally Surf/Mechanical Comparator | L1, L2, L3 |
| 13. Measurement of gear tooth profile using gear tooth vernier /Gear tooth micrometer | L1, L2, L3 |
| 14. Calibration of Micrometer using slip gauges | L1, L2, L3 |

**Course outcomes:**
After studying this course, students will be able to:

1. Apply the relations among materials properties.
2. Identify and classify different measuring tools related to experiments and Identify, define, and explain accuracy, precision.
3. Conduct, Analyze, interpret, and present measurement data from measurements experiments.

| |
|---|
| **Conduct of Practical Examination:**<br>1. All laboratory experiments are to be included for practical examination.<br>2. Students are allowed to pick one experiment from the lot.<br>3. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.<br>4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero. |
| **Graduate Attributes (as per NBA):**<br>• Engineering Knowledge.<br>• Problem Analysis.<br>• Interpretation of data. |

## FLUID MECHANICS LAB

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – III

| | | | |
|---|---|---|---|
| Subject Code | **17ASL38** | IA Marks | 40 |
| Number of Lecture Hours/Week | 03 | Exam Hours | 03 |
| Total Number of Lecture Hours | 42 | Exam Marks | 60 |

CREDITS – 02

**Course objectives:** This course will enable students to:

1. Gain the knowledge of various flow meters and the concept of fluid mechanics.
2. Understand the Bernoulli's Theorem.
3. Measure the pressure using Manometers.

| **Modules** | **Revised Bloom's Taxonomy (RBT) Level** |
|---|---|
| 1. Calibration of Venturimeter | **L1, L2, L3** |
| 2. Calibration of Orifice meter | **L1, L2, L3, L4, L5** |
| 3. Determination of Coefficient of discharge for a small orifice by a constant head method. | **L1, L2, L3, L4, L5** |
| 4. Determination of Coefficient of discharge for an external mouthpiece by variable head method | **L1, L2, L3** |
| 5. Calibration of contracted Rectangular Notch | **L1, L2, L3** |
| 6. Calibration of contracted Triangular Notch | **L1, L2, L3** |
| 7. Determination of Coefficient of loss of head in a sudden contraction and friction factor | **L1, L2, L3, L4, L5** |
| 8. Verification of Bernoulli's equation | **L1, L2, L3** |

| | |
|---|---|
| 9. Determination of Viscosity of a Fluid | **L1, L2, L3** |
| 10. Pipe friction apparatus with loss of head on pipe fittings | **L1, L2, L3** |
| 11. Pelton wheel turbine with mechanical loading | **L1, L2, L3** |
| 12. Multistage centrifugal pump | **L1, L2, L3** |
| 13. Combined orifice meter & venture meter set up Notch apparatus | **L1, L2, L3** |
| 14. Flow visualization equipment | **L1, L2, L3** |

**Course outcomes:**

After studying this course, students will be able to:

1. Acquire knowledge of flow meters and flow visualization.
2. Give student insight into working of various fluid machines.
3. Compare performance of fluid machines under different working conditions.

**Conduct of Practical Examination:**

1. All laboratory experiments are to be included for practical examination.
2. Students are allowed to pick one experiment from the lot.
3. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Interpretation of data.

# Curriculum and Syllabus for 4th Semester, Aerospace Engineering

# B.E. AEROSPACE ENGINEERING

**IV SEMESTER**

| Sl. No | Subject Code | Title | Teaching Dept. | Teaching Hours /Week | | Examination | | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory | Practical / Drawing | Duration | Theory/ Practical Marks | I.A. Marks | Total Marks | |
| 1 | 17MAT 41 | ENGINEERING MATHAMATICS - IV | Mathematics | 04 | | 03 | 60 | 40 | 100 | 4 |
| 2 | 17AS42/ 17AE42 | AERODYNAMICS - I | AS | 04 | | 03 | 60 | 40 | 100 | 4 |
| 3 | 17AS43 | AEROSPACE STRUCTURES-I | AS | 04 | | 03 | 60 | 40 | 100 | 4 |
| 4 | 17AS44/ 17AE44 | MECHANISMS AND MACHINE THEORY | AS | 04 | | 03 | 60 | 40 | 100 | 4 |
| 5 | 17AS45 | HEAT & MASS TRANSFER | AS | 04 | | 03 | 60 | 40 | 100 | 4 |
| 6 | 17AS46 | COMPOSITE MATERIALS | AS | 03 | | 03 | 60 | 40 | 100 | 3 |
| 7 | 17ASL47 | MANUFACTURING TECHNOLOGY LAB | AS | | 1I+2P | 03 | 60 | 40 | 100 | 2 |
| 8 | 17ASL48 | COMPUTER AIDED AIRCRAFT DRAWING LAB | AS | | 1I+2P | 03 | 60 | 40 | 100 | 2 |
| 9 | 17KL/CPH39/49 Core Course | Kannada/Constitution of India, Professional Ethics & Human Rights | Humanities | 01 | | 01 | 30 | 20 | 50 | 1 |
| **TOTAL** | | | | **24** | **06** | **25** | **510** | **340** | **850** | **28** |

**1. Core subject:** This is the course which is to be compulsorily studied by a student as a core requirement to complete the

requirement of a programme in a said discipline of study.

**2. Foundation Course**: The courses based upon the content that leads to Knowledge enhancement.

**B.E.SYLLABUS FOR 2017-2021**

# ENGINEERING MATHEMATICS-IV

**(Common to all Branches)**

**Course Code : 17MAT41** | **CIE Marks : 40**
**Contact Hours/Week : 04** | **SEE Marks: 60**
**Total Hours: 50** | **Exam Hours:03**
**Semester: IV** | **Credits: 04(4:0:0)**

**Course Objectives:**
The purpose of this course is to make students well conversant with numerical methods to solve ordinary differential equations, complex analysis, sampling theory and joint probability distribution and stochastic processes arising in science and engineering.

| MODULE | RBT Levels | No. of Hrs |
|---|---|---|
| **MODULE-I**<br>**Numerical Methods**: Numerical solution of ordinary differential equations of first order and first degree, Taylor's series method, modified Euler's method. Runge - Kutta method of fourth order, Milne's and Adams-Bashforth predictor and corrector methods (No derivations of formulae-single step computation only). | **L1 & L2** | **10** |
| **MODULE-II**<br>**Numerical Methods**: Numerical solution of second order ordinary differential equations, Runge-Kutta method and Milne's method. (No derivations of formulae-single step computation only).<br>**Special Functions:** Series solution of Bessel's differential equation leading to $J_n(x)$-Bessel's function of first kind. Basic properties and orthogonality. Series solution of Legendre's differential equation leading to $P_n(x)$-Legendre polynomials. Rodrigue's formula, problems | **L3** | **10** |
| **MODULE-III**<br>**Complex Variables:** Review of a function of a complex variable, limits, continuity, differentiability. Analytic functions-Cauchy-Riemann equations in cartesian and polar forms. Properties and construction of analytic functions. Complex line integrals-Cauchy's theorem and Cauchy's integral formula, Residue, poles, Cauchy's Residue theorem ( without proof) and problems.<br>**Transformations:** Conformal transformations-Discussion of transformations: $w = z^2$, $w = e^z$, $w = z + (1/z)(z \neq 0)$. Bilinear transformations-problems. | **L1 & L3**<br><br>**L3** | **10** |
| **MODULE-IV**<br>**Probability Distributions:** Random variables (discrete and continuous), probability mass/density functions. Binomial distribution, Poisson distribution. Exponential and normal distributions, problems.<br>**Joint probability distribution:** Joint Probability distribution for two discrete random variables, expectation, covariance, correlation coefficient. | **L3** | **10** |

| | | |
|---|---|---|
| **MODULE-V**<br>**Sampling Theory:** Sampling, Sampling distributions, standard error, test of hypothesis for means and proportions, confidence limits for means, student's t-distribution, Chi-square distribution as a test of goodness of fit.<br>**Stochastic process:**<br>Stochastic processes, probability vector, stochastic matrices, fixed points, regular stochastic matrices, Markov chains, higher transition probability-simple problems. | **L3**<br><br>**L1&L2** | **10** |

**Course Outcomes:** On completion of this course, students are able to:

6. Solve first and second order ordinary differential equation arising in flow problems using single step and multistep numerical methods.
7. Illustrate problems of potential theory, quantum mechanics and heat conduction by employing notions and properties of Bessel's functions and Legendre's polynomials.
8. Explain the concepts of analytic functions, residues, poles of complex potentials and describe conformal and Bilinear transformation arising in field theory and signal processing.
9. Develop probability distribution of discrete, continuous random variables and joint probability distribution occurring in digital signal processing, information theory and design engineering.
10. Demonstrate testing of hypothesis of sampling distributions and illustrate examples of Markov chains related to discrete parameter stochastic process.

**Question Paper Pattern:**

**Note:- The SEE question paper will be set for 100 marks and the marks will be proportionately reduced to 60.**

- The question paper will have **ten** full questions carrying equal marks.
- Each full question consisting of **20** marks.
- There will be **two** full questions (with a **maximum** of **four** sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer **five** full questions, selecting **one** full question from each module.

**Text Books:**

3. *B.S. Grewal: Higher Engineering Mathematics, Khanna Publishers, 43rd Ed., 2015.*
4. *E. Kreyszig: Advanced Engineering Mathematics, John Wiley & Sons, 10th Ed., 2015.*

**Reference books**:

*N.P.Bali and Manish Goyal: A Text Book of Engineering Mathematics, Laxmi Publishers,7th Ed., 2010.*

2. *B.V.Ramana: "Higher Engineering M athematics" Tata McGraw-Hill, 2006.*
3. *H. K. Dass and Er. RajnishVerma: "Higher Engineerig Mathematics", S. Chand publishing, 1st edition, 2011.*

# VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
# CHOICE BASED CREDIT SYSTEM (CBCS)
# SCHEME OF TEACHING AND EXAMINATION 2017-2018

## AERODYNAMICS - I

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV

| | | | |
|---|---|---|---|
| Subject Code | **17AS42/17AE42** | IA Marks | 40 |
| Number of Lecture Hours/Week | 04 | Exam Hours | 03 |
| Total Number of Lecture Hours | 50 | Exam Marks | 60 |

CREDITS – 04

**Course objectives:** This course will enable students to

1. Understand the basics of fluid mechanics as a prerequisite to Aerodynamics
2. Acquire knowledge on typical airfoil characteristics and two-dimensional flows over airfoil and study the incompressible over finite wings
3. Assimilate the understanding of application of finite wing theory and high lift systems.

| **Modules** | **Teaching Hours** | **Revised Bloom's Taxonomy (RBT) Level** |
|---|---|---|
| **Module -1**<br><br>**Review of Basic Fluid Mechanics:** Continuity, momentum and energy equation, Control volume approach to Continuity, momentum and energy equation, Types of flow, pathlines, streamlines, and streaklines, units and dimensions, inviscid and viscous flows, compressibility, Mach number regimes. Vorticity, Angular velocity, Stream function, velocity potential function, Circulation, Numericals, Mach cone and Mach angle, Speed of sound. | **10 Hours** | **L1, L2** |
| **Module -2**<br><br>**Airfoil Characteristics:** Fundamental aerodynamic variables, Airfoil nomenclature, airfoil characteristics. wing planform geometry, aerodynamic forces and moments, centre of pressure, pressure coefficient, aerodynamic center, calculation of airfoil lift and drag from measured surface pressure distributions, typical airfoil aerodynamic characteristics at low speeds. Types of drag-Definitions. | **10 Hours** | **L1, L2** |
| **Module -3**<br><br>**Two Dimensional Flows & Incompressible Flow Over Airfoil:** Uniform flow, Source flow, Sink flow, Combination of a uniform flow with source and sink. Doublet flow. Non-lifting flow over a circular cylinder. Vortex flow. Lifting flow over a circular cylinder. Kutta-Joukowski theorem and generation of Lift, D'Alembert's paradox, Numericals.<br>**Incompressible flow over airfoils:** Kelvin's circulation theorem and the starting vortex, vortex sheet, Kutta condition, Classical thin airfoil theory for symmetric and cambered airfoils. Kutta-Joukowski theorem and generation of Lift, Numericals. | **10 Hours** | **L1, L2, L3, L4, L5** |

| | | |
|---|---|---|
| **Module -4**<br>**Incompressible Flow Over Finite Wings:** Biot-Savart law and Helmholtz's theorems, Vortex filament: Infinite and semi-infinite vortex filament, Induced velocity. Prandtl's classical lifting line theory: Downwash and induced drag. Elliptical and modified elliptical lift distribution. Lift distribution on wings. Limitations of Prandtl's lifting line theory. Extended lifting line theory- lifting surface theory, vortex lattice method for wings. Lift, drag and moment characteristics of complete airplane. | **10 Hours** | **L1, L2** |
| **Module -5**<br>**Applications of Finite Wing Theory & High Lift Systems:** Simplified horse-shoe vortex model, formation flight, influence of downwash on tail plane, ground effects. Swept wings: Introduction to sweep effects, swept wings, pressure coefficient, typical aerodynamic characteristics, Subsonic and Supersonic leading edges. Introduction to high-lift systems, flaps, leading-edge slats and typical high – lift characteristics. critical Mach numbers, Lift and drag divergence, shock induced separation, Effects of thickness, camber and aspect ratio of wings, Transonic area rule, Tip effects. Introduction to Source panel & vortex latice method. | **10 Hours** | **L1, L2, L3** |

**Course outcomes:**

After studying this course, students will be able to:

1. Evaluate typical airfoil characteristics and two-dimensional flows over airfoil
2. Compute and analyze the incompressible flow over finite wings
3. Apply finite wing theory and design high lift systems from the aerodynamics view point.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly).
- Interpretation of data.

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

1. Anderson J .D, "Fundamental of Aerodynamics", McGraw-Hill, New York, 5th edition ,2011, ISBN-13: 978-0073398105.
2. E. L. Houghton, P.W. Carpenter, "Aerodynamics for Engineering Students", Elsevier-New York, 5th edition,2010, ISBN-13: 978-0080966328.

**Reference Books:**

1. Clancy L. J. "Aerodynamics", Sterling book house, New Delhi, 2006 , ISBN 13: 9780582988804
2. Louis M. Milne-Thomson, "*Theoretical Aerodynamics*", Dover Publications-USA, Imported Edition,2011, ISBN 9780486619804.

# AEROSPACE STRUCTURES – I

[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – IV

| | | | |
|---|---|---|---|
| Subject Code | **17AS43** | IA Marks | 40 |
| Number of Lecture Hours/Week | 04 | Exam Hours | 03 |
| Total Number of Lecture Hours | 50 | Exam Marks | 60 |

CREDITS – 04

**Course objectives:** This course will enable students to

1. Comprehend the basic concepts of stress and strain.
2. Acquire the knowledge of types of loads on aerospace vehicles.
3. Understand the theory of elasticity.

| **Modules** | **Teaching Hours** | **Revised Bloom's Taxonomy (RBT) Level** |
|---|---|---|
| **Module -1**<br><br>**Design for Static Strength:** Introduction: Normal, shear, biaxial and tri-axial stresses, Stress tensor, Principal Stresses, Stress Analysis, Design considerations, Codes and Standards. Static Strength: Static loads and factor of safety, Theories of failure: Maximum normal stress theory, Maximum shear stress theory, Maximum strain theory, Strain energy theory, and Distortion energy theory, failure of brittle and ductile materials, Stress concentration, and Determination of Stress concentration factor. | **10 Hours** | **L1, L2** |
| **Module -2**<br><br>**Design for Impact and Fatigue Strength:** Impact Strength: Introduction, Impact stresses due to axial, bending and torsional loads, effect of inertia. Fatigue Strength: Introduction, S-N Diagram, Low cycle fatigue, High cycle fatigue, Endurance limit, modifying factors: size effect, surface effect, Stress concentration effects, Fluctuating stresses, Goodman and Soderberg relationship, stresses due to combined loading, cumulative fatigue damage. | **10 Hours** | **L1, L2** |
| **Module -3**<br>**Loads on Aircraft**: Structural nomenclature, Types of loads, load factor, Aerodynamics loads, Symmetric manoeuvre loads, Velocity diagram, Function of structural components.<br>**Aircraft Materials:** Metallic and non-metallic materials, Use of Aluminium alloy, titanium, stainless steel and composite materials. Desirable properties for aircraft application. Fracture and Fatigue, Stress Intensity Factor, Crack Growth Rate Derivation. | **10 Hours** | **L1, L2, L3** |

| | | |
|---|---|---|
| **Module -4**<br>**Theory of Elasticity:** Theory of Elasticity: Concept of stress and strain, derivation of Equilibrium equations, strain displacement relation, compatibility conditions and boundary conditions. Plane stress and Plane strain problems in 2D elasticity. Principle Stresses and Orientation of Principle Directions.<br>**Structures:** Statically Determinate and Indeterminate structures, Analysis of plane truss, Method of joints, 3D Truss, Plane frames, Composite beam, Clapeyron's Three Moment Equation. | **10 Hours** | **L1, L2, L3** |
| **Module -5**<br>**Energy Methods:** Strain Energy due to axial, bending and Torsional loads. Castigliano's theorem, Maxwell's Reciprocal theorem.<br>**Columns**: Columns with various end conditions, Euler's Column curve, Rankine's formula, Column with initial curvature, Eccentric loading, south-well plot, Beam-column.<br>**Fundamentals:** Different modes of heat transfer and mass and momentum transfer, elements of mass diffusion and boundary layer theory. Mass transfer definition and terms used in mass transfer analysis, Ficks First law of diffusion (no numerical). | **10 Hours** | **L1, L2, L3** |

**Course outcomes:**
After studying this course, students will be able to:
1. Apply the basic concepts of stress and strain analysis.
2. Compute the impact stress.
3. Identify appropriate materials for suitable application based on properties.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Interpretation of data

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**
1. Megson, T.H.G ,'Aircraft Structures for Engineering Students', Butterworth-Heinemann,6th edition,2016,ISBN-13: 978-0081009147
2. Donaldson, B.K., "Analysis of Aircraft Structures – An Introduction", Cambridge University Press,2nd edition,2012,ISBN-13: 978-1107638167.

**Reference Books:**

1. Robert L. Norton , Machine Design, , Pearson Education Asia,2nd edition, 2002,ISBN-13: 978-

8131705339.
2. V.B. Bhandari, 'Design of Machine Elements', Tata McGraw Hill Publishing Company Ltd., New Delhi, 2nd Edition, 2007.
3. Timoshenko and Goodier," 'Theory of Elasticity', McGraw Hill Co,3rd edition,2010,ISBN-13: 978-0070701229
4. Timoshenko, S., "Strength of Materials", Vol. I and II, CBS,3rd edition,2004,ISBN-13: 978-8123910307
5. Joseph E Shigley and Charles R.Mischke. , Mechanical Engineering Design, McGraw Hill International edition, 6th Edition ,2009.
6. Peery, D.J., and Azar, J.J., "Aircraft Structures", McGraw, Hill, N.Y, 2nd edition, 1993.
7. Bruhn. E.H. "Analysis and Design of Flight vehicles Structures", Tri – state off set company, USA, 1985.

**DESIGN DATA HANDBOOK:**

1) **K. Lingaiah**, Design Data Hand Book, McGraw Hill, 2nd Ed.
2) **K. Mahadevan and Balaveera Reddy** , Data Hand Book, CBS Publication

# MECHANISMS AND MACHINE THEORY

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV

| | | | |
|---|---|---|---|
| Subject Code | **17AS44/17AE44** | IA Marks | 40 |
| Number of Lecture Hours/Week | 04 | Exam Hours | 03 |
| Total Number of Lecture Hours | 50 | Exam Marks | 60 |

CREDITS – 04

**Course objectives:** This course will enable students to

1. Understand the theory of mechanisms including velocity, acceleration and static force analysis.
2. Acquire knowledge of spur gears, gear train, balancing of rotating and reciprocating masses.
3. Understand the concept of governors and gyroscope

| **Modules** | **Teaching Hours** | **Revised Bloom's Taxonomy (RBT) Level** |
|---|---|---|
| **Module -1**<br><br>**Introduction to Mechanisms:** Types of constrained motion, Link and its types, joints and its types, kinematic pair and its types, degrees of freedom, Grubler's criterion, Types of kinematic chains and inversions: Inversions of Four bar chain: Beam engine, coupling rod of a locomotive, Watt's indicator mechanism. Inversions of Single Slider Crank Chain: Pendulum pump or Bull engine, Oscillating cylinder engine, Rotary internal combustion engine, Crank and slotted lever quick return motion mechanism, Whitworth quick return motion mechanism. Inversions of Double Slider Crank Chain: Elliptical trammels, Scotch yoke mechanism, Oldham's coupling. Straight line motion mechanisms: Peaucellier's mechanism and Robert's mechanism. Intermittent Motion mechanisms: Geneva wheel mechanism and | **10 Hours** | **L1, L2** |

| | | |
|---|---|---|
| Ratchet and Pawl mechanism, Ackerman steering gear mechanism. | | |
| **Module -2**<br>**Velocity, Acceleration and static force analysis of Mechanisms (Graphical Methods):** Velocity and acceleration analysis of Four Bar mechanism, slider crank mechanism and Simple Mechanisms by vector polygons.<br><br>**Static force analysis:** Introduction: Static equilibrium, Equilibrium of two and three force members. Members with two forces and torque. Free body diagrams, principle of virtual work. Static force analysis of four bar mechanism and slider-crank mechanism with and without friction. | **10 Hours** | **L1, L2, L3, L4** |
| **Module -3**<br><br>**Spur Gears:** Gear terminology, law of gearing, Path of contact, Arc of contact, Contact ratio of spur gear, Interference in involute gears, Methods of avoiding interference.<br><br>**Gear Trains:** Simple gear trains, Compound gear trains, Reverted gear trains, Epicyclic gear trains, Analysis of epicyclic gear train (Algebraic and tabular methods), torques in epicyclic trains. | **10 Hours** | **L1, L2, L3, L4** |
| **Module -4**<br>**Balancing of Rotating Masses:** Balancing of Several Masses Rotating in the Same Plane, Balancing of Several Masses Rotating in Different Planes (only Graphical Methods).<br>**Balancing of Reciprocating Masses:** Primary and Secondary Unbalanced Forces of Reciprocating Masses, Partial Balancing of Unbalanced Primary Force in a Reciprocating Engine, Balancing of Primary and secondary Forces of Multi-cylinder In-line Engines, Balancing of Radial Engines (only Graphical Methods) | **10 Hours** | **L1, L2, L3, L4** |
| **Module -5**<br>**Governors:** Types of governors; force analysis of Porter and Hartnell governors, Controlling force, stability, sensitiveness, isochronism, effort and power of Porter and Hartnell governors.<br>**Gyroscopes:** Vectorial representation of angular motion, gyroscopic couple, effect of gyroscopic couple on plane disc and aeroplane. | **10 Hours** | **L1, L2, L3, L4** |

**Course outcomes:**

After studying this course, students will be able to:

1. Apply the theory of velocity, acceleration and static force analysis to design of mechanisms.
2. Design spur gears, gear train, balancing of rotating and reciprocating masses.
3. Apply governors and gyroscope.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.

- Design / development of solutions (partly).
- Interpretation of data.

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

1. Rattan S.S, "Theory of Machines", Tata McGraw-Hill Publishing Company Ltd., New Delhi,3rd edition ,2009, ISBN: 007014477X, 9780070144774.
2. J.J. Uicker, G.R. Pennock, J.E. Shigley, "Theory of Machines & Mechanisms", OXFORD, 3rd edition, 2009, ISBN-13: 978-0195371239

**Reference Books:**

1. R. S. Khurmi, J.K. Gupta, "Theory of Machines", Eurasia Publishing House, 2008.
2. Robert L Norton, "Design of Machinery",McGraw Hill,3rd edition,2003,ISBN-13: 978-0072470468.
3. Ambekar, "Mechanism and Machine theory", PHI Learning Pvt. Ltd.,1st edition,2007,ISBN-13: 978-8120331341

## HEAT & MASS TRANSFER

[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – IV

| | | | |
|---|---|---|---|
| Subject Code | **17AS45** | IA Marks | 40 |
| Number of Lecture Hours/Week | 04 | Exam Hours | 03 |
| Total Number of Lecture Hours | 50 | Exam Marks | 60 |

CREDITS – 04

**Course objectives:** This course will enable students to

1. Understand the different modes of heat transfer.
2. Understand the free convection and forced convection.
3. Acquire the knowledge of heat transfer problems in combustion chambers.

| **Modules** | **Teaching Hours** | **Revised Bloom's Taxonomy (RBT) Level** |
|---|---|---|

| | | |
|---|---|---|
| **Module -1**<br><br>**Fundamentals:** Different modes of heat transfer and mass and momentum transfer, elements of mass diffusion and boundary layer theory. Mass transfer definition and terms used in mass transfer analysis, Ficks First law of diffusion (no numerical). | **10 Hours** | **L1, L2** |
| **Module -2**<br><br>**Conduction:** Derivation of general three dimensional conduction equation in Cartesian coordinate, special cases, discussion on 3-D conduction in cylindrical and spherical coordinate systems. Effect of variation of thermal conductivity on heat transfer in solids - Heat transfer problems in infinite and semi infinite solids - Extended surfaces. One dimensional transient heat conduction: Systems with negligible internal resistance, Significance of Biot and Fourier Numbers, Chart solutions of transient conduction systems. | **10 Hours** | **L1, L2** |
| **Module -3**<br><br>**Convection:** Concepts of Continuity, Momentum and Energy Equations. Dimensional analysis-Buckingham's Pi Theorem - Application for developing non-dimensional correlation for convective heat transfer<br><br>**Free Convection:** Development of Hydrodynamic and thermal boundary layer along a vertical plate , Use of empirical relations for Vertical plates and pipes.<br><br>**Forced Convection:** External Flows, Concepts of hydrodynamic and thermal boundary layer and use of empirical correlations for Flat plates and Cylinders. Internal Flows, Concepts about Hydrodynamic and Thermal Entry Lengths, use of empirical correlations for Horizontal Pipe Flow and annulus flow. | **10 Hours** | **L1, L2, L3** |
| **Module -4**<br>**Radiation &Heat Exchangers Design: Radiation :** Introduction to physical mechanism - Radiation properties - Radiation shape factors - Heat exchange between non-black bodies - Radiation shields<br>**Heat Exchangers:** Classification of heat exchangers; overall heat transfer coefficient, fouling and fouling factor; LMTD, Effectiveness-NTU methods of analysis of heat exchangers. Numerical problems. | **10 Hours** | **L1, L2, L3** |
| **Module -5**<br><br>**Heat and Mass Transfer Problems in Aerospace Engineering:** Heat transfer problems in gas turbine combustion chambers - Rocket thrust chambers - Aerodynamic heating -Ablative heat transfer.<br>**Mass Transfer:** Introduction, Ficks law, Species conservation equation, Introduction to convective and diffusive mass transfer. | **10 Hours** | **L1, L2, L3** |

**Course outcomes:**
After studying this course, students will be able to:
1. Evaluate the effect of fluid properties.

2. Familiarize the student in the area of conduction, convection and radiation.
3. Analyze the problems due to heat transfer in several areas.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Interpretation of data

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

1. Ozisik, Heat transfer-A basic approach, Tata McGraw Hill 2002
2. Holman, J.P., " Heat Transfer ", McGraw Hill Book Co., Inc., New York, 8th edition., 1996, ISBN-13: 978-0071143202

**Reference Books:**

1. Sachdeva, S.C., " Fundamentals of Engineering Heat and Mass Transfer " , Wiley Eastern Ltd., New Delhi, 1981.
2. Sutton, G.P., " Rocket Propulsion Elements ", John Wiley and Sons, 5th Edn.1986.
3. Mathur, M.and Sharma, R.P., " Gas Turbine and Jet and Rocket Propulsion " , Standard Publishers, New Delhi 1988.
4. P.K. Nag, Heat transfer, Tata McGraw Hill 2002
5. Yunus A- Cengel , Heat transfer, a practical approach, Tata McGraw Hill , 3rd edition, 2007.

