VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

B.E. AERONAUTICAL ENGINEERING

V SEMESTER

Sl. No	Subject Code	Title .	Teaching Hours /Week		Examination				Credits
			Theory	Practical/Drawing	Duration	Theory / Practical Marks	I.A. Marks	Total Marks	
1	15AE51	MANAGEMENT AND ENTREPRENEURSHIP	04		03	80	20	100	4
2	15AE52	INTRODUCTION TO COMPOSITE MATERIALS	04		03	80	20	100	4
3	15AE53	HEAT AND MASS TRANSFER	04		03	80	20	100	4
4	15AE54	AIRCRAFT STRUCTURES-I	04		03	80	20	100	4
5	15AE55X	PROFESSIONAL ELECTIVE	03		03	80	20	100	3
6	15AEL56X	OPEN ELECTIVE	03		03	80	20	100	3
7	15AEL57	AERODYNAMICS LAB		1I+2P	03	80	20	100	2
8	15AEL58	ENERGY CONVERSION & FLUID MECHANICS LAB		1I+2P	03	80	20	100	2
TOTAL			**22**	**06**	**24**	**640**	**160**	**800**	**26**

Professional Elective		Open Elective	
15AE551	FUELS & COMBUSTION	15AE561	HISTORY OF FLIGHT & TECHNOLOGY FORECAST
15AE552	GAS DYNAMICS	15AE562	ELEMENTS OF AERONAUTICS
15AE553	THEORY OF VIBRATIONS	15AE563	AIRCRAFT TRANSPORTATION SYSTEMS
15AE554	AIRCRAFT ELECTRICAL SYSTEMS & INSTRUMENTATION	15AE564	BASICS OF ROCKETS AND MISSILES

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. OpenElective: Electives from other technical and/or emerging subject areas.

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CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

B.E. AERONAUTICAL ENGINEERING

MANAGEMENT AND ENTREPRENEURSHIP

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

SEMESTER – V

Subject Code	**15AE51**	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

CREDITS – 04

Course Objectives:

This course will enable students to

1. Understand the basic concepts of management, planning, organizing and staffing.
2. Acquire the knowledge to become entrepreneur.
3. Comprehend the requirements towards the small-scale industries and project preparation.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module -1 **Management:** Definition, Importance – Nature and Characteristics of Management, Management Functions, Roles of Manager, Levels of Management, Managerial Skills, Management & Administration, Management as a Science, Art & Profession **Planning:** Nature, Importance and Purpose Of Planning, Types of Plans, Steps in Planning, Limitations of Planning, Decision Making – Meaning, Types of Decisions- Steps in Decision Making.	**10 Hours**	**L1, L2, L3**
Module -2 **Organizing and Staffing:** Meaning, Nature and Characteristics of Organization – Process of Organization, Principles of Organization, Departmentalisation, Committees –meaning, Types of Committees, Centralization Vs Decentralization of Authority and Responsibility, Span of Control (Definition only), Nature and Importance of Staffing, Process of Selection and Recruitment. **Directing and Controlling:** Meaning and Nature of Directing- Leadership Styles, Motivation Theories Communication – Meaning and Importance, Coordination- Meaning and Importance, Techniques of Coordination. Controlling – Meaning, Steps in Controlling	**10 Hours**	**L1, L2,L3**
Module -3 **Social Responsibilities of Business:** Meaning of Social Responsibility, Social Responsibilities of Business towards Different Groups, Social Audit, Business Ethics and Corporate Governance. **Entrepreneurship**: Definition of Entrepreneur, Importance of Entrepreneurship, concepts of Entrepreneurship, Characteristics of successful Entrepreneur, Classification of Entrepreneurs, Intrapreneur – An Emerging Class, Comparison between Entrepreneur and	**10 Hours**	**L2, L3, L4**