# COMPOSITE MATERIALS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV

| | | | |
|---|---|---|---|
| Subject Code | **17AS46** | IA Marks | 40 |
| Number of Lecture Hours/Week | 03 | Exam Hours | 03 |
| Total Number of Lecture Hours | 40 | Exam Marks | 60 |

**CREDITS – 03**

**Course Objectives :**

This course will enable students to

1. Understand the advantages of composite materials compared to conventional materials
2. Evaluate the properties of polymer matrix composites with fiber reinforcements
3. Explain the manufacturing process and applications of composite materials

| **Modules** | **Teaching Hours** | **Revised Bloom's Taxonomy** |
|---|---|---|

| | | (RBT) Level |
|---|---|---|
| **Module -1**<br>**Introduction to Composite Materials:** Definition, classification of composite materials, classification of reinforcement - particulate, short fiber, whiskers, long fibers composites. matrix materials – metals, ceramics, polymers (including thermoplastics and thermosets), Carbon-Carbon Composites<br>**Metal Matrix Composites:** MMC with particulate and short fiber reinforcement, liquid and solid state processing of MMC – stir casting, squeeze casting. Properties of MMCs, Applications of Al, Mg, Ti based MMC | **8 Hours** | **L1, L2, L3** |
| **Module -2**<br>**Processing of Polymer Matrix Composites: Thermoset Polymers** Hand layup Process, Vacuum Bagging Process, Post Curing Process, Filament winding, Pultrusion, Pulforming, Autoclave Process<br>**Processing of Polymer Matrix Composites: Thermoplastic Polymers** Extrusion process, Injection Moulding Process, Thermo-forming process. **Post Processing of Composites –** Adhesive bonding, drilling, cutting processes. | **9 Hours** | **L1, L2,L3** |
| **Module -3**<br>**Micro-Mechanical Behavior of a Lamina:** Determination of elastic constants-Rule of mixtures, transformation of coordinates, micro-mechanics based analysis and experimental determination of material constants.<br>**Macro-Mechanical Behavior of a Lamina:** Global and local axis for angle lamina, determination of global and local stresses and moduli, for 2D-UD lamina with different fiber orientation and different fiber materials glass, carbon and aramid fiber reinforcement. | **9 Hours** | **L2, L3, L4** |
| **Module -4**<br>**Failure Analysis:** Failure Theory – Tsai-Hill, Tsai-Wu, Max Stress and Max Strain Classical plate theory- Stress and strain variation in a laminate- Resultant forces and moments- A B & D matrices- Strength analysis of a laminate. | **8 Hours** | **L3,L4,L5** |
| **Module -5**<br>**Inspection & Quality Control** : Destructive & Non-Destructive Testing, Tensile, Compression, Flexural, Shear, Hardness; ultrasonic testing – A-B-C scan<br>**Applications of Composites Materials:** Automobile, Aircrafts, missiles, Space hardware, Electrical and electronics, marine, recreational and Sports equipment, future potential of composites. | **8 Hours** | **L2, L3** |

**Course Outcomes (CO):**

After studying this course, students will be able to:

1. Explain the advantages of using composite materials as an alternative to conventional materials for specific applications
2. Describe the advanced fabrication and processing for producing composite parts.
3. Evaluate the micro- and macro-mechanical behavior of composite laminates

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Modern Tool Usage and Interpretation of data

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

1. K.K Chawla, Composite Materials- Science and Engineering, Springer Verlag,2nd edition,1998, ISBN: 0-387-98409-7
2. Autar Kaw, Mechanics of Composites, CRC Press,2nd edition, 2006, ISBN:978-0-8493-1343-1

Reference Books:

1. Mein Schwartz, Composite Materials Handbook, Vol.3, Department of Defense, USA, 2002.
2. Ajay Kapadia, Non-Destructive Testing of Composite Materials, National Composites Network, Best Practices Guide, TWI Publications, 2006.
3. R M Jones, " Mechanics of Composite Materials", 2nd Edn, Taylor & Francis, 2015; ISBN:978-1560327127

## MANUFACTURING TECHNOLOGY LAB

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV

| | | | |
|---|---|---|---|
| Subject Code | **17ASL47** | IA Marks | 40 |
| Number of Lecture Hours/Week | 03 | Exam Hours | 03 |
| Total Number of Lecture Hours | 42 | Exam Marks | 60 |

CREDITS – 02

**Course objectives:** This course will enable students to

1. Learn the different methods of prepare the moulds.
2. Understand the functions of the lathe, milling, Shaping, Boring & Drilling machines.
3. Familiarize with different machining process.

| **Modules** | **Revised Bloom's Taxonomy (RBT) Level** |
|---|---|
| 1. Preparation of Green Sand Mould specimen and determination of Mechanical Properties using Universal Sand Testing Machine | **L1, L2, L3** |

| | |
|---|---|
| 2. Determination of Permeability of Green Sand | **L1, L2, L3** |
| 3. Forging and Microstructural analysis of mild steel | **L1, L2, L3** |
| 4. Composite Preparation using Hand Lay-up Process | **L1, L2, L3** |
| 5. Preparation of moulds using two moulding boxes.<br>With Patterns.<br>Without Patterns. | **L1, L2, L3** |
| 6. Preparation of Model Involving different lathe operations.<br>Thread Cutting.<br>Knurling. | **L1, L2, L3** |
| 7. Surface Milling & Step Milling in Vertical Milling Machine. | **L1, L2, L3** |
| 8. Machining and time estimation for drilling operation | **L1, L2, L3** |
| 9. Machining and time estimation for boring operation | **L1, L2, L3** |
| 10. Machining and time estimation for eccentric turning | **L1, L2, L3** |
| 11. Machining of square in shaping machine | **L1, L2, L3** |
| 12. Electric Discharge Machining. | **L1, L2, L3** |
| 13. Tungsten Inert-Gas Welding. | **L1, L2, L3** |
| 14. Preparation of Casting. | **L1, L2, L3** |

**Course outcomes:**

After studying this course, students will be able to:

1. Prepare the moulds.
2. Differentiate among different types of machining operations.
3. Manufacture a product using different machining process.

**Conduct of Practical Examination:**

1. All laboratory experiments are to be included for practical examination.
2. Students are allowed to pick one experiment from the lot.
3. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Communication.
- Teamwork.

# VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
# CHOICE BASED CREDIT SYSTEM (CBCS)
# SCHEME OF TEACHING AND EXAMINATION 2017-2018

## COMPUTER AIDED AIRCRAFT DRAWING

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV

| | | | |
|---|---|---|---|
| Subject Code | **17ASL48/17AEL48** | IA Marks | 40 |
| Number of Lecture Hours/Week | 03 | Exam Hours | 03 |
| Total Number of Lecture Hours | 42 | Exam Marks | 60 |

CREDITS – 02

**Course objectives:** This course will enable students to

1. Understand and interpret drawings of machine and aircraft components
2. Prepare assembly drawings either manually or by using standard CAD packages.
3. Familiarize with standard components and their assembly of an aircraft.

| **Modules** | **Revised Bloom's Taxonomy (RBT) Level** |
|---|---|
| **1. Sections of Solids:** Sections of Pyramids, Prisms, Cubes, Tetrahedrons, Cones and Cylinders resting only on their bases (No problems on axis inclinations, spheres and hollow solids). True shape of sections. | **L1, L2, L3, L6** |
| 2. **Orthographic Views:** Conversion of pictorial views into orthographic projections. of **simple machine parts** with or without section. (Bureau of Indian Standards conventions are to be followed for the drawings) Hidden line conventions. Precedence of lines. | **L1, L2, L3** |
| **3.Thread Forms:** Thread terminology, sectional views of threads. ISO Metric (Internal & External) BSW (Internal & External) square and Acme. Sellers thread, American Standard thread. | **L1, L2, L3** |
| **4.Fasteners:** Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly) simple assembly using stud bolts with nut and lock nut. Flanged nut, slotted nut, taper and split pin for locking, counter sunk head screw, grub screw, Allen screw. | **L1, L2, L3** |
| **5.Keys & Joints:** Parallel key, Taper key, Feather key, Gibhead key and Woodruff key | **L1, L2, L3** |
| **6.Riveted Joints:** Single and double riveted lap joints, butt joints with single/double cover straps (Chain and Zigzag, using snap head rivets). Cotter joint (socket and spigot), knuckle joint (pin joint) for two rods. | **L1, L2, L3** |

| | |
|---|---|
| **7. Couplings:**<br>Split Muff coupling, protected type flanged coupling, pin (bush) type flexible coupling, Oldham's coupling and universal coupling (Hooks' Joint) | **L1, L2, L3** |
| **8. Design of propeller and hub assembly** | **L1, L2, L3** |
| **9. Design of wing assembly** | **L1, L2, L3** |
| **10. Design of fuselage assembly** | **L1, L2, L3** |
| **11. Design of Engine Mounts** | **L1, L2, L3** |
| **12. Design of main rotor blade assembly of helicopter** | **L1, L2, L3, L4, L5, L6** |
| **13. Design of UAV assembly** | **L1, L2, L3, L4, L5, L6** |
| **14. Design of Landing Gear Assembly** | **L1, L2, L3, L4, L5, L6** |

**Course outcomes:**

After studying this course, students will be able to:

1. Distinguish drawings of machine and aircraft components
2. Identify assembly drawings either manually or by using standard CAD packages.
3. Practise with standard components and their assembly of an aircraft..

**Conduct of Practical Examination:**

1. All laboratory experiments are to be included for practical examination.
2. Students are allowed to pick one experiment from the lot.
3. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly)
- Interpretation of data.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2017-2018

# Curriculum and Syllabus for 5th Semester, Aerospace Engineering

# VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
# CHOICE BASED CREDIT SYSTEM (CBCS)
# SCHEME OF TEACHING AND EXAMINATION 2017-2018

## B.E. AEROSPACE ENGINEERING

**V SEMESTER**

| Sl. No | Subject Code | Title | Teaching Dept. | Teaching Hours /Week | | Examination | | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory | Practical/Drawing | Duration | Theory / Practical Marks | I.A. Marks | Total Marks | |
| 1 | 17AS51 | AEROSPACE STRUCTURES –II | AS | 04 | | 03 | 60 | 40 | 100 | 4 |
| 2 | 17AS52 | AEROSPACE PROPULSION | AS | 04 | | 03 | 60 | 40 | 100 | 4 |
| 3 | 17AS53 | AERODYNAMICS - II | AS | 04 | | 03 | 60 | 40 | 100 | 4 |
| 4 | 17AS54 | INTRODUCTION TO SPACE TECHNOLOGY | AS | 04 | | 03 | 60 | 40 | 100 | 4 |
| 5 | 17AS55X | **PROFESSIONAL ELECTIVE** | AS | 03 | | 03 | 60 | 40 | 100 | 3 |
| 6 | 17ASL566X | **OPEN ELECTIVE** | AS | 03 | | 03 | 60 | 40 | 100 | 3 |
| 7 | 17ASL57 | AERODYNAMICS LAB | AS | | 1I+2P | 03 | 60 | 40 | 100 | 2 |
| 8 | 17ASL58 | PROPULSION LAB | AS | | 1I+2P | 03 | 60 | 40 | 100 | 2 |
| **TOTAL** | | | | **22** | **06** | **24** | **480** | **320** | **800** | **26** |

| **Professional Elective** | | **Open Elective** | |
|---|---|---|---|
| 17AS551 | GAS TURBINE TECHNOLOGY | 17AS561/ 17AE561 | HISTORY OF FLIGHT & TECHNOLOGY FORECAST |
| 17AS552 | FLIGHT MECHANICS | 17AS562/ 17AE562 | ELEMENTS OF AERONAUTICS |
| 17AS553/17AE553 | THEORY OF VIBRATIONS | 17AS563 | INTRODUCTION TO ASTROPHYSICS AND SPACE ENVIRONMENT |
| 17AS554/ 17AE554 | AIRCRAFT ELECTRICAL SYSTEMS & INSTRUMENTATION | 17AS564 | MECHATRONICS |

1. **Core subject:** This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.
2. **Professional Elective:** Elective relevant to chosen specialization/ branch
3. **Open Elective**: Electives from other technical and/or emerging subject areas.

# VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
# CHOICE BASED CREDIT SYSTEM (CBCS)
# SCHEME OF TEACHING AND EXAMINATION 2017-2018

## AEROSPACE STRUCTURES - II

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – V

| | | | |
|---|---|---|---|
| Subject Code | **17AS51** | IA Marks | 40 |
| Number of Lecture Hours/Week | 04 | Exam Hours | 03 |
| Total Number of Lecture Hours | 50 | Exam Marks | 60 |

CREDITS – 04

**Course objectives:** This course will enable students to

1. Comprehend the basic concepts of theory of bending.
2. Acquire the knowledge of shear flow and buckling.
3. Understand the missile and satellite structures.

| Modules | Teaching Hours | Revised Bloom's Taxonomy (RBT) Level |
|---|---|---|
| **Module -1**<br>**Introduction:** Elementary theory of bending – Introduction to semi-Monocoque structures - Stresses in beams of symmetrical and unsymmetrical sections -Box beams – General formula for bending stresses- principal axes method – Neutral axis method. | **10 Hours** | **L1, L2** |
| **Module -2**<br>**Shear Flow:** Shear stresses in beams – Shear flow in stiffened panels - Shear flow in thin walled open tubes – Shear centre – Shear flow in open sections with stiffeners. | **10 Hours** | **L1, L2** |
| **Module -3**<br>**Shear Flow Analyses:** Shear flow in closed sections with stiffeners– Angle of twist - Shear flow in two flange and three flange box beams – Shear centre - Shear flow in thin walled closed tubes - Bredt-Batho theory - Torsional shear flow in multi cell tubes - Flexural shear flow in multi cell stiffened structures. | **10 Hours** | **L1, L2, L3** |
| **Module -4**<br>**Failure concepts:** Stability problems of thin walled structures– Buckling of sheets under compression, shear, bending and combined loads - Crippling stresses by Needham's and Gerard's methods–Sheet stiffener panels-Effective width, Inter rivet and sheet wrinkling failures-Tension field web beams(Wagner's). | **10 Hours** | **L1, L2** |
| **Module -5** | **10 Hours** | **L1, L2** |

| | | |
|---|---|---|
| **Launch Vehicle and Spacecraft Structures:** Launch vehicle structures – Loads and stresses, thin walled pressure vessels, Buckling of beams, thin wall assumption. spacecraft - mini, micro structures, inflatable structures, flying effector, nanotubing. | | |

**Course outcomes:**

After studying this course, students will be able to:

1. Compute the shear flow in open and closed section.
2. Analyze the stability problems of thin walled structures.
3. Distinguish the mini and micro structures.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Interpretation of data

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

1. Megson, T.M.G; Aircraft Structures for Engineering Students, ELSEVIER,5th edition,2013,ISBN-13: 978-9382291053.
2. E.F. Bruhn, "Analysis and Design of Flight Vehicle Structures", Tristate Offset Co., 1980.

**Reference Books:**

1. Peery, D.J. and Azar, J.J., Aircraft Structures,McGraw-Hill,New York,2nd Edition,1993.
2. Stephen P. Timoshenko & S.woinowsky Krieger, Theory of Plates and Shells, McGraw-Hill, Singapore,2nd edition, 2010,ISBN-13: 978-0070701250.
3. Rivello, R.M., Theory and Analysis of Flight structures, McGraw-Hill, N.Y., 1993.

## AEROSPACE PROPULSION

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – V

| | | | |
|---|---|---|---|
| Subject Code | **17AS52** | IA Marks | 40 |
| Number of Lecture Hours/Week | 04 | Exam Hours | 03 |
| Total Number of Lecture Hours | 50 | Exam Marks | 60 |
| CREDITS – 04 | | | |

**Course objectives:** This course will enable students to

1. Understand the working principles of gas turbine and ramjet propulsion systems, the design principles of inlets, combustion chambers, nozzles used in them.
2. Learn the operation of compressors and turbines in gas turbine propulsion systems.
3. Understand the operation of rocket propulsion

| Modules | Teaching Hours | Revised Bloom's Taxonomy (RBT) Level |
|---|---|---|
| **Module -1**<br>**Introduction:** Classification of power plants - Methods of aircraft propulsion – Propulsive efficiency – Specific fuel consumption - Thrust and power- Factors affecting thrust and power- Illustration of working of Gas turbine engine - Characteristics of turboprop, turbofan and turbojet , Ram jet, Scram jet – Methods of Thrust augmentation. | **10 Hours** | **L1, L2** |
| **Module -2**<br>**Propeller Blade Theory:** Momentum theory, Blade element theory, combined blade element and momentum theory, propeller power losses, propeller performance parameters, prediction of static thrust- and in flight, negative thrust, prop fans, ducted propellers, propeller noise, propeller selection, propeller charts. | **10 Hours** | **L1, L2** |
| **Module -3**<br>**Nozzles and Combustion Chamber:** Subsonic and supersonic inlets – Relation between minimum area ratio and external deceleration ratio – Starting problem in supersonic inlets –Modes of inlet operation, jet nozzle – Efficiencies – Over expanded, under and optimum expansion in nozzles – Thrust reversal. Classification of Combustion chambers - Combustion chamber performance – Flame tube cooling – Flame stabilization. | **10 Hours** | **L1, L2, L3** |
| **Module -4**<br>**Compressor and Turbine:** Introduction to centrifugal compressors- Axial flow compressor- geometry- twin spools- three spools- stage analysis- velocity polygons- degree of reaction – radial equilibrium theory- performance maps- axial flow turbines- geometry- velocity polygons- stage analysis- performance maps- thermal limit of blades and vanes. | **10 Hours** | **L1, L2** |
| **Module -5**<br>**Introduction to rocket propulsion:** Introduction to rocket propulsion – Reaction principle – Thrust equation – Classification of rockets based on propellants used – solid, liquid and hybrid – Comparison of these engines with special reference to rocket performance – electric propulsion – classification- electro thermal – electro static – electromagnetic thrusters- geometries of Ion thrusters- beam/plume characteristics – hall thrusters. | **10 Hours** | **L1, L2** |

**Course outcomes:**
After studying this course, students will be able to:

1. Analyze the engineering concepts of air breathing propulsion systems.
2. Distinguish the different types of compressors.
3. Choose the propellant based on the application.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Interpretation of data

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

1. Hill,P.G. and Peterson, C.R. Mechanics and Thermodynamics of Propulsion, Pearson India,2nd edition,2009,ISBN-13: 978-8131729519
2. Cohen, H. Rogers, G.F.C. and Saravanamuttoo, H.I.H, Gas Turbine Theory, DORLING KINDERSLEY,5th edition,2002,ISBN-13: 978-8177589023

**Reference Books:**

1. G.C. Oates, "Aerothermodynamics of Aircraft Engine Components", AIAA Education Series, 1985,ISBN-13: 978-0915928972.
2. G.P.Sutton, "Rocket Propulsion Elements", Wiley India Pvt Ltd, 7th Edition,2010,ISBN-13: 978-8126525775.
3. W.P.Gill, H.J.Smith & J.E. Ziurys, "Fundamentals of Internal Combustion Engines as applied to Reciprocating, Gas turbine & Jet Propulsion Power Plants", Oxford & IBH Publishing Co., 4th revised edition,2007,ISBN-13: 978-8120417106.

## AERODYNAMICS - II

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – V

| | | | |
|---|---|---|---|
| Subject Code | **15AS53** | IA Marks | 40 |
| Number of Lecture Hours/Week | 04 | Exam Hours | 03 |
| Total Number of Lecture Hours | 50 | Exam Marks | 60 |

CREDITS – 04

**Course objective:** This course will enable students to

1. Understand the concepts of compressible flow and shock phenomenon
2. Acquire the knowledge of oblique shock and expansion wave formation.
3. Appreciate the measurement in high speed flow.

| Modules | Teaching Hours | Revised Bloom's Taxonomy (RBT) Level |
|---|---|---|
| **Module -1**<br>**One Dimensional Compressible Flow:** Energy, Momentum, continuity and state equations, velocity of sound, Adiabatic steady state flow equations, Flow through converging, diverging passages, Performance under various back pressures. Numericals. | **10 Hours** | **L1, L2** |
| **Module -2**<br>**Normal Shock:** Prandtl Meyer equation and Rankine – Hugonoit relation, Normal shock equations: Property ratios in terms of upstream mach number, Numericals, Moving Normal Shock wave. | **10 Hours** | **L1, L2** |
| **Module -3**<br>**Oblique shocks and Expansion waves:** Prandtl equation and Rankine – Hugonoit relation, Normal shock equations, Pitot static tube, corrections for subsonic and supersonic flows, Oblique shocks and corresponding equations, Hodograph and pressure turning angle, shock polars, flow past wedges and concave corners, strong, weak and detached shocks, Flow past convex corners, Prandtl –Meyer expansion function, Reflection and interaction of shocks and expansion, waves, Families of shocks. Flow with Friction and Heat transfer. | **10 Hours** | **L1, L2, L3** |
| **Module -4**<br>**Differential Equations of Motion for Steady Compressible Flows:** Basic potential equations for compressible flow. Linearisation of potential equation-small perturbation theory. Methods for solution of nonlinear potential equation –Introduction, Method of characteristics, Boundary conditions, Pressure coefficient expression, small perturbation equation for compressible flow - Prandtl, Glauret and Geothert's rules - Ackert's supersonic airfoil theory, Von-Karman rule for transonic flow, Lift, drag pitching moment and center of pressure of supersonic profiles. | **10 Hours** | **L1, L2,L3** |
| **Module -5**<br>**Measurements in High speed Flow:** Types of subsonic wind tunnels - Balances and measurements - Interference effects- transonic, Supersonic and hypersonic wind tunnels and characteristic features, their operation and performance - Shock tubes and shock tunnels - Free flight testing - Measurements of pressure, velocity and Mach number -Flow visualization methods of subsonic and supersonic flows. | **10 Hours** | **L1, L2,L3** |

**Course outcomes:** After studying this course, students will be able to:

1. Utilize the concepts of compressible flow and shock phenomenon
2. Apply knowledge of oblique shock and expansion wave formation.
3. Measure the parameters high speed flow.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions

- Interpretation of data

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

1. John D Anderson, "Modern Compressible Flow", Mc Graw Hill,3rd edition,2012,ISBN-13: 978-1259027420.
2. Radhakrishnan, E., "Gas Dynamics", Prentice Hall of India,5th edition,2014,ISBN-13: 978-8120348394

**Reference Books:**

1. Ascher.H.Saphiro, "Dynamics and Thermodynamics of Compressible fluid flow", John Wiley & Sons,1st edition,1977,ISBN-13: 978-0471066910.
2. Yahya, S.M., "Fundamentals of Compressible flow", NEW AGE , 2009,ISBN-13: 978-8122426687.
3. H.W. Liepmann and A.Roshko, "Elements of Gas Dynamics", Dover Publications Inc,2003,ISBN-13: 978-0486419633.
4. Hodge B. K, Koenig K, Compressible Fluid Dynamics with Computer Application, 1st edition, Prentice Hall, New York(1995).
5. Clancy L. J., Aerodynamics, Shroff Publishers, 2006,ISBN-13: 978-8175980570.
6. Zucrow, M.J. and Anderson, J.D., "Elements of gas dynamics", McGraw - Hill Book Co., New York, 1989.

# INTRODUCTION TO SPACE TECHNOLOGY

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – V

| | | | |
|---|---|---|---|
| Subject Code | **17AS54** | IA Marks | 40 |
| Number of Lecture Hours/Week | 04 | Exam Hours | 03 |
| Total Number of Lecture Hours | 50 | Exam Marks | 60 |

CREDITS – 04

**Course objective:** This course will enable students to

1. Understand the fundamentals of aerospace propulsion.
2. Understand the orbit mechanics and orbit maneuvers.
3. Acquire the knowledge of satellite attitude dynamics and space mission operations.

| **Modules** | **Teaching Hours** | **Revised Bloom's Taxonomy (RBT) Level** |
|---|---|---|

| | | |
|---|---|---|
| **Module -1**<br>**Fundamentals of Aerospace Propulsion**: Space Mission, Types, Space Environment, Launch Vehicle Selection. Introduction to rocket propulsion-fundamentals of solid propellant rockets, Fundamentals of liquid propellant rockets, Rocket equation, Tsiolkovsky rocket equation, Concepts of Specific Impulse.<br><br>Two-dimensional trajectories of rockets and missiles, Multi-stage rockets-Vehicle sizing, Two stage Multi-stage Rockets, Trade-off Ratios-Single Stage to Orbit, Sounding Rocket, Aerospace Plane, Gravity Turn Trajectories, Impact point calculation, injection conditions-Flight dispersions, Burnout velocity. | **08 Hours** | **L1, L2** |
| **Module -2**<br>**Atmospheric Reentry**: Introduction-Steep Ballistic Reentry, Ballistic Orbital Reentry, Skip Reentry, "Double-Dip" Reentry, Aero-braking, Lifting Body Reentry. | **8 Hours** | **L1, L2** |
| **Module -3**<br>**Fundamentals of Orbit Mechanics, Orbit Maneuvers**: Two-body motion, Circular, elliptic, hyperbolic, and parabolic orbits-Basic Orbital Elements, Ground trace In-Plane Orbit changes, Hohmann Transfer, Bielliptical Transfer, Plane Changes, Combined Maneuvers, Propulsion for Maneuvers. | **8 Hours** | **L1, L2, L3** |
| **Module -4**<br>**Satellite Attitude Dynamics**: Torque free Axi-symmetric rigid body, Attitude Control for Spinning Spacecraft, Attitude Control for Non-spinning Spacecraft, The Yo-Yo Mechanism, Gravity – Gradient Satellite, Dual Spin Spacecraft, Attitude Determination. | **08 Hours** | **L1, L2** |
| **Module -5**<br>**Space Mission Operations**: Supporting Ground Systems Architecture and Team interfaces, Mission phases and Core operations, Team Responsibilities, Mission Diversity, Standard Operations Practices. | **8 Hours** | **L1, L2** |

**Course outcomes:**

After studying this course, students will be able to:

1. Distinguish the types of aerospace propulsion.
2. Determine the attitude of the satellites.
3. Support the space mission operations.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Interpretation of data

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.

- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

1. W.E. Wiesel," Spaceflight Dynamics",McGraw Hill,2nd edition,2014,ISBN-13: 978-9332901650
2. J.W. Cornelisse, "Rocket Propulsion and Space Dynamics", J.W. Freeman & Co., Ltd., London, 1982.

**Reference Books:**

1. Vincet L. Pisacane, "Fundamentals of Space Systems", Oxford University Press, 2005.
2. J.Sellers ,"Understanding Space: An Introduction to Astronautics" , McGraw Hill, 2nd edition,2000,ISBN-13: 978-0072424683
3. Francis J Hale ,"Introduction to Space Flight", Pearson, 1993,ISBN-13: 978-0134819129.
4. Charies D.Brown ,"Spacecraft Mission Design", AIAA education Series, 1998.
5. Meyer Rudolph X ,"Elements of Space Technology for aerospace Engineers", Meyer Rudolph X, Academic Press, 1999.

# AERODYNAMICS LAB

[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – V

| | | | |
|---|---|---|---|
| Subject Code | **17ASL57** | IA Marks | 40 |
| Number of Lecture Hours/Week | 03 | Exam Hours | 03 |
| Total Number of Lecture Hours | 42 | Exam Marks | 60 |

CREDITS – 02

**Course objectives:** This course will enable students to

1. Study about the types of wind tunnel.
2. Acquire the knowledge on flow visualization techniques.
3. Understand the procedures used for calculating the lift and drag.

| **Modules** | **Revised Bloom's Taxonomy (RBT) Level** |
|---|---|
| 1. Calibration of a subsonic wind tunnel: test section static pressure and total head distributions. | **L1, L2, L3** |
| 2. Smoke flow visualization studies on a two-dimensional circular cylinder at low speeds. | **L1, L2, L3** |
| 3. Smoke flow visualization studies on a two dimensional airfoil at different angles of incidence at low speeds | **L1, L2, L3** |
| 4. Smoke flow visualization studies on a two dimensional multi element airfoil with flaps and slats at different angles of incidence at low speeds | **L1, L2, L3** |

| | |
|---|---|
| 5. Tuft flow visualization on a wing model at different angles of incidence at low speeds: identify zones of attached and separated flows. | **L1, L2, L3** |
| 6. Surface pressure distributions on a two-dimensional circular cylinder at low speeds and calculation of pressure drag. | **L1, L2, L3** |
| 7. Surface pressure distributions on a two-dimensional circular cylinder at low speeds and calculation of pressure drag. | **L1, L2, L3** |
| 8. Surface pressure distributions on a two-dimensional symmetric airfoil | **L1, L2, L3** |
| 9. Surface pressure distributions on a two-dimensional cambered airfoil at different angles of incidence and calculation of lift and pressure drag. | **L1, L2, L3** |
| 10. Calculation of total drag of a two-dimensional circular cylinder at low speeds using pitot-static probe wake survey. | **L1, L2, L3** |
| 11. Calculation of total drag of a two-dimensional cambered airfoil at low speeds at incidence using pitot-static probe wake survey. | **L1, L2, L3** |
| 12. Measurement of a typical boundary layer velocity profile on the tunnel wall (at low speeds) using a pitot probe and calculation of boundary layer displacement and momentum thickness. | **L1, L2, L3** |
| 13. Calculation of aerodynamic coefficients forces acting on a model aircraft using force balance at various angles of incidence, speed. | **L1, L2, L3** |
| 14. Measurement of a typical boundary layer velocity profile on the airfoil at various angles of incidence from leading edge to trailing edge | **L1, L2, L3** |

**Course outcomes:**

After studying this course, students will be able to:

1. Apply the flow visualization techniques.
2. Estimate the pressure distribution over the bodies.
3. Calculate the lift and drag.

**Conduct of Practical Examination:**

1. All laboratory experiments are to be included for practical examination.
2. Students are allowed to pick one experiment from the lot.
3. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly)
- Interpretation of data.

## PROPULSION LAB

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – V

| | | | |
|---|---|---|---|
| Subject Code | **17ASL58** | IA Marks | 40 |
| Number of Lecture Hours/Week | 03 | Exam Hours | 03 |

| Total Number of Lecture Hours | 42 | Exam Marks | 60 |
|---|---|---|---|

CREDITS – 02

**Course objectives:** This course will enable students to

1. Understand how to do the heat transfer
2. Comprehend the analysis over the surface of the aircraft structure,
3. Study the working of different jet engines, study of propellants etc.

| Modules | Revised Bloom's Taxonomy (RBT) Level |
|---|---|
| 1. Study of forced convective heat transfer over a flat plate. | **L1, L2, L3** |
| 2. Determination of heat of combustion of aviation fuel. | **L1, L2, L3** |
| 3. Measurement of burning velocity of a premixed flame. | **L1, L2, L3** |
| 4. Combustion performance studies in a jet engine combustion chamber | **L1, L2, L3** |
| 5. Study of Free Jet | **L1, L2, L3** |
| 6. Study of Wall jet | **L1, L2, L3** |
| 7. Preparation of Propellant | **L1, L2, L3** |
| 8. Computation of burning rate of the propellant. | **L1, L2, L3** |
| 9. Estimate the Calorific value of propellant | **L1, L2, L3** |
| 10. Measurement of Ignition delay of a single propellant with different shapes | **L1, L2, L3** |
| 11. Establishing flame stability of pre-mixed flame through flame stability setup. | **L1, L2, L3** |
| 12. Performance study of Hybrid Motor using a thrust stand | **L1, L2, L3** |
| 13. Analysis of grain stress and strain of a solid propellant | **L1, L2, L3** |
| 14. Testing for performance parameters of a Ramjet engine | **L1, L2, L3** |

**Course outcomes:**

After studying this course, students will be able to:

1. Analyze the performance of jet engine.
2. Evaluate the performance of a propellant.
3. Differentiate among different equipments required for study of propulsion.

**Conduct of Practical Examination:**

1. All laboratory experiments are to be included for practical examination.
2. Students are allowed to pick one experiment from the lot.
3. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly)
- Interpretation of data.

**PROFESSIONAL ELECTIVE**

# GAS TURBINE TECHNOLOGY

[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – V

| | | | |
|---|---|---|---|
| Subject Code | **17AS551** | IA Marks | 40 |
| Number of Lecture Hours/Week | 03 | Exam Hours | 03 |
| Total Number of Lecture Hours | 40 | Exam Marks | 60 |

CREDITS – 03

**Course objective:**

This course will enable students to

1. Comprehend the types of engines and its applications.
2. Understand the materials required for engine manufacturing.
3. Acquire the knowledge of engine performance and testing.

| Modules | Teaching Hours | Revised Bloom's Taxonomy (RBT) Level |
|---|---|---|
| **Module -1**<br>**Types, Variation & Applications:** Types of engines showing arrangement of parts. Operating parameters. Energy distribution of turbojet, turboprop and turbofan engines. Comparison of thrust and specific fuel consumption. Thrust, pressure and velocity diagrams.<br>**Engine Parts:** Compressor assembly, types of burners: advantages and disadvantages. Influence of design factors on burner performance. Effect of operating variables on burner performance. Performance requirements of combustion chambers. Construction of nozzles. Impulse turbine and reaction turbine. Exhaust system, sound suppression. Thrust reversal: types, design & systems. Methods of thrust augmentation, afterburner system | **8 Hours** | **L1, L2** |
| **Module -2**<br>**Materials and Manufacturing:** Criteria for selection of materials. Heat ranges of metals, high temperature strength. surface finishing. Powder metallurgy. Use of composites and Ceramics. Superalloys for Turbines.<br>**Systems:** Fuel systems and components. Sensors and Controls. FADEC interface with engine. Typical fuel system. Oil system components. Typical oil system. Starting systems. Typical starting characteristics. Various gas | **8 Hours** | **L1, L2** |

| | | |
|---|---|---|
| turbine starters | | |
| **Module -3**<br>**Engine Performance:** Design & off-design Performance. Surge margin requirements, surge margin stack up. Transient performance. Qualitative characteristics quantities. Transient working lines. Starting process & Wind milling of Engines. Thrust engine start envelope. Starting torque and speed requirements Calculations for design and off-design performance from given test data – (case study for a single shaft Jet Engine). Engine performance monitoring | **8 Hours** | **L1, L2, L3** |
| **Module -4**<br>**Compressor:** Compressor MAP. Surge margin, Inlet distortions. Testing and Performance Evaluation. **Combustor:** Combustor MAP, Pressure loss, combustion light up test. Testing and Performance Evaluation. **Turbines:** Turbine MAP. Turbine Testing and Performance Evaluation. **Inlet duct & nozzles:** Ram pressure recovery of inlet duct. Propelling nozzles, after burner, maximum mass flow conditions. Testing and Performance Evaluation | **8 Hours** | **L1, L2** |
| **Module -5**<br>**Engine Testing:** Proof of Concepts: Design Evaluation tests. Structural Integrity. Environmental Ingestion Capability. Preliminary Flight Rating Test, Qualification Test, Acceptance Test. Reliability figure of merit. Durability and Life Assessment Tests, Reliability Tests. Engine testing with simulated inlet distortions and, surge test. Estimating engine-operating limits. Methods of displacing equilibrium lines.<br>**Types of engine testing's:** Normally Aspirated Testing, Open Air Test Bed ,Ram Air Testing, Altitude Testing, Altitude test facility, Flying Test Bed, Ground Testing of Engine Installed in Aircraft, Flight testing. Jet thrust measurements in flight. Measurements and Instrumentation. Data Acquisition system, Measurement of Shaft speed, Torque, Thrust, Pressure, Temperature, Vibration, Stress, Temperature of turbine blading etc. Engine performance trends: Mass and CUSUM plots. Accuracy and Uncertainty in Measurements. Uncertainty analysis. Performance Reduction Methodology. | **8 Hours** | **L1, L2** |

**Course outcomes:**

After studying this course, students will be able to:

1. Select the suitable materials for engine manufacturing.
2. Evaluate the performance of the engine.
3. Test the engine using several types of engine testing methods.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Interpretation of data

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.

- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

1. Irwin E. Treager, 'Gas Turbine Engine Technology' ,McGraw Hill Education, 3rd edition,2013,ISBN-13: 978-1259064876
2. P.P Walsh and P. Peletcher, 'Gas Turbine Performance' Blackwell Science, 1998, ISBN 0632047843.

**Reference Books:**

1. Advance Aero-Engine Testing, AGARD-59 Publication
2. MIL –5007 E , 'Military Specifications: Engine , Aircraft, Turbo Jet & Turbofan; General Specification for Advance Aero Engine testing', 15th Oct 1973.
3. J P Holman,' Experimental methods for Engineers', Tata McGraw Hill ,7th edition,2007,ISBN-13: 978-0070647763
4. A S Rangawala,Turbomachinery dynamics-Design and operations, McGraw –Hill, 2005,ISBN-13: 978-0071453691.
5. Michael J. Kores , and Thomas W. Wild,' Aircraft Power Plant', GLENCOE Aviation Technology Series, 7th Edition, Tata McGraw Hill Publishing Co.Ltd. 2002

# FLIGHT MECHANICS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – V

| | | | |
|---|---|---|---|
| Subject Code | **17AS552** | IA Marks | 40 |
| Number of Lecture Hours/Week | 03 | Exam Hours | 03 |
| Total Number of Lecture Hours | 40 | Exam Marks | 60 |

CREDITS – 03

**Course objective:**

This course will enable students to

1. Understand the static longitudinal stability and control for free and fixed stick.
2. Understand about the lateral and directional stability.
3. Acquire the knowledge of dynamic stability.

| **Modules** | **Teaching Hours** | **Revised Bloom's Taxonomy (RBT) Level** |
|---|---|---|
| **Module -1**<br><br>**Static Longitudinal Stability and Control (Stick Fixed):** Degree of freedom of rigid bodies in space - Static and dynamic stability - Purpose of controls in airplanes -Inherently stable and marginal stable airplanes - Static, Longitudinal stability - Stick fixed stability - Basic equilibrium equation - Stability criterion - Effects of fuselage and nacelle - Influence of CG location - Power effects - Stick fixed neutral point. | **08 Hours** | **L1, L2** |
| **Module -2**<br><br>**Static Longitudinal Stability and Control (Stick Free):** Stick free stability-Hinge moment coefficient - Stick free neutral points-Symmetric | **08 Hours** | **L1, L2** |

| | | |
|---|---|---|
| manoeuvres - Stick force gradients - Stick _ force per 'g' - Aerodynamic balancing. Determination of neutral points and maneuver points from flight test. | | |
| **Module -3**<br>**Lateral and Directional Stability:** Dihedral effect - Lateral control - Coupling between rolling and yawing moments - Adverse yaw effects - Aileron reversal - Static directional stability - Weather cocking effect - Rudder requirements - One engine inoperative condition - Rudder lock. | **08 Hours** | **L1, L2, L3** |
| **Module -4**<br>**Dynamic Stability:** Dynamic longitudinal stability: Equations of motion - Stability derivatives - Characteristic equation of stick fixed case - Modes and stability criterion - Effect of freeing-the stick - Brief description of lateral and directional. Dynamic stability - Spiral, divergence, Dutch roll, auto rotation and spin. | **08 Hours** | **L1, L2** |
| **Module -5**<br>**Helicopter Flight Dynamics:** Rotor function in vertical flight, Rotor Mechanism for forward flight, Trim, Stability and control. | **08 Hours** | **L1, L2** |

**Course outcomes:**

After studying this course, students will be able to:

1. Evaluate the static longitudinal stability and control for free and fixed stick.
2. Compute the lateral and directional stability.
3. Calculate the dynamics stability.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Interpretation of data

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

1. Perkins, C.D., and Hage, R.E., "Airplane Performance stability and Control", John Wiley & Son:, Inc, New York, 1988.
2. J.Seddon, "Basic Helicopter Aerodynamics", AIAA Series,3rd revised edition,2011,ISBN-13: 978-1600868610

**Reference Books:**

1. Etkin, B., "Dynamics of Flight Stability and Control", Wiley India Pvt Ltd,3rd edition,2010,ISBN-13: 978-8126528912.
2. Babister, A.W., "Aircraft Dynamic Stability and Response", Pergamon Press, Oxford, 2013.
3. Dommasch, D.O., Shelby, S.S., and Connolly, T.F., "Aeroplane Aero dynamics", Third Edition,

Issac Pitman, London, 1981.

4. Nelson, R.C. "Flight Stability and Automatic Control", McGraw-Hill Book Co., 2nd edition,2007,ISBN-13: 978-0070661103

# THEORY OF VIBRATIONS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – V

| | | | |
|---|---|---|---|
| Subject Code | **17AS553/17AE553** | IA Marks | 40 |
| Number of Lecture Hours/Week | 03 | Exam Hours | 03 |
| Total Number of Lecture Hours | 40 | Exam Marks | 60 |

CREDITS – 03

**Course objectives:** This course will enable students to

1. Understand the basic concepts of vibrations.
2. Understand the working principle of vibration measuring instruments.
3. Acquire the knowledge of numerical methods for multi-degree freedom systems.

| Modules | Teaching Hours | Revised Bloom's Taxonomy (RBT) Level |
|---|---|---|
| **Module -1**<br>**Introduction:** Types of vibrations, S.H.M, principle of super position applied to Simple Harmonic Motions. Beats, Fourier theorem and simple problems. | **4 Hours** | **L1, L2** |
| **Module -2**<br>**Undamped Free Vibrations:** Single degree of freedom systems. Undamped free vibration, natural frequency of free vibration, Spring and Mass elements, effect of mass of spring, Compound Pendulum.<br>**Damped Free Vibrations:** Single degree of freedom systems, different types of damping, concept of critical damping and its importance, study of response of viscous damped systems for cases of under damping, critical and over damping, Logarithmic decrement | **8 Hours** | **L1, L2** |
| **Module -3**<br>**Forced Vibration:** Single degree of freedom systems, steady state solution with viscous damping due to harmonic force. Solution by Complex algebra, reciprocating and rotating unbalance, vibration | **8 Hours** | **L1, L2, L3** |

| | | |
|---|---|---|
| isolation, transmissibility ratio. due to harmonic exitation and support motion.<br>**Vibration Measuring Instruments & Whirling Of Shafts:** Vibration of elastic bodies – Vibration of strings – Longitudinal, lateral and torsional Vibrations | | |
| **Module -4**<br><br>**Systems With Two Degrees Of Freedom:** Introduction, principle modes and Normal modes of vibration, co-ordinate coupling, generalized and principal co-ordinates, Free vibration in terms of initial conditions. Geared systems. Forced Oscillations-Harmonic excitation. Applications:<br>a) Vehicle suspension.<br>b) Dynamic vibration absorber.<br>c) Dynamics of reciprocating Engines.<br>**Continuous Systems:** Introduction, vibration of string, longitudinal vibration of rods, Torsional vibration of rods, Euler's equation for beams. | **10 Hours** | **L1, L2, L3** |
| **Module -5**<br>**Numerical Methods For Multi-Degree Freedom Systems:** Introduction, Influence coefficients, Maxwell reciprocal theorem, Dunkerley's equation. Orthogonality of principal modes, Method of matrix iteration-Method of determination of all the natural frequencies using sweeping matrix and Orthogonality principle. Holzer's method, Stodola method. | **10 Hours** | **L1, L2, L3** |

**Course outcomes:**

After studying this course, students will be able to:

1. Apply the principle of super position to Simple Harmonic Motions.
2. Determine the vibrations using vibration instruments.
3. Apply the numerical methods for multi-degree freedom systems.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Interpretation of data

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

1. W.T. Thomson and Marie Dillon Dahleh ,Theory of Vibration with Applications, Pearson Education 5th edition, 2008,ISBN-13: 978-8131704820.
2. V.P. Singh ,Mechanical Vibrations, Dhanpat Rai & Company Pvt. Ltd.,2016,ISBN-13: 978-8177004014.

**Reference Books:**

1. S.S. Rao ,Mechanical Vibrations, Pearson Education Inc, 4th Edition,2003,ISBN-13: 978-8177588743
2. S.Graham Kelly,Mechanical Vibrations- Schaum's Outline Series,Tata McGraw Hill, Special Indian edition, 2007.
3. J.S. Rao & K. Gupta ,Theory & Practice of Mechanical vibrations, New Age International Publications, New Delhi, 2001.
4. Leonanrd Meirovitch ,Elements of Vibrations Analysis,Tata McGraw Hill, Special Indian edition, 2007.

## AIRCRAFT ELECTRICAL SYSTEMS & INSTRUMENTATION

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – V

| | | | |
|---|---|---|---|
| Subject Code | **17AS544/17AE544** | IA Marks | 40 |
| Number of Lecture Hours/Week | 03 | Exam Hours | 03 |
| Total Number of Lecture Hours | 40 | Exam Marks | 60 |

CREDITS – 03

**Course objective:**

This course will enable students to

1. Understand the aircraft control systems.
2. Understand the aircraft systems.
3. Acquire the knowledge of aircraft instruments.

| **Modules** | **Teaching Hours** | **Revised Bloom's Taxonomy (RBT) Level** |
|---|---|---|
| **Module -1**<br>**Airplane Control Systems:** Conventional Systems, fully powered flight controls, Power actuated systems, Modern control systems, Digital fly by wire systems, Auto pilot system active control Technology. | **8 Hours** | **L1,L2** |
| **Module -2**<br>**Aircraft Systems:** Hydraulic systems, Study of typical workable system, components, Pneumatic systems, Advantages, Working principles, Typical Air pressure system, Brake system, Typical Pneumatic power system, Components, Landing Gear systems, Classification. | **8 Hours** | **L1,L2** |
| **Module -3**<br>**Engine Systems:** Fuel systems for Piston and jet engines, Components of multi engines. lubricating systems for piston and jet engines - Starting and Ignition systems - Typical examples for piston and jet engines. | **8 Hours** | **L1,L2,L3** |
| **Module -4**<br>**Auxiliary System:** Basic Air cycle systems, Vapour Cycle systems, Evaporative vapour cycle systems, Evaporative air cycle systems, Fire protection systems, Deicing and anti-icing systems. | **8 Hours** | **L1,L2,L3** |

| **Module -5** **Aircraft Instruments:** Flight Instruments and Navigation Instruments, Gyroscope, Accelerometers, Air speed Indicators, TAS, EAS, Mach Meters, Altimeters, Principles and operation, Study of various types of engine instruments, Tachometers, Temperature gauges, Pressure gauges, Operation and Principles. | **8 Hours** | **L1,L2,L3** |
|---|---|---|

**Course outcomes:**

After studying this course, students will be able to:

1. Distinguish the conventional and modern control systems.
2. Classify the aircraft systems.
3. Categorize different types of aircraft instruments.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Interpretation of data

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

1. Ian Moir and Allan Seabridge,‘ Aircraft Systems: Mechanical, Electrical and Avionics- Subsystem Integration‘,Wiley India Pvt Ltd, 3rd edition,2012,ISBN-13: 978-8126535217.
2. Pallet, E.H.J., “Aircraft Instruments and Integrated Systems”, Longman Scientific and Technical, Indian reprint 1996.

**Reference Books:**

1. Lalit Gupta and O P Sharma,‘ Aircraft Systems (Fundamentals of Flight Vol. IV)‘, Himalayan Books; 2006.
2. Treager, S., “Gas Turbine Technology”, McGraw-Hill, 3rd edition,2013,ISBN-13: 978-1259064876.
3. R. W. Sloley and W. H. Coulthard,‘ The aircraft Engineers Handbook, No 4, INSTRUMENTS’, Shroff, 6th Edition, 2005,ISBN-13: 978-8175980518
4. S R Majumdar,‘ Pneumatic Systems‘, Tata McGraw Hill Publishing Co,1st edition,2001,ISBN-13: 978-0074602317.
5. William A Neese, ‘Aircraft Hydraulic Systems‘, Himalayan Books; 2007

**OPEN ELECTIVE**

# HISTORY OF FLIGHT & TECHNOLOGY FORECAST

[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – V
**Open Elective**

| | | | |
|---|---|---|---|
| Subject Code | **17AS561/17AE561** | IA Marks | 40 |
| Number of Lecture Hours/Week | 03 | Exam Hours | 03 |
| Total Number of Lecture Hours | 40 | Exam Marks | 60 |

CREDITS – 03

**Course Objectives:**
This course will enable students to
1. Study the basic concepts of flying.
2. Understand about the aircraft structures and materials.
3. Acquire the knowledge of aircraft power plants.

| Modules | Teaching Hours | Revised Bloom's Taxonomy (RBT) Level |
|---|---|---|
| **Module -1**<br>**Introduction**<br>Early Developments – Ornithopters, Balloon Flight, Sir George Cayley – The true inventor of Airplane, the Interregnum, Otto Lilienthal – The Glider Man, Percy Pilcher – Extending the Glider Tradition. | **8 Hours** | **L1, L2** |
| **Module -2**<br>Wilbur and Orville Wright – Inventors of First Practical Airplane, Aeronautical Triangle – Langley, Wrights and Glenn Curtiss, Problem of Propulsion, Faster and Higher, biplanes and monoplanes, Developments in aerodynamics, materials, structures and propulsion over the years. | **8 Hours** | **L1, L2** |
| **Module-3**<br>**Aircraft Configurations:**<br>Different types of flight vehicles, classifications. Components of an airplane and their functions. Conventional control, Powered control, Basic instruments for flying - Typical systems for control actuation. | **8 Hours** | **L1, L2, L3** |

| | | |
|---|---|---|
| **Module -4**<br>**Airplane Structures and Materials:**<br>General types of construction, Monocoque, semi-monocoque and geodesic constructions, Typical wing and fuselage structure. Metallic and non-metallic materials, Use of aluminium alloy, titanium, stainless steel and composite materials. Stresses and strains – Hooke's law – Stress - strain diagrams - elastic constants. | **8 Hours** | **L1, L2** |
| **Module -5**<br>**Power Plants:**<br>Basic ideas about piston, turboprop and jet engines - Use of propeller and jets for thrust production - Comparative merits, Principles of operation of rocket, types of rockets and typical applications, Exploration into space. | **8 Hours** | **L1, L2** |

**Course Outcomes:**
After studying this course, students will be able to:
1. Identify the aspects of aircrafts.
2. Classify the aircraft materials.
3. Describe the instruments and power plants used in airplanes.

**Graduate Attributes:**
- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Interpretation of data

**Question paper pattern:**
- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**
1. Anderson, J.D., "Introduction to Flight", McGraw-Hill, 1995.
2. Stephen. A. Brandt, Introduction to Aeronautics: A design perspective, 2nd Edition, AIAA Education Series, 2004..

**Reference Books:**
1. Kermode, A.C., "Mechanics of Flight", Himalayan Book, 1997
2. Kermode, A.C., "Flight without Formula", Pearson, 2009.

## Elements of Aeronautics
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – V
**Open Elective**

| | | | |
|---|---|---|---|
| Subject Code | **17AS562/17AE562** | IA Marks | 40 |
| Number of Lecture Hours/Week | 04 | Exam Hours | 03 |
| Total Number of Lecture Hours | 40 | Exam Marks | 60 |

CREDITS – 03

**Course objectives:** This course will enable students to

1. To know the history and basic principle of aviation
2. To understand the foundation of flight, aircraft structures, material aircraft propulsion
3. To develop an understanding stability of an aircraft along with its different systems.

| Modules | Teaching Hours | Revised Bloom's Taxonomy (RBT) Level |
|---|---|---|
| **Module -1**<br><br>**Introduction to Aircrafts**<br>History of aviation; Atmosphere and its properties; Classification of aircrafts; Basic components of an aircraft; structural members; aircraft axis system; aircraft motions; control surfaces and high lift devices; classification of aircraft; conventional design configurations; principle of operation of each major part; Helicopters, their parts and functions.<br><br>**Aircraft Structures and Materials:**<br>Introduction; general types of construction; monocoque, semi-monocoque and geodesic structures; typical wing and fuselage structure; metallic and non-metallic materials for aircraft application. | **08 Hours** | **L1, L2** |
| **Module -2**<br><br>**Basic principles of flight** – significance of speed of sound; airspeed and groundspeed; standard atmosphere; Bernoulli's theorem and its application for generation of lift and measurement of airspeed; forces over wing section, aerofoil nomenclature, pressure distribution over a wing section. Lift and drag components – generation of lift and drag; lift curve, drag curve, types of drag, factors affecting lift and drag; centre of pressure and its significance; aerodynamic centre, aspect ratio, Mach number and supersonic flight effects; simple problems on lift and drag. | **08 Hours** | **L1, L2** |
| **Module -3**<br>**Aircraft Propulsion:**<br>Aircraft power plants, classification based on power plant and location and principle of operation. Turboprop, turbojet and turbofan engines; ramjets and scramjets; performance characteristics. Aircraft power plants – basic principles of piston, turboprop and jet engines; Brayton cycle and its application to gas turbine engines; use of propellers and jets for production of thrust; comparative merits and limitations of different types of propulsion engines; principle of thrust augmentation. | **08 Hours** | **L1, L2, L3** |
| **Module -4**<br><br>**Aircraft Stability:**<br>Forces on an aircraft in flight; static and dynamic stability; longitudinal, lateral and roll stability; necessary conditions for longitudinal stability; basics of aircraft control systems. Effect of flaps and stats on lift, control tabs, stalling, gliding, landing, turning, aircraft manoeuvres; stalling, gliding, turning. Simple problems on these. Performance of aircraft – power curves, maximum and minimum speeds for horizontal flight at a given altitude; effect of changes in engine power and altitude | **08 Hours** | **L1, L2** |

| | | |
|---|---|---|
| on performance; correct and incorrect angles of bank; aerobatics, inverted manoeuvre, manoeuvrability. Simple problems. | | |
| **Module -5**<br>**Aircraft Systems:**<br>Mechanical systems and their components; hydraulic and pneumatic systems; oxygen System; environmental Control System; fuel system. Electrical systems, flight deck and cockpit systems; navigation system, communication system.<br><br>**Aircraft systems (Mechanical) –** hydraulic and pneumatic systems and their applications; environment control system; fuel system, oxygen system.<br><br>**Aircraft systems (Electrical)** – flight control system, cockpit instrumentation and displays; communication systems; navigation systems; power generation systems – engine driven alternators, auxiliary power Module, ram air turbine; power conversion, distribution and management. | **08 Hours** | **L1, L2** |

**Course outcomes:**

After studying this course, students will be able to:

4. Appreciate and apply the basic principle of aviation
5. Apply the concepts of fundaments of flight, basics of aircraft structures, aircraft propulsion and aircraft materials during the development of an aircraft
6. Comprehend the complexities involved during development of flight vehicles.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Interpretation of data

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

3. John D. Anderson, *“Introduction to Flight”*, McGraw-Hill Education, 2011. ISBN 9780071086059.
4. Lalit Gupta and O P Sharma, “*Fundamentals of Flight Vol-I to Vol-IV*”, Himalayan Books, 2006, ISBN: 706.

**Reference Books:**

1. A.C. Kermode, “Flight without formulae”, Pearson Education India, 1989. ISBN: 9788131713891.

2. Nelson R.C., "Flight stability and automatic control", McGraw-Hill International Editions, 1998. ISBN 9780071158381.
5. Ian Moir, Allan Seabridge, "Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration", John Wiley & Sons, 2011. ISBN 978111965006.
6. Sutton G.P., "Rocket Propulsion Elements", John Wiley, New York, 8th Ed., 2011; ISBN: 1118174208, 9781118174203.

# INTRODUCTION TO ASTROPHYSICS AND SPACE ENVIRONMENT

[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – V

| | | | |
|---|---|---|---|
| Subject Code | **17AS563** | IA Marks | 40 |
| Number of Lecture Hours/Week | 03 | Exam Hours | 03 |
| Total Number of Lecture Hours | 40 | Exam Marks | 60 |

CREDITS – 03

**Course objective:**
This course will enable students to
1. Understand the basics of astrophysics and space environment.
2. Study the relativistic quantum mechanics.
3. Acquire the knowledge of sun and solar system.

| Modules | Teaching Hours | Revised Bloom's Taxonomy (RBT) Level |
|---|---|---|
| **Module -1**<br>**Introduction:** Overview of major contents of universe, Black body radiation, specific intensity, flux density, luminosity, Basics of radiative transfer (Emission/absorption coefficients, source functions), Magnitudes, distance modulus, Color index, Extinction, Color temperature, effective temperature, Brightness temperature, bolometric magnitude/luminosity, Excitation temperature, kinetic temperature, Utility of stellar spectrum. | **8 Hours** | **L1, L2** |
| **Module -2**<br>**Basic knowledge of stellar atmospheres:** Binaries, variable stars, clusters, open and globular clusters, Laws of planetary motion, Motions and Distances of Stars, Statistical and moving cluster parallax, Velocity Dispersion, Compact objects (BH-systems, Accretion rate/efficiency, Eddington luminosity), Shape, size and contents of our galaxy, Normal and active galaxies, High energy physics (introduction to X-ray and Gamma-ray radiation processes), Newtonian cosmology, microwave background, early universe. | **8 Hours** | **L1, L2** |
| **Module -3**<br>**Relativistic Quantum Mechanics**: Scattering, classical radiation field, creation, annihilation and number operators. Quantized radiation field, unified approach to emission, absorption, and scattering of photons by | **8 Hours** | **L1, L2, L3** |

| | | |
|---|---|---|
| atoms, radiation damping and resonance fluorescence, dispersion relations and causality, relativistic wave equation (Klein- Gordon and Dirac equations), basics of quantum electrodynamics. | | |
| **Module -4**<br>**Sun & Solar System**: The sun, helioseismology, convection, solar magnetism: flux tubes, sun spots, dynamo, solar cycle, chromosphere, corona, solar wind, physical processes in the solar system; dynamics of the solar system; physics of planetary atmospheres; individual planets; comets, asteroids, and other constituents of the solar system; extra-solar planets; formation of the solar system, stars, and planets. | **8 Hours** | **L1, L2** |
| **Module -5**<br>**Space Environment**: Introduction, Vacuum Environments and its effect, Neutral environment and its effects, Plasma environment, Radiation Environment and its effects, Debris Environment and its effects. | **8 Hours** | **L1, L2** |

**Course outcomes:**

After studying this course, students will be able to:

1. Evaluate the Black body radiation, specific intensity, flux density., etc .
2. Apply the relativistic quantum mechanics .
3. Identify and sun and the solar system.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Interpretation of data

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

1. Shu, F., The Physical Universe, University of California, 1981,ISBN-13: 978-0935702057.
2. Padmanabhan, T., Theoretical Astrophysics, Cambridge University Press, south asian edition,2010,ISBN-13: 978-1107400597.

**Reference Books:**

1. Sakurai, JJ., Advanced Quantum Mechanics, Pearson Education India,1st edition,2002,ISBN-13: 978-8177589160 .
2. Stix, M., The Sun: An Introduction, Springer, Reprinted edition, 2012, ISBN-13: 978-3642624773 .
3. Alan C. Tribble, The Space Environment, Princeton University Press,Revised edition, 2003,ISBN-13: 978-0691102993

## MECHATRONICS

[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – V

| | | | |
|---|---|---|---|
| Subject Code | **17AS564** | IA Marks | 40 |
| Number of Lecture Hours/Week | 03 | Exam Hours | 03 |
| Total Number of Lecture Hours | 40 | Exam Marks | 60 |

CREDITS – 03

**Course objective:**
This course will enable students to
1. Study the mechatronic and actuation systems.
2. Understand about the sensors and logic functions.
3. Acquire the knowledge of microprocessors.

| Modules | Teaching Hours | Revised Bloom's Taxonomy (RBT) Level |
|---|---|---|
| **Module -1**<br>**Introduction**<br>**Mechatronic Systems:** Measurement and control systems. Their elements and functions, Microprocessor based controllers. **Electrical Actuation Systems.** Electrical systems, Mechanical switches, solid-state switches, solenoids, DC & AC motors, Stepper motors and their merits and demerits. | **8 Hours** | **L1, L2** |
| **Module -2**<br>**Review of Transducers and Sensors:** Definition and classification of transducers. Definition and classification of sensors. Principle of working and applications of light sensors, proximity sensors and Hall effect sensors.<br>**Signal Conditioning:** Introduction to signal conditioning. The operational amplifier, Protection, Filtering, Wheatstone bridge, Digital signals Multiplexers, Data acquisition. | **8 Hours** | **L1, L2** |
| **Module-3**<br>**Introduction to Microprocessors:** Evolution of Microprocessor, Organization of Microprocessors (Preliminary concepts), basic concepts of programming of microprocessors.<br>Review of concepts - Boolean algebra, Logic Gates and Gate Networks, | **8 Hours** | **L1, L2, L3** |

| | | |
|---|---|---|
| Binary & Decimal number systems, memory representation of positive and negative integers, maximum and minimum integers. Conversion of real, numbers, floating point notation, representation of floating point numbers, accuracy and range in floating point representation, overflow and underflow, addition of floating point numbers, character representation. Introduction to Digital system. Processing Pulse-modulation. | | |
| **Module -4**<br>**Logic Function:** Data word representation. Basic elements of control systems 8085A processor architecture terminology such as CPU, memory and address, ALU, assembler data registers, Fetch cycle, write cycle, state, bus, interrupts. Micro Controllers. Difference between microprocessor and micro controllers. Requirements for control and their implementation in microcontrollers. Classification of micro controllers.<br>**Organization & Programming of Microprocessors:** Introduction to organization of INTEL 8085-Data and Address buses. | **6 Hours** | **L1, L2** |
| **Module -5**<br>**Central Processing Unit of Microprocessors:** Introduction, timing and control unit basic concepts, Instruction and data flow, system timing, examples of INTEL 8085 and INTEL 4004 register organization.<br>Instruction set of 8085, programming the 8085, assembly language programming. | **8 Hours** | **L1, L2** |

**Course outcomes:**

After studying this course, students will be able to:

1. Identify the working principle of mechatronic and actuation systems.
2. Classify the transducers and sensors.
3. Write a Program for 8085 microprocessor.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Interpretation of data

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

1. Bolton, "Mechatronics", Pearson Education,4th edition,2010,ISBN-13: 978-8131732533
2. Ramesh S Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085", Penram International Publishing, 6th Edition, 2013,ISBN-13: 978-8187972884 .

**Reference Books:**

1. K.P.Ramchandran, G.K.Vijayraghavan, M.S.Balasundran, Mechatronics and Microprocessors,Wiley, 1st Ed, 2009,ISBN-13: 978-8126519859.
2. Nitaigour and PremchandMahilik, Mechatronics - Principles, Concepts and applications–- Tata

McGraw Hill- 2003,ISBN-13: 978-0070483743
3. Godfrey C. Onwubolu.Mechatronics Principles & applications, Elsevier,1st edition,2006,ISBN-13: 978-8131205235.
4. David. G. Aliciatore& Michael. B. Bihistaned, Introduction Mechatronics & Measurement systems,Tata McGraw Hill,4th edition,2014,ISBN-13: 978-9339204365.

# Curriculum and Syllabus for 6th Semester Aerospace Engineering

# VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
# CHOICE BASED CREDIT SYSTEM (CBCS)
# SCHEME OF TEACHING AND EXAMINATION 2017-2018

## B.E. AEROSPACE ENGINEERING

**VI SEMESTER**

| Sl. No | Subject Code | Title | Teaching Dept. | Teaching Hours /Week | | Examination | | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory | Practical/ Drawing | Duration | Theory/ Practical Marks | I.A. Marks | Total Marks | |
| 1 | 17AS61 | FINITE ELEMENT METHOD | AS | 04 | | 03 | 60 | 40 | 100 | 4 |
| 2 | 17AS62 | SPACE MECHANICS | AS | 04 | | 03 | 60 | 40 | 100 | 4 |
| 3 | 17AS63 | CONTROL ENGINEERING | AS | 04 | | 03 | 60 | 40 | 100 | 4 |
| 4 | 17AS64 | MISSILES AND LAUNCH VEHICLES | AS | 04 | | 03 | 60 | 40 | 100 | 4 |
| 5 | 17AS65X | **PROFESSIONAL ELECTIVE** | AS | 03 | | 03 | 60 | 40 | 100 | 3 |
| 6 | 17AS66X | **OPEN ELECTIVE** | AS | 03 | | 03 | 60 | 40 | 100 | 3 |
| 7 | 17ASL67 | DESIGN, MODELLING & ANALYSIS LAB | AS | | 1I+2P | 03 | 60 | 40 | 100 | 2 |
| 8 | 17ASL68 | STRUCTURES & VIBRATION LAB | AS | | 1I+2P | 03 | 60 | 40 | 100 | 2 |
| | | **TOTAL** | | **22** | **6** | **24** | **480** | **320** | **800** | **26** |

| **Professional Elective** | | **Open Elective** | |
|---|---|---|---|
| 17AS651 | HYPERSONICS | 17AS661/ 17AE661 | UNMANNED AERIAL VEHICLES BASICS & APPLICATIONS |
| 17AS652 | DIGITAL ELECTRONICS SYSTEMS | 17AS662/ 17AE662 | FUNDAMENTALS OF AERODYNAMIC THEORY |
| 17AS653 | HIGH PERFORMANCE COMPUTING | 17AS663/ 17AE663 | ELEMENTS OF JET PROPULSION SYSTEMS |
| 17AS654 | SATELLITE COMMUNICATION | 17AS664 | EXPERIMENTAL AERODYNAMICS |

1. **Core subject:** This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.
2. **Professional Elective:** Elective relevant to chosen specialization/ branch
3. **Open Elective**: Electives from other technical and/or emerging subject areas

# VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
# CHOICE BASED CREDIT SYSTEM (CBCS)
# SCHEME OF TEACHING AND EXAMINATION 2017-2018

## FINITE ELEMENT METHOD

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VI

| | | | |
|---|---|---|---|
| Subject Code | **17AS61** | IA Marks | 40 |
| Number of Lecture Hours/Week | 04 | Exam Hours | 03 |
| Total Number of Lecture Hours | 50 | Exam Marks | 60 |

CREDITS – 04

**Course objectives:** This course will enable students to

1. Understand the importance of discretisation of domain using different finite elements
2. Acquire the knowledge of different loading and boundary conditions
3. Understand the governing methods of finite element analysis

| Modules | Teaching Hours | Revised Bloom's Taxonomy (RBT) Level |
|---|---|---|
| **Module -1**<br>**Introduction: Basic Concepts, Background Review:** Stresses and Equilibrium, Plane stress, Plane strain, Potential energy and Equilibrium. Rayleigh - Ritz Method, Galerkin's Method, Simple applications in structural Analysis. Construction or discrete models - sub domains and nodes - simple elements for the FEM - Simplex, complex and multiples elements Polynomial selection -illustrative examples Elements and shape functions and natural coordinates, Use of local and natural coordinates, compatibility and convergence requirements of shape functions. | **10 Hours** | **L1,L2** |
| **Module -2**<br>**Fundamentals of Finite Element Method:** Construction of shape functions for bar element and beam element, Bar elements, uniform bar elements, uniform section, mechanical and thermal loading, varying section, truss analysis, Frame element, Beam element, problems for various loadings and boundary conditions. | **10 Hours** | **L1,L2** |
| **Module -3**<br>**Analysis of Two and Three dimensional Elements:** Shape functions of Triangular, Rectangular and Quadrilateral elements, different types of | **10 Hours** | **L1, L2,L3** |

| | | |
|---|---|---|
| higher order elements, constant and linear strain triangular elements, stiffness matrix Four-Noded Tetrahedral Element (TET 4), Eight-Noded Hexahedral Element (HEXA 8), Tetrahedral elements, Hexahedral elements: Serendipity family, Hexahedral elements: Lagrange family. | | |
| **Module -4**<br>**Theory of Isoparametric Elements and Axisymmetric:** Isoparametric, sub parametric and super-parametric elements, characteristics of Isoparametric quadrilateral elements, structure of computer program for FEM analysis, description of different modules, pre and post processing, Axisymmetric formulation finite element modeling of triangular and quadrilateral element. | **10 Hours** | **L1, L2,L3** |
| **Module -5**<br>**Field Problems:** Heat transfer problems, Steady state fin problems, 1D heat conduction governing equation, Derivation of element matrices for two dimensional problems, Dynamic consideration- Formulation- Hamilton's principle, Element mass matrices. | **10 Hours** | **L1,L2,L3** |

**Course outcomes:**

After studying this course, students will be able to:

1. Apply discretisation technique for domain decomposition.
2. Evaluate the effects of different loading and boundary conditions
3. Analyze the governing equations of finite element analysis

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Interpretation of data

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

1. Chandrupatla T. R., "Finite Elements in engineering", PHI, 3rd edition, 2002, ISBN-13: 978-8120321069.
2. Bhavikatti, Finite element Analysis, New Age International,3rd edition,2015,ISBN-13: 978-8122436716

**Reference Books:**

1. Rajasekharan. S - "Finite element analysis in engineering design", Wheeler Publishers
2. Bathe. KJ , "Finite Element Procedures", PHI Pvt. Ltd., New Delhi,1996,ISBN-13: 978-8126529988
3. Zienkiewicz. O.C. - "The Finite Element Method", Elsevier,7th edition,2013,ISBN-13: 978-9351071587
4. Rao S. S., "Finite Elements Method in Engineering", Elsevier,5th edition, 2008,ISBN-13: 978-

9380931555

5. C.S. Krishnamurthy - "Finite Element analysis - Theory and Programming", Tata McGraw Hill Co. Ltd, New Delhi,2nd edition,2011,ISBN-13: 978-0074622100

## SPACE MECHANICS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VI

| | | | |
|---|---|---|---|
| Subject Code | **17AS62** | IA Marks | 40 |
| Number of Lecture Hours/Week | 04 | Exam Hours | 03 |
| Total Number of Lecture Hours | 50 | Exam Marks | 60 |

CREDITS – 04

**Course objectives:** This course will enable students to

1. Understand the basic concepts of space mechanics and the general N- body.
2. Study satellite injection and satellite orbit perturbations.
3. Acquire the knowledge of interplanetary and ballistic missile trajectories.

| Modules | Teaching Hours | Revised Bloom's Taxonomy (RBT) Level |
|---|---|---|
| **Module -1**<br>**Space Environment:** Peculiarities of space environment and its description, effect of space environment on materials of spacecraft structure and astronauts, manned space missions, effect on satellite life time. | **10 Hours** | **L1, L2** |
| **Module -2**<br>**Basic Concepts and the General N-Body:** The solar system, reference frames and coordinate systems, terminology related to 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 body problem, Lagrange-Jacobi identity, the circular restricted three body problem, libration points, the general N-body problem, two body problem, relations between position and time. | **10 Hours** | **L1, L2** |
| **Module -3**<br>**Satellite Injection and Satellite Perturbations**: General aspects of satellite injection, satellite orbit transfer, various cases, orbit deviations due to injection errors, special and general perturbations, Cowell's method and Encke's method, method of variations of orbital elements, general perturbations approach. | **10 Hours** | **L1, L2, L3** |

| | | |
|---|---|---|
| **Module -4**<br>**Interplanetary Trajectories**: Two-dimensional interplanetary trajectories, fast interplanetary trajectories, three dimensional interplanetary trajectories, launch of interplanetary spacecraft, trajectory estimation about the target planet, concept of sphere of influence, Lambert's theorem. | **10 Hours** | **L1, L2** |
| **Module -5**<br>**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. | **10 Hours** | **L1, L2** |

**Course outcomes:**

At the end of this course the student will be able to :

1. Apply the basic concepts of space mechanics and the general N- body.
2. Explain satellite injection and satellite orbit perturbations.
3. Distinguish between interplanetary and ballistic missile trajectories.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Interpretation of data

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

1. Cornelisse, J.W., Rocket Propulsion and Space Dynamics, W.H. Freeman & co,1984.
2. Thomson, Introduction to Space Dynamics, Dover Publications,Revised edition,2012.

**Reference Books:**

1. Van de Kamp, P., "Elements of Astromechanics", Pitman, 1979
2. Willian E. Wiesel, Space Flight Dynamics, Create Space Independent Publishing Platform, 3rd Edition ,2010,ISBN-13: 978-1452879598
3. George P. Sutton and Oscar Biblarz, Rocket Propulsion Elements,Wiley India Pvt Ltd,7th edition, 2010,ISBN-13: 978-8126525775.

## CONTROL ENGINEERING

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VI

| | | | |
|---|---|---|---|
| Subject Code | **17AS63** | IA Marks | 40 |

# VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
# CHOICE BASED CREDIT SYSTEM (CBCS)
# SCHEME OF TEACHING AND EXAMINATION 2017-2018

| | | | |
|---|---|---|---|
| Number of Lecture Hours/Week | 04 | Exam Hours | 03 |
| Total Number of Lecture Hours | 50 | Exam Marks | 60 |

CREDITS – 04

**Course objectives:** This course will enable students to
1. Understand the concepts of open loop, closed loop systems and types of controllers.
2. Construct signal flow diagram from the Blocks and signal flow graphs.
3. Know about the Bode plot, Nyquist plot, polar plot and Root locus method.

| Modules | Teaching Hours | Revised Bloom's Taxonomy (RBT) Level |
|---|---|---|
| **Module -1**<br>**Introduction:** Concept of automatic controls, Open loop and closed loop systems, Concepts of feedback, requirements of an ideal control system, Types of controllers- Proportional, Integral Proportional Integral, Proportional Integral Differential controllers.<br><br>**Mathematical Models:** Transfer function models, models of mechanical systems, models of electrical circuits, DC and AC motors in control systems, Analogous systems: Force voltage, Force current | **10 Hours** | **L1, L2** |
| **Module -2**<br>**Block Diagrams and Signal Flow Graphs:** Transfer Functions definition, function, block representation of systems elements, reduction of block diagrams, Signal flow graphs: Mason's gain formula | **10 Hours** | **L1, L2** |
| **Module -3**<br>**Transient and Steady State Response Analysis:** Introduction, first order and second order system response to step, ramp and impulse inputs, concepts of time constant and its importance in speed of response. System stability: Routh's- Hurwitz Criterion | **10 Hours** | **L1, L2, L3** |
| **Module -4**<br>**Root Locus Plots:** Definition of root loci, General rules for constructing root loci, Analysis using root locus plots.<br>**Frequency Response Analysis:** Polar plots, Nyquist stability criterion, Stability analysis, Gain margin and phase margin.<br>**Frequency Response Analysis Using Bode Plots:** Bode attenuation diagrams, Stability analysis using Bode plots, Simplified Bode Diagrams. | **10 Hours** | **L1, L2** |
| **Module -5**<br>**System Compensation and State Variable Characteristics of Linear Systems:** Series and feedback compensation, Introduction to state concepts, state equation of linear continuous data system. Matrix representation of state equations, controllability and Observability, Kalman and Gilberts test | **10 Hours** | **L1, L2** |

**Course outcomes:**
After studying this course, students will be able to:
1. Apply the concepts of open loop, closed loop systems and types of controllers.
2. Develop signal flow diagram from the Blocks and signal flow graphs.

3. Interpret the Bode plot, Nyquist plot, polar plot and Root locus method.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Interpretation of data

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

1. Katsuhiko Ogatta,Modern Control Engineering**,** Pearson Education,5th edition,2015,ISBN-13: 978-9332550162.
2. M.Gopal,Control Systems Principles and Design,TMH,4th edition,2012,ISBN-13: 978-0071333269.

**Reference Books:**

1. Richard.C.Dorf and Robert.H.Bishop,Modern Control Systems, Pearson Education India,12th edition,2013,ISBN-13: 978-9332518629
2. Eronini-Umez, System dynamics & control ,Thomson Asia pvt Ltd. singapore, 2002.
3. Schaum’s series ,Feedback Control System, 2001.

# MISSILES AND LAUNCH VEHICLES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VI

| | | | |
|---|---|---|---|
| Subject Code | **17AS64** | IA Marks | 40 |
| Number of Lecture Hours/Week | 04 | Exam Hours | 03 |
| Total Number of Lecture Hours | 50 | Exam Marks | 60 |

CREDITS – 04

**Course objective:**

This course will enable students to

1. Understand the types of space launch vehicles and missiles.
2. Study the solid and liquid rocket motors.
3. Acquire the knowledge on launch vehicle dynamics, attitude control, rocket testing and materials.

| **Modules** | **Teaching Hours** | **Revised Bloom’s Taxonomy (RBT) Level** |
|---|---|---|

| | | |
|---|---|---|
| **Module -1**<br>**Introduction:** Space launch Vehicles and military missiles, function, types, role, mission, mission profile, thrust profile, propulsion system, payload, staging, control and guidance requirements, performance measures, design, construction, operation, similarities and differences. Some famous space launch vehicles and strategic missiles. | **8 Hours** | **L1, L2** |
| **Module -2**<br>**Solid Propellant Rocket Motor Systems:** Solid Propellant rocket motors, principal features, applications. Solid propellants, types, composition, properties, performance. Propellant grain, desirable properties, grain configuration, preparation, loading, structural design of grain. Liners, insulators and inhibitors, function, requirements, materials. Rocket motor casing – materials. Nozzles, types, design, construction, thermal protection. Igniters, types, construction. Description of modern solid boosters I) Space Shuttle SRB, II)the Arienne SRB<br><br>**Liquid Propellant Rocket Motor Systems:** Liquid propellants, types, composition, properties, performance. Propellant tanks, feed systems, pressurization, turbo-pumps, valves and feed lines, injectors, starting and ignition. Engine cooling, support structure. Control of engine starting and thrust build up, system calibration, integration and optimisation – safety and environmental concerns. Description of the space shuttle main engine. Propellant slosh, propellant hammer, geysering effect in cryogenic rocket engines. | **8 Hours** | **L1, L2** |
| **Module -3**<br>**Aerodynamics Of Rockets And Missiles:** Classification of missiles. 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, longitudinal moment of a rocket, lift and drag forces, drag estimation, body upwash and downwash in missiles. Rocket dispersion, re-entry body design considerations. | **8 Hours** | **L1, L2, L3** |
| **Module -4**<br>**Launch Vehicle Dynamics:** Tsiolskovsky's rocket equation, range in the absence of gravity, vertical motion in the earth's gravitational field, inclined motion, flight path at constant pitch angle, motion in the atmosphere, the gravity turn – the culmination altitude, multi staging. Earth launch trajectories – vertical segment, the gravity turn, constant pitch trajectory, orbital injection. Actual launch vehicle trajectories, types. Examples, the Mu 3-S-II, Ariane, Pegasus launchers. Reusable launch vehicles, future launchers, launch assist technologies.<br><br>**Attitude Control Of Rockets And Missiles:** Rocket Thrust Vector Control – Methods of Thrusts Vector Control for solid and liquid propulsion systems, thrust magnitude control, thrust termination; stage separation dynamics, separation techniques. | **8 Hours** | **L1, L2** |
| **Module -5**<br>**Rocket Testing:** Ground Testing and Flight Testing, Types of Tests | **8 Hours** | **L1, L2** |

| | | |
|---|---|---|
| facilities and safeguards, monitoring and control of toxic materials, instrumentation and data management. Ground Testing, Flight Testing, Trajectory monitoring, post -accident procedures. Description of a typical space launch vehicle launch procedure.<br>**Materials:** Criteria for selection of materials for rockets and missiles, requirements for choice of materials for propellant tanks, liners, insulators, inhibitors, at cryogenic temperatures, requirements of materials at extremely high temperatures, requirements of materials for thermal protection and for pressure vessels. | | |

**Course outcomes:**
After studying this course, students will be able to:
1. Identify the types of space launch vehicles and missiles.
2. Distinguish the solid and liquid propellant motors.
3. Classify different types of materials used for rockets and missies.

**Graduate Attributes (as per NBA):**
- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Interpretation of data

**Question paper pattern:**
- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**
1. George P Sutton and Oscar Biblarz, 'Rocket Propulsion Element', John Wiley and Sons Inc,7th edition, 2010,ISBN-13: 978-8126525775.
2. Jack N Neilson, 'Missile Aerodynamics', AIAA,1st edition, 1988,ISBN-13: 978-0962062902.

**Reference Books:**
1. S S Chin, 'Missile Configuration Design'.
2. Cornelisse, J.W., Schoyer H.F.R. and Wakker,. K.F., Rocket Propulsion and Space-Flight Dynamics, Pitman, 1979,ISBN-13: 978-0273011415
3. Turner, M.J.L., Rocket and Spacecraft propulsion, Springer,3rd edition,2010,ISBN-13: 978-3642088698.
4. Ball, K.J., Osborne, G.F., Space Vehicle Dynamics, Oxford University Press, 1967,ISBN-13: 978-0198561071
5. Parker, E.R., Materials for Missiles and Spacecraft, McGraw Hill, 1982.

## DESIGN, MODELLING & ANALYSIS LAB
[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – VI

| | | | |
|---|---|---|---|
| Subject Code | **17ASL67** | IA Marks | 40 |
| Number of Lecture Hours/Week | 03 | Exam Hours | 03 |
| Total Number of | 42 | Exam Marks | 60 |

| Lecture Hours | | | |
|---|---|---|---|
| CREDITS – 02 | | | |

**Course objectives:** This course will enable students to
1. Understand the procedure to draw the geometric models of symmetric, cambered aerofoil, nozzle, wing and other structures.
2. Acquire the knowledge of types of meshing.
3. Understand the basics of flow and stress analysis.

| Modules | Revised Bloom's Taxonomy (RBT) Level |
|---|---|
| 1. Modeling of Symmetric Aerofoil Geometry, And Generation of Body Fitting Mesh. | **L1, L2, L3** |
| 2. Modeling of Cambered Aerofoil Geometry, And Generation of Body Fitting Mesh. | **L1, L2, L3** |
| 3. Modeling of 2-D Incompressible and Inviscid Flow over an Aerofoil. Computations and Analysis for Velocity Vectors and Pressures Distributions. | **L1, L2, L3, L4** |
| 4. Modeling of 2-D Incompressible and Viscous Flow over an Aerofoil. Computations and Analysis for Velocity Vectors and Pressures Distributions. | **L1, L2, L3, L4** |
| 5. Geometric Modeling and Mesh Generation of 2-D Convergent Divergent Nozzle and Analyses of Flow for Adiabatic Conditions. | **L1, L2, L3, L4** |
| 6. Structural Modeling of Sandwich Beam of Rectangular Cross-Section and Analyses for Stresses. | **L1, L2, L3, L4** |
| 7. Structural Modeling of a Three Dimensional Wing. | **L1, L2, L3** |
| 8. Structural Modeling and Stress Analysis of a Fuselage Bulk Head. | **L1,L2,L3,L4** |
| 9. Structural Modeling and Stress Analysis of a Simply Supported Rectangular Plate Uniformly Compressed In one Direction. | **L1,L2,L3,L4** |
| 10. Structural Modeling and Stress Analysis of a Simply Supported Rectangular Plate Uniformly Compressed In one Direction with a Cut-Out in Center. | **L1,L2,L3,L4** |
| 11. Simulation of Hydraulic / Pneumatic cylinder using C / MATLAB. | **L1, L2, L3** |
| 12. Simulation of cam and follower mechanism using C / MAT Lab. | **L1, L2, L3** |

| | |
|---|---|
| 13. Thermal Analysis – 1D & 2D problem with conduction and convection boundary conditions. (Minimum 4 exercises) | **L1, L2, L3** |
| 14. Dynamic Analysis<br>a) Fixed – fixed beam for natural frequency determination<br>b) Bar subjected to forcing function<br>c) Fixed – fixed beam subjected to forcing function | **L1, L2, L3** |

Course outcomes: After studying the course the students will be able to

1. Draw the geometric models of symmetric, cambered aerofoil, nozzle, wing and other structures.
2. Apply different types of meshing .
3. Perform the flow and stress analysis.

**Conduct of Practical Examination:**

1. All laboratory experiments are to be included for practical examination.
2. Students are allowed to pick one experiment from the lot.
3. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

**Graduate Attributes (as per NBA)[TO BE MODIFIED]:**

- Engineering Knowledge.
- Problem Analysis.
- Team work
- Communication

## STRUCTURES AND VIBRATION LAB

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VI

| | | | |
|---|---|---|---|
| Subject Code | **17ASL68** | IA Marks | 40 |
| Number of Lecture Hours/Week | 03 | Exam Hours | 03 |
| Total Number of Lecture Hours | 42 | Exam Marks | 60 |

CREDITS – 02

**Course objectives:** This course will enable students to

1. Understand the functions of different equipments to study deflection and vibration
2. Familiarize with the use of equipments to measure deflections and vibration of structures.
3. Understand the methods to determine the vibration characteristics.

| **Modules** | **Revised Bloom's Taxonomy (RBT) Level** |
|---|---|
| 1. Deflection of a Simply Supported Beam. | **L1, L2, L3** |

| | |
|---|---|
| 2. Deflection of a cantilever Beam | **L1, L2, L3** |
| 3. Deflection of a beam under combined loading | **L1, L2, L3** |
| 4. Verification of Maxwell's Reciprocal Theorem. | **L1, L2, L3** |
| 5. Determination of Young’s Modulus using strain gages and Poisson Ratio Determination | **L1, L2, L3** |
| 6. Determination natural frequency and damping ratio using forcing function. | **L1, L2, L3** |
| 7. Buckling load of slender Eccentric Columns and Construction of Southwell Plot | **L1, L2, L3** |
| 8. Shear Failure of Bolted and Riveted Joints using Wagner beam | **L1, L2, L3** |
| 9. Determination of fundamental frequency of a cantilever beam and harmonics. | **L1, L2, L3** |
| 10. Frequency spectrum analysis for a cantilever beam. | **L1, L2, L3** |
| 11. Estimation of the natural frequency for a rigid body-spring system | **L1, L2, L3** |
| 12. Estimation of the natural frequency for two rotor system | **L1, L2, L3** |
| 13. Verification of Dunkerley's Equation. | **L1, L2, L3** |
| 14. Determine the Structural Damping Coefficient of a Composite Material Cantilever Beam and to Draw the Polar Plots of Damping Coefficient. | **L1, L2, L3** |

**Course outcomes:**

After studying this course, students will be able to:

1. Use different equipments to study deflection and vibration
2. Utilize the equipments to measure deflections and vibration of structures.
3. Determine the vibration characteristics.

**Conduct of Practical Examination:**

1. All laboratory experiments are to be included for practical examination.
2. Students are allowed to pick one experiment from the lot.
3. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly)
- Interpretation of data.

# VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
# CHOICE BASED CREDIT SYSTEM (CBCS)
# SCHEME OF TEACHING AND EXAMINATION 2017-2018

**PROFESSIONAL ELECTIVE**

## HYPERSONICS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VI

| | | | |
|---|---|---|---|
| Subject Code | **17AS651** | IA Marks | 40 |
| Number of Lecture Hours/Week | 03 | Exam Hours | 03 |
| Total Number of Lecture Hours | 40 | Exam Marks | 60 |

CREDITS – 03

**Course objective:**

This course will enable students to

1. Understand the basics of hypersonic flows.
2. Understand the approximate methods for inviscid hypersonic flows.
3. Acquire the knowledge of viscous interactions in hypersonic flows.

| Modules | Teaching Hours | Revised Bloom's Taxonomy (RBT) Level |
|---|---|---|
| **Module -1**<br>**Basics of Hypersonic Flows:** Thin shock layers, entropy layers, low density and high density flows, hypersonic flight paths hypersonic flight similarity parameters, shock wave and expansion wave relations of inviscid hypersonic flows. | **8 Hours** | **L1, L2** |
| **Module -2**<br>**Surface Inclination Methods For Hypersonic Inviscid Flows:** Local surface inclination methods, modified Newtonian Law, Newtonian theory – tangent wedge or tangent cone and shock expansion methods, Calculation of surface flow properties. | **8 Hours** | **L1, L2** |
| **Module -3**<br>**Approximate Methods For Inviscid Hypersonic Flows:** Approximate methods hypersonic small disturbance equation and theory, thin shock | **8 Hours** | **L1, L2, L3** |

| | | |
|---|---|---|
| layer theory , blast wave theory, entropy effects, rotational method of characteristics, hypersonic shock wave shapes and correlations | | |
| **Module -4**<br>**Viscous Hypersonic Flow Theory:** Navier–Stokes equations, boundary layer equations for hypersonic flow, hypersonic boundary layer, hypersonic boundary layer theory and non similar hypersonic boundary layers, hypersonic aerodynamic heating and entropy layers effects on aerodynamic heating, heat flux estimation | **8 Hours** | **L1, L2** |
| **Module -5**<br>**Viscous Interactions In Hypersonic Flows:** Strong and weak viscous interactions, hypersonic shockwaves and boundary layer interactions, Estimation of hypersonic boundary layer transition, Role of similarity parameter for laminar viscous interactions in hypersonic viscous flow. | **8 Hours** | **L1, L2** |

**Course outcomes:**
After studying this course, students will be able to:
1. Apply the basics of hypersonic flows.
2. Apply the approximate methods for inviscid hypersonic flows.
3. Classify the viscous interactions in hypersonic flows.

**Graduate Attributes (as per NBA):**
- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Interpretation of data

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

1. John D. Anderson, Jr, Hypersonic and High Temperature Gas Dynamics, AIAA Series,2nd revised edition,2006,ISBN-13: 978-1563477805.
2. John. D. Anderson, Jr., Modern Compressible Flow with Historical perspective Hypersonic Series, McGraw Hill Education,3rd edition,2012,ISBN-13: 978-1259027420


**Reference Books:**

1. William H. Heiser and David T. Pratt, Hypersonic Air Breathing propulsion, AIAA Education Series,1994,ISBN-13: 978-1563470356
2. John T. Bertin, Hypersonic Aerothermodynamics,AIAA Inc., Washington D,1994.


## DIGITAL ELECTRONICS SYSTEMS

[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – VI

| | | | |
|---|---|---|---|
| Subject Code | **17AS652** | IA Marks | 40 |

# VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
# CHOICE BASED CREDIT SYSTEM (CBCS)
# SCHEME OF TEACHING AND EXAMINATION 2017-2018

| | | | |
|---|---|---|---|
| Number of Lecture Hours/Week | 03 | Exam Hours | 03 |
| Total Number of Lecture Hours | 40 | Exam Marks | 60 |

CREDITS – 03

**Course objective:** This course will enable students to

1. Understand the concepts of digital electronics systems
2. Acquire the knowledge on digital electronics systems
3. Understand the functions of different components of digital electronics systems.

| Modules | Teaching Hours | Revised Bloom's Taxonomy (RBT) Level |
|---|---|---|
| **Module -1**<br>**Principles of combinational logic-1**: Definition of combinational logic, Canonical forms, Generation of switching equations from truth tables Karnaugh maps-3, 4 and 5 variables, Incompletely specified functions (Don't Care terms), Simplifying Max term equations.<br>**Principles of combinational logic-2**: Quine-McCluskey minimization technique- Quine-McCluskey using don't care terms, Reduced Prime Implicant Tables, Map entered variables. | **8 Hours** | **L1, L2** |
| **Module -2**<br>**Analysis and design of combinational logic - I**: General approach, Decoders-BCD decoders, Encoders.<br>**Analysis and design of combinational logic - II**: Digital multiplexers Using multiplexers as Boolean function generators. Adders and subtractors - Cascading full adders, Look ahead carry, Binary comparators. Design methods of building blocks of combinational logics. | **8 Hours** | **L1, L2** |
| **Module -3**<br>**Sequential Circuits – 1:**<br>Basic Bistable Element, Latches, SR Latch, Application of SR Latch, A Switch Debouncer, The S R Latch, The gated SR Latch, The gated D Latch, The Master-Slave Flip-Flops (Pulse-Triggered Flip-Flops): The Master-Slave SR Flip-Flops, The Master-Slave JK FlipFlop, Edge Triggered Flip-Flop: The Positive Edge-Triggered D Flip-Flop, Negative-Edge Triggered D Flip-Flop. | **8 Hours** | **L1, L2, L3** |
| **Module -4**<br>**Sequential Circuits – 2:** Characteristic Equations, Registers, Counters - Binary Ripple Counters, Synchronous Binary counters, Counters based on Shift Registers, Design of a Synchronous counters, Design of a Synchronous Mod-6 Counter using clocked JK Flip-Flops Design of a Synchronous Mod-6 Counter using clocked D, T, or SR Flip-Flops | **8 Hours** | **L1, L2,** |
| **Module -5**<br>**Sequential Design - I**: Introduction, Mealy and Moore Models, State Machine Notation, Synchronous Sequential Circuit Analysis and Design.<br>**Sequential Design - II**: Construction of state Diagrams, Counter | **8 Hours** | **L1, L2** |

Design.

**Course outcomes:**

1. Apply the concepts of digital electronics systems
2. Evaluate digital electronics systems
3. Differentiate the functions of different components of digital electronics systems

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Interpretation of data

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

1. John M Yarbrough ,"Digital Logic Applications and Design", Nelson Engineering,1st edition,2006,ISBN-13: 978-8131500583
2. Donald D Givone ,"Digital Principles and Design ", Tata McGraw Hill,1st edition,2002,ISBN-13: 978-0070529069

**Reference Books:**

1. Charles H Roth, Jr "Fundamentals of logic design",; Thomson Learning, 2004.
2. Mano and Kime "Logic and computer design Fundamentals", , Pearson, 4th edition, 2013,ISBN-13: 978-9332518728
3. Sudhakar Samuel, "Logic Design", Pearson/Saguine, 2007

## HIGH PERFORMANCE COMPUNTING

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VI

| | | | |
|---|---|---|---|
| Subject Code | **17AS653** | IA Marks | 40 |
| Number of Lecture Hours/Week | 03 | Exam Hours | 03 |
| Total Number of Lecture Hours | 40 | Exam Marks | 60 |

CREDITS – 03

**Course objective:**

This course will enable students to

1. Understand the concepts of high performance computing
2. Acquire the knowledge of various algorithms required for parallel computing.
3. Understand the concepts of architecture.

| Modules | Teaching Hours | Revised Bloom's Taxonomy |
|---|---|---|

| | | (RBT) Level |
|---|---|---|
| **Module -1**<br>**Computational Science and Engineering Introduction**: Computational Science and Engineering Applications; characteristics and requirements, Review of Computational Complexity, Performance: metrics and measurements, Granularity and Partitioning, Locality: temporal/spatial/stream/kernel, Basic methods for parallel programming, Real-world case studies (drawn from multi-scale, multi-discipline applications) | **8 Hours** | **L1, L2** |
| **Module -2**<br>**High-End Computer Systems: Memory Hierarchies, Multi-core Processors**: Homogeneous and Heterogeneous, Shared-memory Symmetric Multiprocessors, Vector Computers, Distributed Memory Computers, Supercomputers and Petascale Systems, Application Accelerators / Reconfigurable Computing, Novel computers: Stream, multithreaded, and purpose-built | **8 Hours** | **L1, L2** |
| **Module -3**<br>**Parallel Algorithms**: Parallel models: ideal and real frameworks, Basic Techniques: Balanced Trees, Pointer Jumping, Divide and Conquer, Partitioning, Regular Algorithms: Matrix operations and Linear Algebra, Irregular Algorithms: Lists, Trees, Graphs, Randomization: Parallel Pseudo-Random Number Generators, Sorting, Monte Carlo techniques. | **8 Hours** | **L1, L2, L3** |
| **Module -4**<br>**Parallel Programming**: Revealing concurrency in applications, Task and Functional Parallelism, Task Scheduling, Synchronization Methods, Parallel Primitives (collective operations), SPMD Programming (threads, OpenMP, MPI), I/O and File Systems, Parallel Matlabs (Parallel Matlab, Star-P, Matlab MPI), Partitioning Global Address Space (PGAS) languages (UPC, Titanium, Global Arrays) | **8 Hours** | **L1, L2** |
| **Module -5**<br>**Achieving Performance**: Measuring performance, Identifying performance bottlenecks, Restructuring applications for deep memory hierarchies, Partitioning applications for heterogeneous resources, Using existing libraries, tools, and frameworks. | **8 Hours** | **L1, L2** |

**Course outcomes:**

After studying the course the students will be able to

1. Apply the concepts of high performance computing
2. Develop various algorithms required for parallel computing.
3. Compare architectures for high performance computing .

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- **Modern tools**

**Question paper pattern:**

- The question paper will have ten questions.

- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

1. Grama, A. Gupta, G. Karypis, V. Kumar, An Introduction to Parallel Computing, Design and Analysis of Algorithms,Pearson Education India,2nd edition, 2004,ISBN-13: 978-8131708071.
2. G.E. Karniadakis, R.M. Kirby II, Parallel Scientific Computing in C++ and MPI: A Seamless Approach to Parallel Algorithms and their Implementation,Cambridge University Press, 2003.

**Reference Books:**

1. Wilkinson and M. Allen, Parallel Programming: Techniques and Applications Using Networked Workstations and Parallel Computers, Pearson,2nd edition, 2006,ISBN-13: 978-8131702390.
2. M.J. Quinn, Parallel Programming in C with MPI and OpenMP, McGraw-Hill, 1st edition,2003,ISBN-13: 978-0070582019.
3. G.S. Almasi and A. Gottlieb, Highly Parallel Computing, 2/E, Addison-Wesley, 1994.
4. J. Dongarra, I. Foster, G. Fox, W. Gropp, K. Kennedy, L. Torczon, A. White, editors, The Sourcebook of Parallel Computing, Morgan Kaufmann, 2002.

## SATELLITE COMMUNICATION

[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – VI

| Subject Code | **17AS654** | IA Marks | 40 |
|---|---|---|---|
| Number of Lecture Hours/Week | 03 | Exam Hours | 03 |
| Total Number of Lecture Hours | 40 | Exam Marks | 60 |

CREDITS – 03

**Course objective:**
This course will enable students to

1. Understand the elements of satellite communication.
2. Understand the Different modulation and Multiplexing Schemes.
3. Acquire the knowledge of Satellite Telemetry, Tracking and Telecommand.

| **Modules** | **Teaching Hours** | **Revised Bloom's Taxonomy (RBT) Level** |
|---|---|---|
| **Module -1**<br>**Elements Of Satellite Communication:** Satellite Systems, Orbital description and Orbital mechanics of LEO, MEO and GSO, Placement of a Satellite in a GSO, Satellite – description of different Communication subsystems, Bandwidth allocation. | **7 Hours** | **L1, L2** |
| **Module -2**<br>**Transmission, Multiplexing, Multiple Access And Coding:** Different modulation and Multiplexing Schemes, Multiple Access Techniques FDMA, TDMA, CDMA and DAMA, Coding Schemes, Satellite Packet Communications. | **8 Hours** | **L1, L2** |

| | | |
|---|---|---|
| **Module -3**<br>**Satellite Link Design:** Basic link analysis, Interference analysis, Rain induced attenuation and interference, Ionospheric characteristics, Link Design with and without frequency reuse. | **8 Hours** | **L1, L2, L3** |
| **Module -4**<br>**Satellite Telemetry, Tracking And Telecommand:** Introduction to telemetry systems, Aerospace transducer, signal conditioning, multiplexing methods, Analog and digital telemetry, Command line and remote control system, Application of telemetry in spacecraft systems, Base Band Telemetry system, Computer command & Data handling , Satellite command system, Issues. | **8 Hours** | **L1, L2** |
| **Module -5**<br>**Applications:** VSAT-VSAT Technologies, Networks MSS-AMSS, MMSS. | **7 Hours** | **L1, L2** |

**Course outcomes:**

After studying this course, students will be able to:

1. Apply of concepts of orbital mechanics.
2. Classify the modulation and Multiplexing Schemes.
3. Identify the applications of satellites.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Interpretation of data

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

1. Wilbur L. Pritchard and Joseph A.Sciulli, Satellite Communication Systems Engineering, Pearson Education India,2nd edition,2003,ISBN-13: 978-8131702420.

2. Timothy Pratt and Charles W.Bostain, Satellite Communications, John Wiley and Sons,2nd edition,2006,ISBN-13: 978-8126508334.

**Reference Books:**

1. Tri T Ha, Digital Satellite Communication, McGraw Hill Education, 2nd edition, 2008, ISBN-13: 978-0070077522.
2. Kadish, Jules E, Satellite Communications Fundamentals, Artech House, Boston ,2000,ISBN-13: 978-1580531368
3. Lida,Takashi ed.,Satellite communications: System and its design technology, IOS Press,US, 2000,ISBN-13: 978-1586030858
4. Maral, Gerard,Satellite communications systems: Systems, techniques and technology, John Wiley, Newyork 2002.

5. Elbert, Bruce R, Satellite communication applications handbook, Artech house Boston 2004.Publishers, New Delhi 1991.

# VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
# CHOICE BASED CREDIT SYSTEM (CBCS)
# SCHEME OF TEACHING AND EXAMINATION 2017-2018

**OPEN ELECTIVE**

## UNMANNED AERIAL VEHICLES BASICS & APPLICATIONS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VI

**Open Elective**

| | | | |
|---|---|---|---|
| Subject Code | **17AS661/17AE661** | IA Marks | 40 |
| Number of Lecture Hours/Week | 03 | Exam Hours | 03 |
| Total Number of Lecture Hours | 40 | Exam Marks | 60 |

CREDITS – 03

**Course Objectives:** This course will enable students to

1. Comprehend the basic aviation history and UAV systems.
2. Acquire the knowledge of basic aerodynamics, performance, stability and control.
3. Understand the propulsion, loads and structures.

| Modules | Teaching Hours | Revised Bloom's Taxonomy (RBT) Level |
|---|---|---|
| **Module -1**<br><br>**Introduction**<br>Aviation History and Overview of UAV systems, Classes and Missions of UAVs, Definitions and Terminology, UAV fundamentals, Examples of UAV systems-very small, small, Medium and Large UAV | **6 Hours** | **L1, L2** |
| **Module -2**<br><br>**The Air Vehicle**<br><br>**Basic Aerodynamics:**<br>Basic Aerodynamics equations, Aircraft polar, the real wing and Airplane, Induced drag, the boundary layer, Flapping wings, Total Air-Vehicle Drag | **6 Hours** | **L1, L2** |

| | | |
|---|---|---|
| **Performance:**<br>Overview, climbing flight, Range and Endurance – for propeller-driven aircraft, range- a jet-driven aircraft, Guiding Flight | | |
| **Module -3**<br><br>**Stability and Control**<br>Overview, Stability, longitudinal, lateral, dynamic stability, Aerodynamics control, pitch control, lateral control, Autopilots, sensor, controller, actuator, airframe control, inner and outer loops, Flight-Control Classification, Overall Modes of Operation, Sensors Supporting the Autopilot. | **8 Hours** | **L1, L2, L3** |
| **Module -4**<br><br>**Propulsion**<br>Overview, Thrust Generation, Powered Lift, Sources of Power, The Two-Cycle Engine, The Rotary Engine, The Gas Turbine, Electric Motors, Sources of Electrical Power<br><br>**Loads and Structures**<br>Loads, Dynamic Loads, Materials, Sandwich Construction, Skin or Reinforcing Materials, Resin Materials, Core Materials, Construction Techniques | **10 Hours** | **L1, L2, L3** |
| **Module -5**<br>**Mission Planning and Control:** Air Vehicle and Payload Control, Reconnaissance/Surveillance Payloads, Weapon Payloads, Other Payloads, Data-Link Functions and Attributes, Data-Link Margin, Data-Rate Reduction, Launch Systems, Recovery Systems, Launch and Recovery Tradeoffs | **10 Hours** | **L1, L2, L3** |

**Course Outcomes:**
After studying this course, students will be able to:
1. Apply the basic concepts of UAV systems.
2. Explain the basic aerodynamics, performance, stability and control required for UAV.
3. Select the propulsion system and materials for structures.

**Graduate Attributes:**
- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Interpretation of data

**Question paper pattern:**
- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

1. Paul Gerin Fahlstrom, Thomas James Gleason, Introduction to UAV Systems, 4th Edition, Wiley Publication, 2012 John Wiley & Sons, Ltd
2. Landen Rosen, Unmanned Aerial Vehicle, Publisher: Alpha Editions, ISBN13: 9789385505034.

**Reference Books:**

1. Unmanned Aerial Vehicles: DOD's Acquisition Efforts, Publisher: Alpha Editions, ISBN13: 9781297017544.
2. Valavanis, Kimon P., Unmanned Aerial Vehicles, Springer, 2011.
3. Valavanis, K., Vachtsevanos, George J., Handbook of Unmanned Aerial Vehicles, Springer, 2015.

# FUNDAMENTALS OF AERODYNAMIC THEORY

[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – VI
**Open Elective**

| | | | |
|---|---|---|---|
| Subject Code | **17AS662/17AE662** | IA Marks | 40 |
| Number of Lecture Hours/Week | 03 | Exam Hours | 03 |
| Total Number of Lecture Hours | 40 | Exam Marks | 60 |

CREDITS – 03

**Course objectives:** This course will enable students to

1. Understand the basics of fluid mechanics as a prerequisite to Aerodynamics
2. Acquire knowledge on typical airfoil characteristics and two-dimensional flows over airfoil and study the incompressible over finite wings
3. Assimilate the understanding of application of finite wing theory and high lift systems

| Modules | Teaching Hours | Revised Bloom's Taxonomy (RBT) Level |
|---|---|---|
| **Module -1**<br>**Review of Basic Fluid Mechanics**<br>Continuity, momentum and energy equation, Control volume approach to Continuity, momentum and energy equation, Types of flow, pathlines, streamlines, and streaklines, units and dimensions, inviscid and viscous flows, compressibility, Mach number regimes. Vorticity, Angular velocity, Stream function, velocity potential function, Circulation, Numericals, Mach cone and Mach angle, Speed of sound. | **08 Hours** | **L1, L2** |
| **Module -2**<br><br>**Airfoil Characteristics**<br>Fundamental aerodynamic variables, Airfoil nomenclature, airfoil characteristics. wing planform geometry, aerodynamic forces and moments, centre of pressure, pressure coefficient, aerodynamic center, calculation of airfoil lift and drag from measured surface pressure distributions, typical airfoil aerodynamic characteristics at low speeds. | **08 Hours** | **L1, L2** |

| | | |
|---|---|---|
| Types of drag-Definitions. | | |
| **Module -3**<br>**Two Dimensional Flows & Incompressible Flow Over Airfoil**<br>Uniform flow, Source flow, Sink flow, Combination of a uniform flow with source and sink. Doublet flow. Non-lifting flow over a circular cylinder. Vortex flow. Lifting flow over a circular cylinder. Kutta-Joukowski theorem and generation of Lift, D'Alembert's paradox, Numericals,<br>**Incompressible flow over airfoils:** Kelvin's circulation theorem and the starting vortex, vortex sheet, Kutta condition, Classical thin airfoil theory for symmetric and cambered airfoils. Kutta-Joukowski theorem and generation of Lift, Numericals. | **08 Hours** | **L1, L2, L3, L4, L5** |
| **Module -4**<br>**Incompressible Flow Over Finite Wings**<br>Biot-Savart law and Helmholtz's theorems, Vortex filament: Infinite and semi-infinite vortex filament, Induced velocity. Prandtl's classical lifting line theory: Downwash and induced drag. Elliptical and modified elliptical lift distribution. Lift distribution on wings. Limitations of Prandtl's lifting line theory. Extended lifting line theory- lifting surface theory, vortex lattice method for wings. Lift, drag and moment characteristics of complete airplane. | **08 Hours** | **L1, L2** |
| **Module -5**<br><br>**Applications of Finite Wing Theory & High Lift Systems**<br>Simplified horse-shoe vortex model, formation flight, influence of downwash on tail plane, ground effects. Swept wings: Introduction to sweep effects, swept wings, pressure coefficient, typical aerodynamic characteristics, Subsonic and Supersonic leading edges. Introduction to high-lift systems, flaps, leading-edge slats and typical high – lift characteristics. critical Mach numbers, Lift and drag divergence, shock induced separation, Effects of thickness, camber and aspect ratio of wings, Transonic area rule, Tip effects. Introduction to Source panel & vortex lattice method. | **08 Hours** | **L1, L2, L3** |

**Course outcomes:**

After studying this course, students will be able to:

1. Evaluate typical airfoil characteristics and two-dimensional flows over airfoil
2. Compute and analyse the incompressible flow over finite wings
3. Apply finite wing theory and design high lift systems from the aerodynamics view point

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly).
- Interpretation of data.

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.

- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

3. Anderson J.D, "Fundamental of Aerodynamics", 5th edition, McGraw-Hill International Edition, New York (2011), ISBN-13: 978-0073398105.
4. E. L. Houghton, P.W. Carpenter, "Aerodynamics for Engineering Students", 5th edition, Elsevier, New York. (2010), ISBN-13: 978-0080966328

**Reference Books:**

3. Clancy L. J. "Aerodynamics", Sterling book house, New Delhi. (2006), ISBN 13: 9780582988804
4. Louis M. Milne-Thomson, "Theoretical Aerodynamics", Imported Edition, Dover Publications, USA (2011), ISBN 9780486619804.

# ELEMENTS OF JET PROPULSION SYSTEMS

[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – VI
**Open Elective**

| | | | |
|---|---|---|---|
| Subject Code | **17AS663/17AE663** | IA Marks | 40 |
| Number of Lecture Hours/Week | 03 | Exam Hours | 03 |
| Total Number of Lecture Hours | 40 | Exam Marks | 60 |

CREDITS – 03

**Course objectives:** This course will enable students to

1. Understand the basic principle and theory of aircraft propulsion.
2. Understand the purpose of a centrifugal, axial compressors, axial and radial turbines
3. Acquire knowledge of importance of nozzles & inlets and combustion chamber

| Modules | Teaching Hours | Revised Bloom's Taxonomy (RBT) Level |
|---|---|---|
| **Module -1**<br><br>**Introduction:** Review of thermodynamic principles, Principles of aircraft propulsion, Types of power plants, Working principles of internal combustion engine, Two – stroke and four – stroke piston engines, Gas- turbine engines, Cycle analysis of reciprocating engines and jet engines , advantages and disadvantages. | **08 Hours** | **L1, L2** |
| **Module -2**<br><br>**Propeller Theories & Jet propulsion** Types of propeller, Propeller thrust: momentum theory, Blade element theories, propeller blade design, propeller selection.<br><br>**Jet Propulsion:** Illustration of working of gas turbine engine – The thrust equation – Factors affecting thrust – Effect of pressure, velocity | **08 Hours** | **L1, L2, L3** |

| | | |
|---|---|---|
| and temperature changes of air entering compressor – Methods of thrust augmentation – Characteristics of turboprop, turbofan and turbojet – Performance characteristics. | | |
| **Module -3**<br><br>**Inlets & Nozzles**<br>Internal flow and Stall in Subsonic inlets, Boundary layer separation. Major features of external flow near a subsonic inlet. Relation between minimum area ratio and eternal deceleration ratio. Diffuser performance.<br>**Supersonic inlets:** Supersonic inlets, starting problem in supersonic inlets, Shock swallowing by area variation, External deceleration. Modes of inlet operation.<br><br>**Nozzles:** Theory of flow in isentropic nozzles, Convergent nozzles and nozzle choking, Nozzle throat conditions. Nozzle efficiency, Losses in nozzles. Over-expanded and under-expanded nozzles, Ejector and variable area nozzles, Thrust reversal. | **08 Hours** | **L1, L2** |
| **Module -4**<br><br>**Gas Turbine Engine Compressors**<br><br>**Centrifugal compressors:** Principle of operation of centrifugal compressors. Work done and pressure rise -Velocity diagrams, Diffuser vane design considerations. performance characteristics. Concept of Pre-whirl, Rotating stall.<br><br>**Axial flow compressors:** Elementary theory of axial flow compressor, Velocity triangles, Degree of reaction, three dimensional flow. Air angle distribution for free vortex and constant reaction designs, Compressor blade design. Axial compressor performance characteristics. | **08 Hours** | **L1, L2, L3** |
| **Module -5**<br><br>**Combustion chambers and Turbines**<br><br>Classification of combustion chambers, important factors affecting combustion chamber design, Combustion process, Combustion chamber performance Effect of operating variables on performance – Flame tube cooling – Flame stabilization – Use of flame holders<br><br>**Axial Flow Turbines:** Introduction, Turbine stage, Multi-staging of turbine, Exit flow conditions, Turbine cooling, Heat transfer in turbine cooling.<br><br>**Radial turbine**: Introduction, Thermodynamics of radial turbines, Losses and efficiency. | **08 Hours** | **L1, L2, L3** |
| **Course outcomes:**<br><br>After studying this course, students will be able to: | | |

1. Apply the basic principle and theory of aircraft propulsion.
2. Explain the functions of centrifugal, axial compressors, axial and radial turbines
3. Analyse the performance of nozzles & inlets and combustion chamber

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly).
- Interpretation of data.

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

1. Bhaskar Roy, "Aircraft propulsion", Elsevier (2011), ISBN-13: 9788131214213
2. V. Ganesan, "Gas Turbines", Tata McGraw-Hill, 2010, New Delhi, India, ISBN: 0070681929, 9780070681927

**Reference Books:**

1. Hill, P.G. & Peterson, C.R., "Mechanics & Thermodynamics of Propulsion" Addison – Wesley Longman INC, 1999, ISBN-13: 978-0201146592.
2. Cohen, H. Rogers, G.F.C. and Saravanamuttoo, H.I.H., "Gas Turbine Theory", Longman, 1989, ISBN 13: 9780582236325.
3. Irwin E. Treager, "Gas Turbine Engine Technology" GLENCOE Aviation Technology Series, 7th Edition, Tata McGraw Hill Publishing Co. Ltd, 2003, ISBN-13: 978-0028018287
4. S. M. Yahya, "Fundamentals of Compressible Flow with Aircraft and Rocket propulsion", 4th Edition, New Age International Publications, New Delhi 2014, ISBN 13: 9788122426687.

## EXPERIMENTAL AERODYNAMICS

[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – VI

| | | | |
|---|---|---|---|
| Subject Code | **17AS664** | IA Marks | 40 |
| Number of Lecture Hours/Week | 03 | Exam Hours | 03 |
| Total Number of Lecture Hours | 40 | Exam Marks | 60 |
| CREDITS – 03 | | | |

**Course objective:**

This course will enable students to
1. Understand the basics of experimental aerodynamics.
2. Understand the procedures for model measurements.
3. Acquire the knowledge of wind tunnel testing.

| Modules | Teaching Hours | Revised Bloom's Taxonomy (RBT) Level |
|---|---|---|
| **Module -1**<br><br>**Wind Energy Collectors:** Horizontal axis and vertical axis machines. Power coefficient. Betz coefficient by momentum theory.<br><br>**Vehicle Aerodynamics:** Power requirements and drag coefficients of automobiles. Effects of cut back angle. Aerodynamics of Trains and Hovercraft. | **8 Hours** | **L1, L2** |
| **Module -2**<br><br>**Building Aerodynamics:** Pressure distribution on low rise buildings, wind forces on buildings. Environmental winds in city blocks, Special problems of tall buildings, building codes, building ventilation and architectural aerodynamics.<br><br>**Flow Induced Vibrations:** Effects of Reynolds number on wake formation of bluff shapes, Vortex induced vibrations, Galloping and stall flutter. | **8 Hours** | **L1, L2** |
| **Module -3**<br>**Model Measurements:** Balances: design, installation and, calibration. Internal balances. Mounting of models, rigidity. Measurement of interference. Lift and drag measurements through various techniques. Testing procedures. Testing:- 3-D wings, controls, complete model, power effects, aero elasticity, dynamic stability. Testing with ground plane, testing wind mill generator. Testing for local loads. Testing of rotor. Testing engines, Jettison tests. Data reduction. Data correction | **8 Hours** | **L1, L2, L3** |
| **Module -4**<br>**Wind Tunnel Boundary Corrections and Scale Effects:** Effects of lateral boundaries. Method of images. Wall corrections. Effects of Buoyancy, Solid Blocking, Wake Blocking. General downwash correction. Lift interference correction. Corrections for reflection plane models. Scale effects on aerodynamic characteristics and stability derivatives | **8 Hours** | **L1, L2** |
| **Module -5**<br>**Near sonic And Transonic Testing:** Near sonic tunnel design. Calibration of test section. Model support system. Tare and interference evaluation. Near transonic testing.<br>**Supersonic Wind Tunnel Testing:** Types of supersonic tunnels: - continuous, intermittent (indraft and blowdown). Pressure-vacuum tunnels. Supersonic tunnel design features. Calibration of test section. Optical systems- Schlieren set-up. Starting loads. Hypersonic wind tunnels - General introduction | **8 Hours** | **L1, L2** |

**Course outcomes:**
After studying this course, students will be able to:
1. Distinguish the building and vehicle aerodynamics.
2. Evaluate the boundary corrections and scale effects.
3. Classify the wind tunnel testing.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Interpretation of data

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

1. Jewel B. Barlow, William H RAE, Jr. and Alan Pope, ' Low speedWind Tunnel Testing', John Wiley & Sons,3rd edition,2010,ISBN-13: 978-8126525683
2. M.Sovran (Ed), "Aerodynamics and drag mechanisms of bluff bodies and road Vehicles", Plenum press, New york, 1978.

**Reference Books:**

1. P.Sachs, "Winds forces in engineering", Pergamon Press, 2nd edition,2013.
2. R.D.Blevins, " Flow induced vibrations",Van Nostrand,1990.
3. N.G.Calvent, "Wind Power Principles", Calvert Technical Press ,2nd edition,2004,ISBN-13: 978-0951362068

# Curriculum and Syllabus for 7th Semester, Aerospace Engineering

# VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
# CHOICE BASED CREDIT SYSTEM (CBCS)
# SCHEME OF TEACHING AND EXAMINATION 2017-2018

## B.E. AEROSPACE ENGINEERING

**VII SEMESTER**

| Sl. No | Subject Code | Title | Teaching Dept. | Teaching Hours /Week | | Examination | | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory | Practical/ Drawing | Duration | Theory/ Practical Marks | I.A. Marks | Total Marks | |
| 1 | 17AS71 | AVIONICS SYSTEMS | AS | 04 | | 03 | 60 | 40 | 100 | 4 |
| 2 | 17AS72/17AE72 | COMPUTATIONAL FLUID DYNAMICS | AS | 04 | | 03 | 60 | 40 | 100 | 4 |
| 3 | 17AS73/ | SPACE VEHICLE DESIGN | AS | 04 | | 03 | 60 | 40 | 100 | 4 |
| 4 | 17AS74X | **PROFESSIONAL ELECTIVE** | AS | 03 | | 03 | 60 | 40 | 100 | 3 |
| 5 | 17AS75X | **PROFESSIONAL ELECTIVE** | AS | 03 | | 03 | 60 | 40 | 100 | 3 |
| 6 | 17ASL77 | COMPUTATIONAL FLUID DYNAMICS LAB | AS | | 1I+2P | 03 | 60 | 40 | 100 | 2 |
| 7 | 17ASL78 | SPACE SIMULATION LAB | AS | | 1I+2P | 03 | 60 | 40 | 100 | 2 |
| 8 | 17ASP78 | PROJECT PHASE I + PROJECT SEMINAR | AS | | 03 | - | - | 100 | 100 | 2 |
| **TOTAL** | | | | **18** | **9** | **21** | **420** | **380** | **800** | **24** |

| **Foundation Elective** | | **Elective** | |
|---|---|---|---|
| 17AS741/ 17AE741 | FATIGUE AND FRACTURE MECHANICS | 17AS751 | OPTIMIZATION TECHNIQUES |
| 17AS742 | TOTAL QUALITY MANAGEMENT | 17AS752/ 17AE752 | WIND TUNNEL TECHNIQUES. |
| 17AS743 | THEORY OF ELASTICITY & PLASTICITY | 17AS753 | SMART MATERIALS & CONTROLS |
| 17AS744/ 17AE744 | AERO-ELASTICITY | 17AS754/ 17AE754 | GUIDANCE, NAVIGATION & CONTROL |

1. **Core subject:** This is the course which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.
2. **Professional Elective:** Elective relevant to chosen specialization/ branch
3. **Project Phase –I + Project Seminar:** Literature Survey, Problem Identification, objectives and Methodology. Submission of synopsis and seminar.

# VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
# CHOICE BASED CREDIT SYSTEM (CBCS)
# SCHEME OF TEACHING AND EXAMINATION 2017-2018

## AVIONICS SYSTEMS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VII

| | | | |
|---|---|---|---|
| Subject Code | **17AS71** | IA Marks | 40 |
| Number of Lecture Hours/Week | 04 | Exam Hours | 03 |
| Total Number of Lecture Hours | 50 | Exam Marks | 60 |

CREDITS – 04

**Course objectives:** This course will enable students to

1. Understand the need for avionics in civil, military and space systems.
2. Appreciate the use of microprocessors, data buses and avionics system architectures.
3. Acquire the knowledge of display technologies, communication and navigation systems.

| Modules | Teaching Hours | Revised Bloom's Taxonomy (RBT) Level |
|---|---|---|
| **Module -1**<br>**Power Distribution System:** Bus Bar, split bus bar system, special purpose cables. Electrical diagram and identification scheme. Circuit controlling devices. Power utilisation-typical application to avionics. Need for Avionics in civil and military aircraft. | **10 Hours** | **L1, L2** |
| **Module -2**<br>**Inertial Navigation System:** Gyroscopic versus Inertial platform. Structure of stable platform. Inertial Navigation units. Inertial alignment. Inertial interface system. Importance of Compass swing.<br>**Electronic Flight Control System:** Fly-by-wire system: - basic concept and features. Pitch and Roll rate: - command and response. Control Laws. Frequency response of a typical FBW actuator. Cooper Harper scale. Redundancy and failure survival. Common mode of failures and effects analysis. | **10 Hours** | **L1, L2** |
| **Module -3**<br>**Electronic Flight Instrument Systems:** Display -units, presentation, failure, and annunciation. Display of air data.<br>**Introduction to Avionics Sub Systems and Electronic Circuits:** Typical avionics subsystems. Amplifier, oscillator, aircraft communication system, transmitter, receiver, antenna. | **10 Hours** | **L1, L2, L3** |
| **Module -4**<br>**Principles of Digital Systems:** Digital Computers, Microprocessors, Memories<br>**Flight Deck and Cockpits:** Control and display technologies CRT, LED, LCD, EL and plasma panel, Touch screen, Direct voice input (DVI) - Civil cockpit and military cockpit : MFDS, HUD, MFK, HOTAS. | **10 Hours** | **L1, L2** |
| **Module -5**<br>**Avionics Systems Integration:** Avionics equipment fit. Electrical data bus system. Communication Systems, Navigation systems, Flight control | **10 Hours** | **L1, L2** |

| | | |
|---|---|---|
| systems, Radar , Electronic Warfare, and fire control system. Avionics system architecture, Data buses, MIL–STD 1553 B. | | |

**Course outcomes:**

After studying this course, students will be able to:

1. Select the suitable data bus based on the application.
2. Identify the suitable navigation systems.
3. Distinguish the avionics system architecture.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Interpretation of data

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

1. R.P.G. Collinson., "Introduction to Avionics Systems", Springer,3rd edition, 2011,ISBN-13: 978-9400707078
2. Gaonkar, R.S., "Microprocessors Architecture - Programming and Application", Penram International Publishing,6th edition,2013,ISBN-13: 978-8187972884.

**Reference Books:**

1. Middleton, D.H., Ed., "Avionics Systems, Longman Scientific and Technical", Longman Group UK Ltd., England, 1989,ISBN-13: 978-0582018815.
2. Spitzer, C.R., "Digital Avionic Systems", McGraw-Hill Inc., US, 2nd edition, 1992, ISBN-13: 978-0070603332.
3. Brain Kendal, "Manual of Avionics", Wiley India Pvt Ltd, 3rd edition,2011,ISBN-13: 978-8126532292

# VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
# CHOICE BASED CREDIT SYSTEM (CBCS)
# SCHEME OF TEACHING AND EXAMINATION 2017-2018

## COMPUTATIONAL FLUID DYNAMICS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VII

| | | | |
|---|---|---|---|
| Subject Code | **17AS72/17AE72** | IA Marks | 40 |
| Number of Lecture Hours/Week | 04 | Exam Hours | 03 |
| Total Number of Lecture Hours | 50 | Exam Marks | 60 |

CREDITS – 04

**Course objectives:** This course will enable students to

1. Know the basic equations of fluid dynamics, boundary layer and discretization.
2. Understand the source and vortex panel method.
3. Know about FDM, FVM and FEM.

| Modules | Teaching Hours | Revised Bloom's Taxonomy (RBT) Level |
|---|---|---|
| **Module -1**<br>**Introduction:** CFD Applications. Need for Parallel Computers in CFD algorithms. Models of flows. Substantial derivative, Divergence of velocity. Continuity, Momentum, and Energy Equations-Derivation in various forms. Integral versus Differential form of equations. Comments on governing equations. Physical boundary conditions. Forms of equations especially suitable for CFD work. Shock capturing, and shock fitting. | **10 Hours** | **L1, L2** |
| **Module -2**<br>**Mathematical Behaviour of Partial Differential Equations:** Classification of partial differential equations. Cramer Rule and Eigen value methods for classification. Hyperbolic, parabolic, and elliptic forms of equations. Impact of classification on physical and computational fluid dynamics. Case studies: steady inviscid supersonic flow, unsteady inviscid flow, steady boundary layer flow, and unsteady thermal conduction, steady subsonic inviscid flow. | **10 Hours** | **L1, L2** |
| **Module -3**<br>**Grid Generation and Adaptive Grids:** Need for grid generation and Body-fitted coordinate system. Structured Grids-essential features. Structured Grid generation techniques- algebraic and numerical methods. Unstructured Grids-essential features. Unstructured Grid generation techniques- Delaunay-Voronoi diagram, advancing front method. Surface grid generation, multi-block grid generation, and meshless methods. Grid quality and adaptive grids. Structured grids adaptive methods and unstructured grids adaptive methods. | **10 Hours** | **L1, L2, L3** |
| **Module -4**<br>**Discretisation & Transformation:**<br>Discretisation: Finite differences methods, and difference equations. Explicit and Implicit approaches. Unsteady Problem -Explicit versus Implicit Scheme. Errors and stability analysis. Time marching and space marching. Reflection boundary condition. Relaxation techniques. Alternating direction implicit method. Successive over relaxation/under | **10 Hours** | **L1, L2** |

| | | |
|---|---|---|
| relaxation. Second order Lax-Wendroff method, mid-point Leap frog method, upwind scheme, numerical viscosity, and artificial viscosity.<br><br>**Transformation:** Transformation of governing partial differential equations from physical domain to computational domain. Matrices and Jacobians of transformation. Example of transformation. Generic form of the Governing flow equations in Strong Conservative form in the Transformed Space. | | |
| **Module -5**<br>**Finite Volume Technique and Some Applications:** Spatial discretisation- cell centered and cell vertex techniques (overlapping control volume, duel control volume). Temporal discretisation- Explicit time stepping, and implicit time stepping. Time step calculation. Upwind scheme and high resolution scheme. Flux vector splitting, approximate factorisation. Artificial dissipation and flux limiters. Unsteady flows and heat conduction problems. Upwind biasing. | **10 Hours** | **L1, L2** |

**Course outcomes:**

After studying this course, students will be able to:

1. Differentiate the FDM, FVM and FEM
2. Perform the flow, structural and thermal analysis.
3. Utilize the discretization methods according to the application.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Interpretation of data

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

1. Fletcher, C.A.J., "Computational Techniques for Fluid Dynamics", Springer, Berlin,2nd edition, 2002,ISBN-13: 978-3540543046
2. John D. Anderson, "Computational Fluid Dynamics", McGraw Hill, 2013, **ISBN-13:** 978-0070016859.

**Reference Books:**

1. John F. Wendt, "Computational Fluid Dynamics - An Introduction", Springer , 3rd edition,2013
2. Charles Hirsch, "Numerical Computation of Internal and External Flows",Elsevier,1st edition, 2007,ISBN-13: 978-9381269428.
3. Klaus A Hoffmann and Steve T. Chiang. "Computational Fluid Dynamics for Engineers", Vols. I & II Engineering Education System, P.O. Box 20078, W. Wichita, K.S., 67208 - 1078 USA, 1993.

## SPACE VEHICLE DESIGN

[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – VII

| | | | |
|---|---|---|---|
| Subject Code | **17AS73** | IA Marks | 40 |
| Number of Lecture Hours/Week | 04 | Exam Hours | 03 |
| Total Number of Lecture Hours | 50 | Exam Marks | 60 |

CREDITS – 04

**Course objectives:**
This course will enable students to

1. Understand space mission analysis and design process
2. Acquire the knowledge of spacecraft configuration and structural design
3. Comprehend the importance of space craft attitude control and instrumentation

| **Modules** | **Teaching Hours** | **Revised Bloom's Taxonomy (RBT) Level** |
|---|---|---|
| **Module -1**<br>**Introduction to Launch Vehicle:** Launch Vehicles Available Launch Vehicle Capabilities Deciding which Launch Vehicle to Use..Characteristics of Spacecraft Necessary to Choose a Launch Vehicle Structures. Primary Structural Design Other Functional Divisions Mechanisms Used by the Other Subsystem. Materials for Constructing Spacecraft Manufacturing Techniques Applicable to the Structure. | **10 Hours** | **L1, L2** |
| **Module -2**<br>**Propulsion:** Rocket Propulsion Fundamentals, Ascent Flight Mechanics, Launch Vehicle selection, Entry flight Mechanics, Entry heating, entry vehicle design, Aeroassisted orbit transfer. | **10 Hours** | **L1, L2** |
| **Module -3**<br>**Introduction to Launch Vehicle structures:** Loads on the vehicle structures, Stages, Motor case, Base shroud, Inter stages, Heat shield, Equipment Bay and their functions Modeling and Analysis Structures. Loads and Stresses Thin-Walled Pressure Vessels Buckling of Beams Thin-Wall Assumption. Finite Element Analysis. | **10 Hours** | **L1, L2, L3** |
| **Module -4**<br>**Vehicle Dynamics:** Mode shape and frequencies of launch vehicles, Vibrations .Flexible Body Dynamics of Liquid propellant in Moving containers Sloshing, POGO Orbital Vibration Mitigation Vibrations Aero elastic phenomenon of launch vehicles. | **10 Hours** | **L1, L2** |
| **Module -5**<br>**Technologies and Examples:** Available Technologies, Available Launch Vehicles, New Technologies. Magnetically Inflated Cable System Flying Effector Nano tubing Example, Load and Deflection Nodal Analysis Example, Material Selection Analysis Example, Strained Example, Reaction Wheel Example, Space Shuttle Landing Example, Vibrations Example. | **10 Hours** | **L1, L2** |

**Course outcomes:**

After studying this course the students will be able to :

1. Carry out space mission analysis and design process
2. Explain a spacecraft configuration.
3. Apply the concepts of space craft attitude control and instrumentation

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Interpretation of data

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

1. M.D. Griffin, J.R. French, "Space Vehicle Design", AIAA Series, 1991.
2. P. Fortescue, J. stark, and G. Swinerd, " Spacecraft Systems Engineering" Wiley-Blackwell,4th revised edition,2011,ISBN-13: 978-0470750124

**Reference Books:**

1. W.J. Larson and J. R. Wertz., "Space Mission Analysis and design", Springer,2nd edition,1992,ISBN-13: 978-9401051927
2. M.J.L. Turner, "Rocket and Spacecraft Propulsion" (Principles, Practice and New Developments), Springer,3rd edition,2009,ISBN-13: 978-3642088698

## COMPUTATIONAL FLUID DYNAMICS LAB

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VII

| | | | |
|---|---|---|---|
| Subject Code | **17ASL76** | IA Marks | 40 |
| Number of Lecture Hours/Week | 03 | Exam Hours | 03 |
| Total Number of Lecture Hours | 42 | Exam Marks | 60 |

CREDITS – 02

**Course objectives:** This course will enable students to

1. Design the wing, bluff, blunt and slender structures.
2. Design a subsonic and supersonic wind tunnel.
3. Know the thermal analysis of structural components.

| **Modules** | **Revised Bloom's Taxonomy** |
|---|---|

| | **(RBT) Level** |
|---|---|
| 1. Static & Dynamic analysis of beams. | **L1, L2, L3** |
| 2. Structural analysis of wing structure. | **L1, L2, L3, L4, L5** |
| 3. 2D design and flow analysis of subsonic and supersonic wind tunnels. | **L1, L2, L3, L4, L5** |
| 4. 2D design and flow analysis of subsonic and supersonic flow over bluff body and streamlined body. | **L1, L2, L3** |
| 5. 3D design and flow analysis of subsonic and supersonic wind tunnels | **L1, L2, L3** |
| 6. 3D design and analysis of subsonic flow over bluff body and streamlined body. | **L1, L2, L3** |
| 7. 3D design and analysis of supersonic flow over blunt body and slender body | **L1, L2, L3, L4, L5** |
| 8. Flow past simple 2D body such as Cylinder-wedge-flat plate at M=6.0, $\alpha=0^0$ | **L1, L2, L3** |
| 9. Flow past simple 2D body such as Cylinder-wedge-flat plate at M=6.0, α=10 deg | **L1, L2, L3** |
| 10. Flow past simple 3D body such as Sphere-Cone-Cylinder at M=6.0, $\alpha=0^o$ | **L1, L2, L3** |
| 11. Flow past simple 3D body such as Sphere-Cone-Cylinder at M=6.0, $\alpha=10^o$ | **L1, L2, L3** |
| 12. Thermal analysis of structural components | **L1, L2, L3** |
| 13. Simulation of combustion process | **L1, L2, L3** |
| 14. Simulation of heat transfer process | **L1, L2, L3** |

**Course outcomes:**

After studying this course, students will be able to:

- Do the flow analyze over the different types of structures.
- Conduct the thermal analysis of structural components.
- Simulate the combustion and heat transfer process.

**Conduct of Practical Examination:**

1. All laboratory experiments are to be included for practical examination.
2. Students are allowed to pick one experiment from the lot.
3. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly)
- Interpretation of data.

# VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
# CHOICE BASED CREDIT SYSTEM (CBCS)
# SCHEME OF TEACHING AND EXAMINATION 2017-2018

## SPACE SIMULATION LAB

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VII

| | | | |
|---|---|---|---|
| Subject Code | **17ASL77** | IA Marks | 40 |
| Number of Lecture Hours/Week | 03 | Exam Hours | 03 |
| Total Number of Lecture Hours | 42 | Exam Marks | 60 |

CREDITS – 02

**Course objectives:** This course will enable students to

1. Understand the basics of stability analysis.
2. Acquire the knowledge on Hoffmann transfer and orbit manoeuvring.
3. Get the ideas about the orbital perturbations.

| **Modules** | **Revised Bloom's Taxonomy (RBT) Level** |
|---|---|
| 1. Falling sphere with viscous drag – Investigate velocity versus time plot; & simulate the fall. | **L1, L2, L3** |
| 2. Frequency response for a spring-mass system; simulation of the oscillations. | **L1, L2, L3** |
| 3. Stability analysis using Root locus, Bode plot, Nyquist plot and Polar plot techniques | **L1, L2, L3** |
| 4. Simulation of Hoffmann transfer | **L1, L2, L3** |
| 5. Simulation of velocity calculations for orbit maneuvering | **L1, L2, L3** |
| 6. Simulation of time period calculations for orbital motion | **L1, L2, L3** |
| 7. Simulation of orbit propagation | **L1, L2,L3** |
| 8. Simulation of Attitude and orbital perturbations | **L1, L2, L3** |
| 9. Study and implementation of frame conversions | **L1, L2, L3** |
| 10. Link budget analysis | **L1, L2, L3** |
| 11. Simulation of Rocketry culmination and trajectory calculations | **L1, L2, L3** |
| 12. 3-DOF Gyroscope for System Identification. | **L1, L2, L3** |
| 13. 2- DOF Rotor System for Coupled Dynamic Analysis | **L1, L2, L3** |
| 14. Magnetic Levitation system for close loop Control | **L1, L2, L3** |

**Course outcomes:**

After studying this course, students will be able to:

1. Do the stability analysis using Root locus, Bode plot, Nyquist plot and Polar plot techniques.
2. Simulate the Hoffmann transfer and orbit maneuvering.
3. Simulate the trajectory of the rocket or missile.

**Conduct of Practical Examination:**

1. All laboratory experiments are to be included for practical examination.
2. Students are allowed to pick one experiment from the lot.
3. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly)
- Interpretation of data.

# VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
# CHOICE BASED CREDIT SYSTEM (CBCS)
# SCHEME OF TEACHING AND EXAMINATION 2017-2018

**PROFESSIONAL ELECTIVE**

## FATIGUE AND FRACTURE MECHANICS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VII

| | | | |
|---|---|---|---|
| Subject Code | **17AS741/17AE741** | IA Marks | 40 |
| Number of Lecture Hours/Week | 03 | Exam Hours | 03 |
| Total Number of Lecture Hours | 40 | Exam Marks | 60 |

CREDITS – 03

**Course objective:**

This course will enable students to

1. Understand the basics of fatigue of structures.
2. Comprehend the fracture mechanics.
3. Acquire the knowledge of fatigue design and testing.

| Modules | Teaching Hours | Revised Bloom's Taxonomy (RBT) Level |
|---|---|---|
| **Module -1**<br>**Fatigue of Structures:** S.N. curves, Endurance limit, Effect of mean stress, Goodman, Gerber and Soderberg relations and diagrams, Notches and stress concentrations, Neuber's stress concentration factors, plastic stress concentration factors – Notched S-N curves | **10 Hours** | **L1, L2** |
| **Module -2**<br>**Statistical Aspects Of Fatigue Behaviour:** Low cycle and high cycle fatigue, Coffin-Manson's relation, Transition life, Cyclic Strain hardening and softening, Analysis of load histories, Cycle counting techniques, Cumulative damage, Miner's theory, other theories. | **8 Hours** | **L1, L2** |
| **Module -3**<br>**Physical Aspects Of Fatigue:** Phase in fatigue life, Crack initiation, Crack growth, Final fracture ,Dislocations, Fatigue fracture surfaces. | **6 Hours** | **L1, L2, L3** |
| **Module -4**<br>**Fracture Mechanics:** Strength of cracked bodies, potential energy and surface energy, Griffith's theory, Irwin – Orwin extension of Griffith's theory to ductile materials, Stress analysis of cracked bodies, Effect of thickness on fracture toughness, Stress intensity factors for typical geometries. | **8 Hours** | **L1, L2** |
| **Module -5**<br>**Fatigue Design And Testing:** Safe life and fail safe design philosophies, Importance of Fracture Mechanics in aerospace structure, Application to composite materials and structures. | **8 Hours** | **L1, L2** |

**Course outcomes:**

After studying this course, students will be able to:

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

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Interpretation of data

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

1. D.Brock, "Elementary Engineering Fracture Mechanics", Noordhoff International Publishing Co., London, 1994.
2. J.F.Knott, "Fundamentals of Fracture Mechanics", Butterworth & Co., (Publishers) Ltd., London,1983.

**Reference Books:**

1. W.Barrois and L.Ripley, "Fatigue of Aircraft Structures", Pergamon Press, Oxford, 1983.
2. C.G.Sih, "Mechanics of Fracture", Vol.1 Sijthoff and Noordhoff International Publishing Co.,Netherland, 1989.

## TOTAL QUALITY MANAGEMENT

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VII

| | | | |
|---|---|---|---|
| Subject Code | **17AS742** | IA Marks | 40 |
| Number of Lecture Hours/Week | 03 | Exam Hours | 03 |
| Total Number of Lecture Hours | 40 | Exam Marks | 60 |

CREDITS – 03

**Course objective:** This course will enable students to

1. Understand the basic principles of TQM.
2. Comprehend the customer satisfaction and customer involvement.
3. Acquire the knowledge of quality management tools and Statistical Process Control**.**

| **Modules** | **Teaching Hours** | **Revised Bloom's Taxonomy (RBT) Level** |
|---|---|---|

| | | |
|---|---|---|
| **Module -1**<br>**Principles and Practice:** Definition, basic approach, gurus of TQM, TQM Framework, awareness, defining quality, historical review, obstacles, benefits of TQM<br>**Leadership:** Definition, characteristics of quality leaders, leadership concept, characteristics of effective people, ethics, the Deming philosophy, role of TQM leaders, implementation, core values, concepts and framework, strategic planning communication, decision making. | **8 Hours** | **L1, L2** |
| **Module -2**<br>**Customer Satisfaction and Customer Involvement:** Customer Satisfaction **:** customer and customer perception of quality, feedback, using customer complaints, service quality, translating needs into requirements, customer retention, Case studies.<br>Employee Involvement – Motivation, employee surveys, empowerment, teams, suggestion system, recognition and reward, gain sharing, performance appraisal, unions and employee involvement, case studies. | **8 Hours** | **L1, L2** |
| **Module -3**<br>**Continuous Process Improvement:** Process, the Juran trilogy, improvement strategies, types of problems, the PDSA Cycle, problem-solving methods, Kaizen, reengineering, six sigma, case studies.<br>**Tools and Techniques:** Benching marking, information technology, quality management systems, environmental management system, quality function deployment, quality by design, failure mode and effect analysis, product liability, total productive maintenance. | **8 Hours** | **L1, L2, L3** |
| **Module -4**<br>**Quality Management Tools :** Why force field analysis, nominal group technique, affinity diagram, interrelationship digraph, tree diagram, matrix diagram, prioritization matrices, process decision program chart, activity network diagram.<br>**Statistical Process Control** : Pareto diagram, process flow diagram, cause- and-effect diagram, check sheets, histograms, statistical fundamentals, Control charts, state of control, out of control process, control charts for variables, control charts for attributes, scatter diagrams, case studies. | **8 Hours** | **L1, L2** |
| **Module -5**<br>**Building and Sustaining Performance Excellence in Organizations:** Making the commitment to total quality, organizational culture and total quality, change management, sustaining the quality organization, self-assessment processes, implementing ISO 9000, Bald ridge, and sis sigma, a view toward the future.<br>**Design for Six Sigma:** Tools for concept development, tools for design development, tools for design optimization, tools for design verification, problems. | **8 Hours** | **L1, L2** |
| **Course outcomes:**<br>After studying this course, students will be able to:<br>1. Apply the basic principles of TQM. | | |

2. Classify customer satisfaction and customer involvement.
3. Apply quality management tools and Statistical Process Control.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Interpretation of data

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

1. Dale H. Bester,Total Quality Management,Pear son Education India, Special Indian Edition, ISBN: 8129702606
2. M. Zairi ,Total Quality Management for Engineers,Wood head Publishing, ISBN: 1855730243

**Reference Books:**

1. Shoji Shiba, Alan Graham, David Walden, A New American TQM, four revolutions in management, Productivity press, Oregon, 1990
2. Gopal K. Kanji and Mike Asher ,100 Methods for Total Quality Management, Sage Publications,1st edition,ISBN: 0803977476
3. H. Lai, Organizational Excellence through TQM, New age pub, 2008.

## THEORY OF ELASTICITY & PLASTICITY

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VII

| | | | |
|---|---|---|---|
| Subject Code | **17AS743** | IA Marks | 40 |
| Number of Lecture Hours/Week | 03 | Exam Hours | 03 |
| Total Number of Lecture Hours | 40 | Exam Marks | 60 |

CREDITS – 03

**Course objective:**

This course will enable students to

1. Understand the basic equations of elasticity.
2. Understand the plane stress and plane strain problems.
3. Acquire the knowledge of theory of plates and shells.

| Modules | Teaching Hours | Revised Bloom's Taxonomy (RBT) |
|---|---|---|

| | | Level |
|---|---|---|
| **Module -1**<br>**Basic Equations of Elasticity:** Definition of Stress and Strain: Stress - Strain relationships - Equations of Equilibrium, Compatibility equations, Boundary Conditions, Saint Venant's principle - Principal Stresses, Stress Ellipsoid - Stress invariants. | **8 Hours** | **L1, L2** |
| **Module -2**<br>**Plane Stress and Plane Strain Problems:** Airy's stress function, Bi-harmonic equations, Polynomial solutions, Simple two dimensional problems in Cartesian coordinates like bending of cantilever and simply supported beams | **7 Hours** | **L1, L2** |
| **Module -3**<br>**Polar Coordinates**: Equations of equilibrium, Strain - displacement relations, Stress – strain relations, Airy's stress function, Axi – symmetric problems, Introduction to Dunder's table, Curved beam analysis, Lame's, Kirsch, Michell's and Boussinesque problems – Rotating discs. | **8 Hours** | **L1, L2, L3** |
| **Module -4**<br>**Torsion**: Navier's theory, St. Venant's theory, Prandtl's theory on torsion, semi- inverse method and applications to shafts of circular, elliptical, equilateral triangular and rectangular sections. Membrane Analogy | **7 Hours** | **L1, L2** |
| **Module -5**<br>**Introduction To Theory Of Plates And Shells**: Classical plate theory – Assumptions – Governing equations – Boundary conditions – Navier's method of solution for simply supported rectangular plates – Levy's method of solution for rectangular plates under different boundary conditions. | **8 Hours** | **L1, L2** |

**Course outcomes:**
After studying this course, students will be able to:
1. Apply the basic equations of elasticity.
2. Evaluate the plane stress and plane strain.
3. Classify the theory of plates and shells.

**Graduate Attributes (as per NBA):**
- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Interpretation of data

**Question paper pattern:**
- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**
1. Timoshenko, S., and Goodier, T.N., "Theory of Elasticity", McGraw – Hill Ltd., Tokyo,3rd edition,2010,ISBN-13: 978-0070701229

2. Ansel C Ugural , "Advanced Strength and Applied Elasticity", 4th Edition, Prentice Hall, New Jersey, 2003.

**Reference Books:**

1. Wang, C. T., "Applied Elasticity", McGraw – Hill Co., New York, 1993.
2. Sokolnikoff, I. S., "Mathematical Theory of Elasticity", McGraw – Hill, New York, new edition,1992,ISBN-13: 978-0898745559.
3. Volterra & J.H. Caines, "Advanced Strength of Materials", Prentice Hall, New Jersey, 1991
4. Barber, J. R., "Elasticity", Kluwer Academic Publishers,3rd edition, 2009,ISBN-13: 978-9048138081

# AEROELASTICITY

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VII

| | | | |
|---|---|---|---|
| Subject Code | **17AS744/17AE744** | IA Marks | 40 |
| Number of Lecture Hours/Week | 03 | Exam Hours | 03 |
| Total Number of Lecture Hours | 40 | Exam Marks | 60 |

CREDITS – 03

**Course objective:**

This course will enable students to

1. Understand the basic aero elastic phenomena.
2. Comprehend the steady state aero elastic problems and flutter phenomena.
3. Acquire the knowledge on the aero elastic problems.

| **Modules** | **Teaching Hours** | **Revised Bloom's Taxonomy (RBT) Level** |
|---|---|---|
| **Module -1**<br><br>**Aeroelastic Phenomena**: Stability versus response problems, The aeroelastic triangle of forces, Aeroelasticity in Aircraft Design, Prevention of aeroelastic instabilities. Influence and stiffness coefficients. Flexure,torsional oscillations of beam, Differential equation of motion of beam. | **8 Hours** | **L1, L2** |
| **Module -2**<br>**Divergence of a Lifting Surface:** Simple two dimensional idealizations -Strip theory – Integral equation of the second kind – Exact solutions for simple rectangular wings – 'Semirigid' assumption and approximate solutions – Generalised coordinates – Successive approximations – Numerical approximations using matrix equations. | **8 Hours** | **L1, L2** |
| **Module -3**<br><br>**Steady State Aerolastic Problems:** Loss and reversal of aileron control – Critical aileron reversal speed – Aileron efficiency – Semi | **8 Hours** | **L1, L2, L3** |

| | | |
|---|---|---|
| rigid theory and successive approximations – Lift distribution – Rigid and elastic wings. Tail efficiency. Effect of elastic deformation on static longitudinal stability. | | |
| **Module -4**<br><br>**Flutter Phenomenon**: Non-dimensional parameters – Stiffness criteria – Dynamic mass balancing – Dimensional similarity. Flutter analysis – Two dimensional thin airfoils in steady incompressible flow – Quasisteady aerodynamic derivatives. Galerkin method for critical flutter speed – Stability of disturbed motion – Solution of the flutter determinant – Methods of determining the critical flutter speeds – Flutter prevention and control. | **9 Hours** | **L1, L2** |
| **Module -5**<br>**Examples of Aeroelastic Problems**: Galloping of transmission lines and Flow induced vibrations of transmission lines, tall slender structures and suspension bridges | **7 Hours** | **L1, L2** |

**Course outcomes:**

After studying this course, students will be able to:

1. Apply the aero elastic phenomena.
2. Evaluate the steady state aero elastic problems and flutter phenomena.
3. Classify the types of aero elastic problems.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Interpretation of data

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

1. Y.C. Fung, "An Introduction to the Theory of Aeroelasticity", Dover Publications Inc, 2008,ISBN-13: 978-0486469362
2. E.G. Broadbent, "Elementary Theory of Aeroelasticity", Bun Hill Publications Ltd., 1986

**Reference Books:**

1. R.L. Bisplinghoff, H.Ashley, and R.L. Halfmann, "Aeroelasticity", II Edition Addison Wesley Publishing Co., Inc., 1996.
2. R.H. Scanlan and R.Rosenbaum, "Introduction to the study of Aircraft Vibration and Flutter", Macmillan Co., New York, 1981.
3. R.D.Blevins, "Flow Induced Vibrations", Krieger Pub Co., 2001

# OPTIMIZATION TECHNIQUES

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VII

| | | | |
|---|---|---|---|
| Subject Code | **17AS751** | IA Marks | 40 |
| Number of Lecture Hours/Week | 03 | Exam Hours | 03 |
| Total Number of Lecture Hours | 40 | Exam Marks | 60 |

CREDITS – 03

**Course objective:**
This course will enable students to

1. Understand the unconstrained and constrained minimization.
2. Comprehend the direct search methods, discrete and dynamics programming.
3. Acquire the knowledge on finite element based optimization.

| **Modules** | **Teaching Hours** | **Revised Bloom's Taxonomy (RBT) Level** |
|---|---|---|
| **Module -1**<br>**Introduction:** Non-linear programming. Mathematical fundamentals. Numerical evaluation of gradient.<br>**Unconstrained Optimisation:** One dimensional, single variable optimization. Maximum of a function. Unimodal-Fibonacci method. Polynomial based methods. | **8 Hours** | **L1, L2** |
| **Module -2**<br>**Unconstrained Minimization:** Multivariable functions. Necessary and sufficient conditions for optimality. Convexity. Steepest Descent Method -Convergence Characteristics. Conjugate Gradient Method. Linear programming -Simplex Method. | **7 Hours** | **L1, L2** |
| **Module -3**<br>**Constrained Minimization:** Non-linear programming. Gradient based methods. Rosens`s gradient, Zoutendijk`s method, Generalised reduced gradient, Sequential quadratic programming. Sufficient condition for optimality. | **7 Hours** | **L1, L2, L3** |
| **Module -4**<br>**Direct Search Methods:** Direct search methods for nonlinear optimization. Cyclic coordinate search. Hooke and Jeeves Pattern search method. Generic algorithm.<br>**Discrete And Dynamic Programming:** Integer and discrete programming. Branch and bound algorithm for mixed integers. General definition of dynamic programming problem. Problem modeling and computer implementation. Shortest path problem | **9 Hours** | **L1, L2** |
| **Module -5**<br>**Optimisation Application:** Transportation problem. Transportation simplex method. Network problems. Maximum flow in net works. General definition of dynamic programming. Problem modeling and computer implementation. | **9 Hours** | **L1, L2** |

| | | |
|---|---|---|
| **Finite Element Based Optimisation:** Parameter optimization using gradient methods -Derivative calculation. Shape optimisation. Topology optimisation of continuum structures. | | |

**Course outcomes:**
After studying this course, students will be able to:
1. Identify the unconstrained and constrained minimization effect of fluid properties.
2. Apply the direct search methods, discrete and dynamics programming.
3. Classify the optimisation application.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Interpretation of data

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**
1. Ashok D Belegundu and Tirupathi R . Chandrupatla, `Optimisation Concepts and Applications in Engineering`, Pearson Education, In C.,1991.
2. Fletcher, R, `Practical Methods of Optimisation`, Wiley, New York ,2nd Edition, 2009,ISBN-13: 978-8126524259.

**Reference Books:**
1. Dennis J.E. and Schnabel, R. B., `Numerical Methods for Unconstrained Optimisation and Nonlinear Equations`, Prentice Hall, Engle Wood Cliffs, New Jersey, 1983.
2. S.S. Rao, ` Optimisation -Theory and Application`, Wiley Eastern Ltd., 5th Edition.1990.

## WIND TUNNEL TECHNIQUES

[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – VII

| | | | |
|---|---|---|---|
| Subject Code | **17AS752/17AE752** | IA Marks | 40 |
| Number of Lecture Hours/Week | 03 | Exam Hours | 03 |
| Total Number of Lecture Hours | 40 | Exam Marks | 60 |

CREDITS – 03

**Course objective:**
This course will enable students to
1. Understand the basic of wind tunnel testing.
2. Understand the types and functions of wind tunnel.
3. Acquire the knowledge on conventional measurement techniques and special wind tunnel

techniques.

| Modules | Teaching Hours | Revised Bloom's Taxonomy (RBT) Level |
|---|---|---|
| **Module -1**<br>**Principles Of Model Testing**: Buckingham Theorem, Non dimensional numbers, Scale effect, Geometric Kinematic and Dynamic similarities. | **8 Hours** | **L1, L2** |
| **Module -2**<br>**Types And Functions Of Wind Tunnels**: Classification and types, special problems of testing in subsonic, transonic, supersonic and hypersonic speed regions, Layouts, sizing and design parameters. | **7 Hours** | **L1, L2** |
| **Module -3**<br>**Calibration Of Wind Tunnels**: Test section speed, Horizontal buoyancy, Flow angularities, Flow uniformity & turbulence measurements, Associated instrumentation, Calibration of subsonic & supersonic tunnels. | **8 Hours** | **L1, L2, L3** |
| **Module -4**<br>**Conventional Measurement Techniques**: Force measurements and measuring systems, Multi component internal and external balances, Pressure measurement system, Steady and Unsteady Pressure, single and multiple measurements, Velocity measurements, Intrusive and Non-intrusive methods, Flow visualization techniques, surface flow, oil and tuft, flow field visualization, smoke and other optical and nonintrusive techniques | **9 Hours** | **L1, L2** |
| **Module -5**<br>**Special Wind Tunnel Techniques**: Intake tests, store carriage and separation tests, Unsteady force and pressure measurements, wind tunnel model design | **8 Hours** | **L1, L2** |

**Course outcomes:**

After studying this course, students will be able to:

1. Apply the principles and procedures for model testing in the wind tunnel.
2. Classify the types and functions of wind tunnel.
3. Distinguish the conventional measurement techniques and special wind tunnel techniques

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Interpretation of data

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.

- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

1. Rae, W.H. and Pope, A., "Low Speed Wind Tunnel Testing", John Wiley Publication, 3rd edition, 2010, ISBN-13: 978-8126525683.
2. NAL-UNI Lecture Series 12:" Experimental Aerodynamics", NAL SP 98 01 April 1998

**Reference Books:**

1. Pope, A., and Goin, L., "High Speed Wind Tunnel Testing", John Wiley, 1985.
2. Bradsaw "Experimental Fluid Mechanics", Pergamon Press, 2nd Revised edition,1970,ISBN-13: 978-0080069814
3. Short term course on Flow visualization techniques, NAL , 2009
4. Lecture course on Advanced Flow diagnostic techniques 17-19 September 2008 NAL, Bangalore

## SMART MATERIALS AND CONTROLS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VII

| | | | |
|---|---|---|---|
| Subject Code | **17AS753** | IA Marks | 40 |
| Number of Lecture Hours/Week | 03 | Exam Hours | 03 |
| Total Number of Lecture Hours | 40 | Exam Marks | 60 |

CREDITS – 03

**Course objective:**

This course will enable students to

1. Understand the basic smart materials.
2. Understand the control design.
3. Acquire the knowledge of neural networks and data processing.

| **Modules** | **Teaching Hours** | **Revised Bloom's Taxonomy (RBT) Level** |
|---|---|---|
| **Module -1**<br>**Introduction**: Characteristics of composites and ceramics materials, Dynamics and controls, concepts, Electro-magnetic materials and shape memory alloys processing and characteristics.<br>Sensing And Actuation: Principals of electromagnetic, acoustics, chemical and mechanical sensing and actuation, Types of sensors and their applications, their compatibility writer conventional and advanced materials, signal processing, principals and characterization. | **9 Hours** | **L1, L2** |
| **Module -2**<br>**Control Design**: Design of shape memory alloys, Types of MR fluids, Characteristics and application, principals of MR fluid value designs, | **9 Hours** | **L1, L2** |

| | | |
|---|---|---|
| Magnetic circuit design, MR Dampers, Design issues.<br>Optics and Electromagnetic: Principals of optical fiber technology, characteristics of active and adaptive optical system and components, design and manufacturing principles. | | |
| **Module -3**<br>**Structures**: Principles of drag and turbulence control through smart skins, applications in environment such as aerospace and transportation vehicles, manufacturing, repair and maintainability aspects. | **7 Hours** | **L1, L2, L3** |
| **Module -4**<br>**Controls**: Principles of structural acoustic control, distributed, analog and digital feedback controls, Dimensional implications for structural control.<br>**Principles of Vibration And Modal Analysis**: PZT Actuators, MEMS, Magnetic shape Memory Alloys, Characteristics and Applications. | **8 Hours** | **L1, L2** |
| **Module -5**<br>**Information Processing**: Neural Network, Data Processing, Data Visualization and Reliability – Principals and Application domains. | **7 Hours** | **L1, L2** |

**Course outcomes:**

After studying this course, students will be able to:

1. Identify the types of materials, sensors and their applications.
2. Apply the control design.
3. Classify the neural network and data processing.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Interpretation of data

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

1. A. V. Srinivasan ,Analysis and Design’, ‘Smart Structures –Cambridge University Press, New York, 2001, (ISBN : 0521650267)
2. M V Gandhi and B S Thompson ,‘Smart Materials and Structures’, Chapmen & Hall, London, 1992 (ISBN : 0412370107)

**Reference Books:**

1. Banks HT, RC Smith, Y Wang ,‘Smart Materials and Structures’, , Massow S A, Paris 1996.
2. Clark R L, W R Saunolers ,G P Gibss,’Adaptive Structres’, Jhon Wiles and Sons, New York, 1998
3. Esic Udd, An introduction for scientists and Engineers’, Optic Sensors : Jhon Wiley & Sons, New York, 1991 (ISBN : 0471830070)

# VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
# CHOICE BASED CREDIT SYSTEM (CBCS)
# SCHEME OF TEACHING AND EXAMINATION 2017-2018

## GUIDANCE, NAVIGATION AND CONTROL

[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – VII

| | | | |
|---|---|---|---|
| Subject Code | **17AS754/17AE754** | IA Marks | 40 |
| Number of Lecture Hours/Week | 03 | Exam Hours | 03 |
| Total Number of Lecture Hours | 40 | Exam Marks | 60 |

CREDITS – 03

**Course objective:**

This course will enable students to

1. Understand the basic of guidance and navigation.
2. Comprehend the missile control system.
3. Acquire the knowledge of flight control systems.

| Modules | Teaching Hours | Revised Bloom's Taxonomy (RBT) Level |
|---|---|---|
| **Module -1**<br>**Introduction**: Concepts of navigation, guidance and control. Introduction to basic principles. Air data information.<br>**Radar Systems**: Principle of working of radar. MTI and Pulse Doppler radar. Moving target detector. Limitation of MTI performance. MTI from a moving platform (AMTI) | **9 Hours** | **L1, L2** |
| **Module -2**<br>**Tracking**:Tracking With Radar Mono pulse tracking. Conical scan and sequential lobbing. Automatic tracking with surveillance radar (ADT) | **7 Hours** | **L1, L2** |
| **Module -3**<br>**Other Guidance Systems**: Gyros and stabilised platforms. Inertial guidance and Laser based guidance. Components of Inertial Navigation System. Imaging Infrared guidance. Satellite navigation. GPS. | **7 Hours** | **L1, L2, L3** |
| **Module -4**<br>**Missile Control System**: Guided missile concept. Roll stabilisation. Control of aerodynamic missile. Missile parameters for dynamic analysis. Missile autopilot schematics. Acceleration command and root locus.<br>Missile Guidance Proportional navigation guidance; command guidance. Comparison of guidance system performance. Bank to turn missile guidance. | **9 Hours** | **L1, L2** |
| **Module -5**<br>**Flight control systems:** Integrated Flight/Fire Control System Director fire control system. Tracking control laws. Longitudinal flight control | **8 Hours** | **L1, L2** |

| | | |
|---|---|---|
| system. Lateral flight control system. Rate of change of Euler angle , Auto Pilot. | | |

**Course outcomes:**

After studying this course, students will be able to:

1. Apply the concepts of navigation, guidance and control.
2. Classify the missile control system.
3. Identify the flight control systems.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Interpretation of data

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

1. Merrilh I. Skolnik, Introduction to Radar Systems, Tata Mc Graw Hill , 3rd edition,2001,ISBN-13: 978-0070445338
2. John H Blakelock, ’Automatic control of Aircraft & Missiles’,John Wiley & Sons, 2nd edition,1991,ISBN-13: 978-0471506515

**Reference Books:**

1. N.S. Nagaraj, Elements of Electronic Navigation, TMH publication, 2nd Edition ,2006.
2. R.B. Underdown & Tony Palmer, ‘Navigation‘, Black Well Publishing,6th revised edition, 2001,ISBN-13: 978-0632053339

# Curriculum and Syllabus for 8th Semester, Aerospace Engineering

# VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
# CHOICE BASED CREDIT SYSTEM (CBCS)
# SCHEME OF TEACHING AND EXAMINATION 2017-2018

## B.E. AEROSPACE ENGINEERING

**VIII SEMESTER**

| Sl. No | Subject Code | Title | Teaching Dept. | Teaching Hours /Week | | Examination | | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory | Practical/Drawing | Duration | Theory / Practical Marks | I.A. Marks | Total Marks | |
| 1 | 17AS81 | SATELLITE DESIGN | AS | 4 | - | 3 | 60 | 40 | 100 | 4 |
| 2 | 17AS82 | MISSILE DESIGN | AS | 4 | - | 3 | 60 | 40 | 100 | 4 |
| 3 | 17AS83X | **Professional Elective** | AS | 3 | - | 3 | 60 | 40 | 100 | 3 |
| 4 | 17AS84 | Internship | AS | Industry Oriented | | 3 | 50 | 50 | 100 | 2 |
| 5 | 17ASP85 | Project Work Phase II | AS | - | 6 | 3 | 100 | 100 | 200 | 6 |
| 6 | 17ASS86 | Seminar | AS | - | 4 | - | - | 100 | 100 | 1 |
| **TOTAL** | | | | **11** | **10** | **15** | **330** | **370** | **700** | **20** |

| **Elective-I** | |
|---|---|
| 17AS831 | ARTIFICIAL INTELLIGENCE |
| 17AS832 | CRYOGENICS |
| 17AS833 | ROBOTICS |
| 17AS834 | SPACE CRAFT SYSTEMS |

1. **Core subject:** This is the course, which is to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.

**2. Professional Elective:** Elective relevant to chosen specialization/ branch

**3. Internship / Professional Practice:** To be carried between the 6$^{th}$ and 7$^{th}$ semester vacation or 7$^{th}$ and 8$^{th}$ semester vacation period.

# VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
# CHOICE BASED CREDIT SYSTEM (CBCS)
# SCHEME OF TEACHING AND EXAMINATION 2017-2018

## SATELLITE DESIGN

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VIII

| | | | |
|---|---|---|---|
| Subject Code | **17AS81** | IA Marks | 40 |
| Number of Lecture Hours/Week | 04 | Exam Hours | 03 |
| Total Number of Lecture Hours | 50 | Exam Marks | 60 |

CREDITS – 04

**Course objectives:** This course will enable students to

1. Understand about the space environment and spacecraft.
2. Know the attitude sensors and actuators.
3. Understand the TT&C system.

| **Modules** | **Teaching Hours** | **Revised Bloom's Taxonomy (RBT) Level** |
|---|---|---|
| **Module -1**<br>**Introduction:** Mission Overview, Requirements for different missions, Space Environment, Spacecraft configuration, Spacecraft Bus, Payload, Requirements and constraints, Initial configuration decisions and Trade offs, Spacecraft configuration process, Broad design of Spacecraft Bus, Subsystem layout , Types of Satellites, Constellations, Applications. | **10 Hours** | **L1, L2** |
| **Module -2**<br>**Power sources:** Power sources, Energy storage, Solar panels, Deployable solar panels, Spacecraft Power management, Power distribution, Deep Space Probes | **08 Hours** | **L1, L2** |
| **Module -3**<br>**Coordinate System:** Coordinate system, AOCS requirements, Environment effects, Attitude stabilization, Attitude sensors, Actuators, Design of control algorithms. | **10 Hours** | **L1, L2, L3** |
| **Module -4**<br>**Temperature and Requirements:** Systems Trade-off, Mono-propellant systems, Thermal consideration, System integration design factors, Pre-flight test requirements, System reliability Configuration design of Spacecraft structure, Structural elements, Material selection, Environmental Loads, Vibrations, Structural fabrication, Orbital environments, Average temperature in Space, Transient temperature evaluation, Thermal control techniques, Temperature calculation for a spacecraft, Thermal design and analysis program structure, Thermal design verification, Active thermal control techniques. | **12 Hours** | **L1, L2** |
| **Module -5**<br>**Tele Systems:** Base Band Telemetry system, Modulation, TT & C RF system, Telecommand system, Ground Control Systems. | **10 Hours** | **L1, L2** |

**Course outcomes:**

At the end of this course the student will be able to :

1. Identify the satellite constellations.
2. Analyze the power requirement for a spacecraft

3. Select a suitable material for designing a spacecraft.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Interpretation of data

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

1. Fortescue, Peter, ‘ Spacecraft Systems Engineering’ John Wiley England,4th edition,2011,ISBN-13: 978-0470750124
2. Patel, Mukund R, ‘Spacecraft Power Systems’ ,CRC Press Boca Raton,2nd edition, 2005.

**Reference Books:**

1. Wilbur L. Pritchard and Joseph A.Sciulli, Satellite Communication Systems Engineering, Pearson Education India,2nd edition,2003,ISBN-13: 978-8131702420.
2. Marcel j. sidi, “Spacecraft Dynamics and control, A Practical Engineering Approach”, Cambridge University Press, Reprint edition,2000,ISBN-13: 978-0521787802.

## MISSILE DESIGN

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VIII

| | | | |
|---|---|---|---|
| Subject Code | **17AS82** | IA Marks | 40 |
| Number of Lecture Hours/Week | 04 | Exam Hours | 03 |
| Total Number of Lecture Hours | 50 | Exam Marks | 60 |

CREDITS – 04

**Course objective:**

This course will enable students to

1. Understand the basic of missile systems.
2. Comprehend the Missile airframe, autopilots and control.
3. Acquire the knowledge on missile guidance and delivery systems.

| Modules | Teaching | Revised Bloom’s |
|---|---|---|

| | Hours | Taxonomy (RBT) Level |
|---|---|---|
| **Module -1**<br>**Missile Systems Introduction:** History of guided missile for defence applications, Classification of missiles, The Generalized Missile Equations of Motion, Coordinate Systems, Lagrange's Equations for Rotating Coordinate Systems, Rigid-Body Equations of Motion, missile system elements, missile ground systems. | 8 Hours | L1, L2 |
| **Module -2**<br>**Missile Airframes, Autopilots and Control:** Missile aerodynamics, Force Equations, Moment Equations, Phases of missile flight. Missile control configurations. Missile Mathematical Model. Autopilots, Definitions, Types of Autopilots, Example Applications. Open-loop autopilots. Inertial instruments and feedback. Autopilot response, stability, and agility, Pitch Autopilot Design, Pitch-Yaw-Roll Autopilot Design. | 8 Hours | L1, L2 |
| **Module -3**<br>**Missile Guidance Laws:** Tactical Guidance Intercept Techniques, Derivation of the fundamental Guidance Equations, explicit, Proportional Navigation, Augmented Proportional Navigation, beam riding, bank to turn missile guidance, Three-Dimensional Proportional Navigation, comparison of guidance system performance, Application of Optimal Control of Linear Feedback Systems. | 8 Hours | L1, L2, L3 |
| **Module -4**<br>**Strategic Missiles:** Introduction, The Two-Body Problem, Lambert's Theorem, First-Order Motion of a Ballistic Missile , Correlated Velocity and Velocity to be gained Concepts, Derivation of the Force Equation for Ballistic Missiles, Atmospheric Reentry, Ballistic Missile Intercept, Missile Tracking Equations of Motion, Introduction to Cruise Missiles , The Terrain-Contour Matching (TERCOM) Concept. | 8 Hours | L1, L2 |
| **Module -5**<br>**Weapon Delivery Systems:** Weapon Delivery Requirements, Factors Influencing Weapon Delivery Accuracy, Unguided Weapons, The Bombing Problem, Guided Weapons, Integrated Flight Control in Weapon Delivery, Missile Launch Envelope, Mathematical Considerations Pertaining to the Accuracy of Weapon Delivery Computations. | 8 Hours | L1, L2 |

**Course outcomes:**

After studying this course, students will be able to:

1. Classify the missile systems.
2. Configure the missile control using the design and control laws.
3. Identify the weapon delivery systems.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Interpretation of data

**Question paper pattern:**

- The question paper will have ten questions.

- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

1. Siouris, G.M. "Missile Guidance and control systems", Springer, Reprinted edition, 2010, ISBN-13: 978-1441918352
2. Blakelock, J. H.; Automatic Control of Aircraft and Missiles,John Wiley & Sons, 2nd Edition,1990

**Reference Books:**

1. Fleeman, Eugene L, Tactical Missile Design, AIAA Education series, First Edition, 2001,ISBN-13: 978-1563474941
2. Garnell, P., "Guided Weapon Control Systems", 2nd Edition, Pergamon Press, 1980.
3. Joseph Ben Asher and Isaac Yaesh "Advances in Missile Guidance Theory" AIAA Education series, 1998,ISBN-13: 978-1563472756
4. Paul Zarchan "Tactical and Strategic Missile Guidance" AIAA Education series,$6^{th}$ revised edition,2012,ISBN-13: 978-1600868948

# VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
# CHOICE BASED CREDIT SYSTEM (CBCS)
# SCHEME OF TEACHING AND EXAMINATION 2017-2018

**PROFESSIONAL ELECTIVE**

## ARTIFICIAL INTELLIGENCE

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VIII

| | | | |
|---|---|---|---|
| Subject Code | **17AS831** | IA Marks | 40 |
| Number of Lecture Hours/Week | 03 | Exam Hours | 03 |
| Total Number of Lecture Hours | 40 | Exam Marks | 60 |

CREDITS – 03

**Course objective:**

This course will enable students to

1. Understand the basic techniques of artificial intelligence.
2. Understand the Non-monotonic reasoning and statistical reasoning.
3. Acquire the knowledge on filler structures, and understanding.

| Modules | Teaching Hours | Revised Bloom's Taxonomy (RBT) Level |
|---|---|---|
| **Module -1**<br>**AI**: The AI Problems, The Underlying Assumption, What Is An AI Techniques, The Level Of The Model, Criteria For Success, Some General References, One Final Word.<br>Problems, State Space Search & Heuristic Search Techniques: Defining The Problems As A State Space Search, Production Systems, Production Characteristics, Production System Characteristics, And Issues In The Design Of Search Programs, Additional Problems. Generate-And-Test, Hill Climbing, Best-First Search, Problem Reduction, Constraint Satisfaction, Means-Ends Analysis | **8 Hours** | **L1, L2** |
| **Module -2**<br>**Knowledge Representation Issues** : Representations And Mappings, Approaches To Knowledge Representation.<br>Using Predicate Logic : Representation Simple Facts In Logic, Representing Instance And Isa Relationships, Computable Functions And Predicates, Resolution<br>**Representing Knowledge Using Rules** : Procedural Versus Declarative Knowledge, Logic Programming, Forward Versus Backward Reasoning. | **8 Hours** | **L1, L2** |
| **Module -3**<br>**Symbolic Reasoning Under Uncertainty** : Introduction To Nonmonotonic Reasoning, Logics For Non-monotonic Reasoning. Turning performance limitations. Drag estimation. Take-off and landing - methods, procedures and data reduction.<br>**Statistical Reasoning** : Probability And Bays' Theorem, Certainty Factors And Rule-Base Systems, Bayesian Networks, DempsterShafer | **8 Hours** | **L1, L2, L3** |

| | | |
|---|---|---|
| Theory, Fuzzy Logic. | | |
| **Module -4**<br>**Weak Slot-and-Filler Structures** : Semantic Nets, Frames.<br>**Strong Slot-and-Filler Structures** : Conceptual Dependency, Scripts, CYC.<br>**Game Playing**: Overview, And Example Domain : Overview, MiniMax, Alpha-Beta Cut-off, Refinements, Iterative deepening, The Blocks World, Components Of A Planning System, Goal Stack Planning, Nonlinear Planning Using Constraint Posting, Hierarchical Planning, Reactive Systems, Other Planning Techniques | **8 Hours** | **L1, L2** |
| **Module -5**<br>**Understanding**: What is understanding? , What makes it hard?, As constraint satisfaction.<br>Natural Language Processing: Introduction, Syntactic Processing, Semantic Analysis, Semantic Analysis, Discourse And Pragmatic Processing, Spell Checking.<br>Connectionist Models : Introduction: Hopfield Network, Learning In Neural Network, Application Of Neural Networks, Recurrent Networks, Distributed Representations, Connectionist AI And Symbolic AI | **8 Hours** | **L1, L2** |

**Course outcomes:**

After studying this course, students will be able to:

1. Apply the basic techniques of artificial intelligence.
2. Distinguish Non-monotonic reasoning and statistical reasoning.
3. Evaluate the natural language processing and connectionist models.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Interpretation of data

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

1. Elaine Rich And Kevin Knight,“Artificial Intelligence”, Tata Mcgraw-Hill,3rd edition,2008,ISBN-13: 978-0070087705
2. Stuart Russel, Peter Norvig ,Artificial Intelligence- A Modern Approach, PEI,3rd edition,2015,ISBN-13: 978-9332543515

**Reference Books:**

1. Carl Townsend, Introduction to Prolog Programming.
2. Ivan Bratko( Addison-Wesley),“PROLOG Programming For Artificial Intelligence” PEI, 3rd edition,2002,ISBN-13: 978-8131711347.
3. Clocksin and Mellish,“Programming with PROLOG” , Springer, 5th edition, 2003,ISBN-13: 978-3540006787

# VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
# CHOICE BASED CREDIT SYSTEM (CBCS)
# SCHEME OF TEACHING AND EXAMINATION 2017-2018

## CRYOGENICS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VIII

| | | | |
|---|---|---|---|
| Subject Code | **17AS832** | IA Marks | 40 |
| Number of Lecture Hours/Week | 03 | Exam Hours | 03 |
| Total Number of Lecture Hours | 40 | Exam Marks | 60 |

CREDITS – 03

**Course objective:**

This course will enable students to

1. Understand the basic of cryogenic engineering.
2. Understand the cryogenic properties and insulation.
3. Acquire the knowledge on storage of cryogenic liquids and equipments.

| Modules | Teaching Hours | Revised Bloom's Taxonomy (RBT) Level |
|---|---|---|
| **Module -1**<br>**Introduction to Cryogenic Engineering:** Thermo physical and fluid dynamic properties of liquid and gas hydrogen, Thermo physical and fluid dynamic properties of liquid and gas helium, Liquefaction systems of hydrogen and helium gases, Liquefaction systems of hydrogen and helium gases, Refrigeration and liquefaction principals; Joule Thomson effect and inversion curve; Adiabatic and isenthalpic expansion with their comparison. | **9 Hours** | **L1, L2** |
| **Module -2**<br>**Properties:** Cryogenic fluids, Solids at cryogenic temperatures; Superconductivity, Recuperative - Linde - Hampson, Claude, Cascade, Heylandt, Kapitza, Collins, Simon; Regenerative - Stirling cycle and refrigerator, Slovay refrigerator, Gifford-McMahon refrigerator, Vuilleumier refrigerator, Pulse Tube refrigerator; Liquefaction of natural gas.<br>. | **8 Hours** | **L1, L2** |
| **Module -3**<br>**Cryogenic Insulation:** Vacuum insulation, Evacuated porous insulation, Gas filled Powders and fibrous materials, Solid foams, Multilayer insulation, Liquid and vapour Shields, Composite insulations | **7 Hours** | **L1, L2, L3** |
| **Module -4**<br>**Storage and Instrumentation of Cryogenic liquids:** Design considerations of storage vessel; Dewar vessels; Industrial storage vessels; Storage of cryogenic fluids in space; Transfer systems and Lines for cryogenic liquids; Cryogenic valves in transfer lines; Two phase flow in Transfer system; Cool-down of storage and transfer systems, Measurement of strain, pressure, flow, liquid level and Temperature in cryogenic environment; Cryostats. | **8 Hours** | **L1, L2** |

| **Module -5** | **8 Hours** | **L1, L2** |
|---|---|---|
| **Cryogenic Equipment:** Cryogenic heat exchangers - recuperative and regenerative; Variables affecting heat exchanger and system performance; Cryogenic compressors, Pumps, expanders; Turbo alternators; Effect of component inefficiencies; System Optimization, Magneto-caloric refrigerator; 3He-4He Dilution refrigerator; Cryopumping; Cryogenic Engineering applications in energy, aeronautics, space, industry, biology, preservation Application of Cryogenic Engineering in Transport. | | |

**Course outcomes:**

After studying this course, students will be able to:

1. Recognize the basic of cryogenic engineering.
2. Identify the storage and instrumentation required for cryogenic liquids.
3. Classify the types of cryogenic equipments.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Interpretation of data

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

1. T.M. Flynn, Marcel Dekker., Cryogenic Engineering, CRC Press,2nd edition, 2004,ISBN-13: 978-8126504985
2. A. Bose and P. Sengupta, "Cryogenics: Applications and Progress", Tata McGraw Hill.

**Reference Books:**

1. J.G. Weisend II, Taylor and Francis , "Handbook of Cryogenic Engineering", CRC Press,1st edition,1998,ISBN-13: 978-1560323327
2. R.Barron,"Cryogenic Systems", Oxford University Press.
3. K.D.Timmerhaus and T.M. Flynn, "Cryogenic Process Engineering", Plenum Press,1st edition,2013,ISBN-13: 978-1468487589
4. G.G.Haselden,"Cryogenic Fundamentals", Academic Press.
5. C.A.Bailey,"Advanced Cryogenics", Springer,1971,ISBN-13: 978-0306304583
6. R.W. Vance and W.M. Duke , "Applied Cryogenic Engineering", John Wiley & sons,1962,ISBN-13: 978-0471902706

# VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
# CHOICE BASED CREDIT SYSTEM (CBCS)
# SCHEME OF TEACHING AND EXAMINATION 2017-2018

## ROBOTICS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VIII

| | | | |
|---|---|---|---|
| Subject Code | **17AS833** | IA Marks | 40 |
| Number of Lecture Hours/Week | 03 | Exam Hours | 03 |
| Total Number of Lecture Hours | 40 | Exam Marks | 60 |

CREDITS – 03

**Course objective:**

This course will enable students to

1. Comprehend the mathematical representation of robots.
2. Understand the manipulators.
3. Acquire the knowledge of control, actuators and sensors.

| **Modules** | **Teaching Hours** | **Revised Bloom's Taxonomy (RBT) Level** |
|---|---|---|
| **Module -1**<br><br>**Introduction and Mathematical Representation of Robots:** History of Robots, Types of Robots, Notation, Position and Orientation of a Rigid Body, Some Properties of Rotation Matrices, Successive Rotations, Euler Angles for fixed frames X- Y -Z and moving frame ZYZ. Transformation between coordinate system, Homogeneous coordinates, Properties of A/BT, Types of Joints: Rotary, Prismatic joint, Cylindrical joint, Spherical joint, Representation of Links using Denvit - Hartenberg Parameters: Link parameters for intermediate, first and last links, Link transformation matrices, Transformation matrices of 3R manipulator, PUMA560 manipulator, SCARA manipulator. | **8 Hours** | **L1, L2** |
| **Module -2**<br>**Kinematics of Serial Manipulators:** Direct kinematics of 2R, 3R, RRP, RPR manipulator, puma560 manipulator, SCARA manipulator, Stanford arm, Inverse kinematics of 2R, 3R manipulator, puma560 manipulator.<br>**Velocity and Static's of Manipulators:** Differential relationships, Jacobian, Differential motions of a frame (translation and rotation), Linear and angular velocity of a rigid body, Linear and angular velocities of links in serial manipulators, 2R, 3R manipulators, Jacobian of serial manipulator, Velocity ellipse of 2R manipulator, Singularities of 2R manipulators, Statics of serial manipulators, Static force and torque analysis of 3R manipulator, Singularity in force domain. | **8 Hours** | **L1, L2** |
| **Module -3**<br>**Dynamics of Manipulators:** Kinetic energy, Potential energy, Equation of motion using Lagrangian, Equation of motions of one and two degree freedom spring mass damper systems using Lagrangian formulation, Inertia of a link, Recursive formulation of Dynamics using Newton Euler equation, Equation of motion of 2R manipulator using Lagrangian Newton-Euler formulation<br><br>**Trajectory Planning:** Joint space schemes, cubic trajectory, Joint space | **8 Hours** | **L1, L2, L3** |

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| schemes with via points, Cubic trajectory with a via point, Third order polynomial trajectory planning, Linear segments with parabolic blends, Cartesian space schemes, Cartesian straight line and circular motion planning | | |
| **Module -4**<br>**Control:** Feedback control of a single link manipulator- first order, second order system, PID control, PID control of multi link manipulator, Force control of manipulator, force control of single mass, Partitioning a task for force and position control- lever, peg in hole Hybrid force and position controller.<br><br>**Actuators:** Types, Characteristics of actuating system: weight, power-to-weight ratio, operating pressure, stiffness vs. compliance, Use of reduction gears, comparison of hydraulic, electric, pneumatic actuators, Hydraulic actuators, proportional feedback control, Electric motors: DC motors, Reversible AC motors, Brushless DC motors, Stepper motors- structure and principle of operation, stepper motor speed-torque characteristics | **9 Hours** | **L1, L2** |
| **Module -5**<br>**Sensors:** Sensor characteristics, Position sensors- potentiometers, Encoders, LVDT, Resolvers, Displacement sensor, Velocity sensor-encoders, tachometers, Acceleration sensors, Force and Pressure sensors piezoelectric, force sensing resistor, Torque sensors, Touch and tactile sensor, Proximity sensors-magnetic, optical, ultrasonic, inductive, capacitive, eddy-current proximity sensors. | **7 Hours** | **L1, L2** |

**Course outcomes:**

After studying this course, students will be able to:

1. Identify the mathematical representation of robots.
2. Classify the manipulators.
3. Classify the sensors and actuators.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Interpretation of data

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

1. Ghosal A ,Fundamental Concepts and Analysis of Robotics,Oxford,2006,ISBN-13: 978-0195673913
2. Niku, S. B ,Introduction to Robotics Analysis, Systems, Applications,., Pearso Education, 2008

**Reference Books:**

1. Craig, J. J, Introduction to Robotics: Mechanics and Control, Addison-Welsey, 2nd edition, 1989.
2. Schilling R. J ,Fundamentals of Robotics, Analysis and Control,., PHI,1st edition, 2011,ISBN-13: 978-8120310476

## SPACECRAFT SYSTEMS

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – VIII

| | | | |
|---|---|---|---|
| Subject Code | **17AS834** | IA Marks | 40 |
| Number of Lecture Hours/Week | 03 | Exam Hours | 03 |
| Total Number of Lecture Hours | 40 | Exam Marks | 60 |

CREDITS – 03

**Course objective:**

This course will enable students to

1. Understand the spacecraft environment and design consideration.
2. Comprehend the navigation concepts and navigation systems.
3. Acquire the knowledge on control actuators and satellite TTC.

| **Modules** | **Teaching Hours** | **Revised Bloom's Taxonomy (RBT) Level** |
|---|---|---|
| **Module -1**<br>**Spacecraft Environment & Design Consideration:** Orbit definition /Mission Requirements of LEO, GEO, GTO & HEO, Lunar orbits, IPO with respect to Power Generation, Power System Elements, Solar aspect angle Variations.<br>**Power Generation:** Study of Solar spectrum, Solar cells, Solar Panel design, Solar Panel Realization, Solar Panel testing, Effects of Solar cells and panels (IR, UV, Particles) | **9 Hours** | **L1, L2** |
| **Module -2**<br>**Navigation Concepts:** Fundamentals of spacecraft navigation systems and Position Fixing, Geometric concepts of Navigation, Elements, The Earth in inertial space, Earth's Rotation, Revolution of Earth, Different Coordinate Systems, Coordinates Transformation, Euler angle formulations, Direction cosine formulation, Quaternion formulation. | **8 Hours** | **L1, L2** |
| **Module -3**<br>**Inertial Navigation Systems:** Accelerometers, Pendulous type, Force Balance type, MEMs Accelerometers, Basic Principles of Inertial Navigation, Types, Platform and Strap down, Mechanization INS system, Rate Corrections, Block diagram, Acceleration errors,Coriolis effect, Schuler Tuning, Cross coupling, Gimbal lock , Alignment | **8 Hours** | **L1, L2, L3** |
| **Module -4**<br>**CONTROL ACTUATORS**<br>Thrusters, Momentum Wheel, Control Moment Gyros, reaction wheel, Magnetic Torquers, Reaction Jets, Ion Propulsion, Electric propulsion, | **7 Hours** | **L1, L2** |

| | | |
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| solar sails. | | |
| **Module -5**<br>**Satellite Telemetry, Tracking and Telecommand:** Introduction to telemetry systems, Aerospace transducer, signal conditioning, multiplexing methods, Analog and digital telemetry, Command line and remote control system, Application of telemetry in spacecraft systems, Base Band Telemetry system, Computer command & Data handling, Satellite command system, Issues | **8 Hours** | **L1, L2** |

**Course outcomes:**

After studying this course, students will be able to:

1. Identify the spacecraft environment for design consideration.
2. Apply the navigation concepts and systems.
3. Classify the control actuators.

**Graduate Attributes (as per NBA):**

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Interpretation of data

**Question paper pattern:**

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer 5 full questions, selecting one full question from each module.

**Text Books:**

1. Fortescue Peter, ‘Spacecraft Systems Engineering’ Wiley-Blackwell England,4th edition,2003,ISBN-13:978-0470750124.
2. Patel Mukund R, ‘Spacecraft Power Systems’ CRC Press Boca Raton,1st edition,2005,ISBN-13: 978-0849327865

**Reference Books:**

1. Wilbur L. Pritchard and Joseph A.Sciulli, Satellite Communication Systems Engineering, Prentice Hall, New Jersey, 1986.
2. Marcel j. sidi, “Spacecraft Dynamics and control, A Practical Engineering Approach”, Cambridge University Press, Reprint edition,2000,ISBN-13: 978-0521787802
3. Kaplan m, “Modern Spacecraft Dynamics and control”, Wiley Press,1976,ISBN-13: 978-0471457039
4. Maxwell Noton, ”Spacecraft navigation and guidance”, Springer (London, New York), Reprint edition of 1998,ISBN-13: 978-1447115854

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