Intrapreneur, Myths of Entrepreneurship, Entrepreneurial Development models, Entrepreneurial development cycle, Problems faced by Entrepreneurs and capacity building for Entrepreneurship.		
Module -4 **Modern Small Business Enterprises:** Role of Small Scale Industries, Concepts and definitions of SSI Enterprises, Government policy and development of the Small Scale sector in India, Growth and Performance of Small Scale Industries in India, Sickness in SSI sector, Problems for Small Scale Industries, Impact of Globalization on SSI, Impact of WTO/GATT on SSIs, Ancillary Industry and Tiny Industry (Definition only). **Institutional Support for Business Enterprises:** Introduction, Policies & Schemes of Central–Level Institutions, State-Level Institutions.	**10 Hours**	**L3,L4,L5**
Module -5 **Project Management:** Meaning of Project, Project Objectives & Characteristics, Project Identification- Meaning & Importance; Project Life Cycle, Project Scheduling, Capital Budgeting, Generating an Investment Project Proposal, Project Report-Need and Significance of Report, Contents, Formulation, Project Analysis-Market, Technical, Financial, Economic, Ecological, Project Evaluation and Selection, Project Financing, Project Implementation Phase, Human & Administrative aspects of Project Management, Prerequisites for Successful Project Implementation. New Control Techniques- PERT and CPM, Steps involved in developing the network, Uses and Limitations of PERT and CPM	**10 Hours**	**L2, L3**

Course Outcomes :

After studying this course, students will be able to:

1. Explain about the management and planning.
2. Apply the knowledge on planning, organizing, staffing, directing and controlling.
3. Describe the requirements towards the small-scale industries and project preparation.

Graduate Attributes :

- 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. PrinciplesofManagement–P.C.Tripathi,P.N.Reddy–TataMcGraw Hill,
2. DynamicsofEntrepreneurialDevelopment&ManagementVasantDesai-HimalayaPublishingHouse
3. EntrepreneurshipDevelopment–Poornima.M.CharantimathSmall BusinessEnterprises-PearsonEducation-2006(2&4).

Reference Books:

1. ManagementFundamentals- Concepts,Application, Skill Development-RobersLusier-Thomson
2. EntrepreneurshipDevelopment-S.S.Khanka-S.Chand&Co.
3. Management-StephenRobbins-PearsonEducation/PHI-17th Edition,2003.

INTRODUCTION TO COMPOSITE MATERIALS

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

Subject Code	**15AE52**	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

CREDITS – 04

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 **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 **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 **Processing of Polymer Matrix Composites: Thermoset Polymers** Hand layup Process, Vacuum Bagging Process, Post Curing Process, Filament winding, Pultrusion, Pulforming, Autoclave Process **Processing of Polymer Matrix Composites: Thermoplastic Polymers** Extrusion process, Injection Moulding Process, Thermo-forming process. **Post Processing of Composites –** Adhesive bonding, drilling, cutting processes.	**10 Hours**	**L1, L2,L3**
Module -3 **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. **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	**12 Hours**	**L2, L3, L4**

reinforcement.		
Module -4 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.	**10 Hours**	**L3,L4,L5**
Module -5 **Inspection & Quality Control** : Destructive & Non-Destructive Testing, Tensile, Compression, Flexural, Shear, Hardness; ultrasonic testing – A-B-C scan **Applications of Composites Materials** Automobile, Aircrafts, missiles, Space hardware, Electrical and electronics, marine, recreational and Sports equipment, future potential of composites.	**10 Hours**	**L2, L3**

Course Outcomes:

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 :

- 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, II edition, Springer Verlag, 1998: ISBN: 0-387-98409-7
2. **Autar Kaw**, Mechanics of Composites, II edition, CRC Press. 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

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SCHEME OF TEACHING AND EXAMINATION 2015-2016

HEAT & MASS TRANSFER

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

SEMESTER – V

Subject Code	**15AE53**	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

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 **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, Fick's First law of diffusion (no numerical).	**10 Hours**	**L1, L2**
Module -2 **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 **Convection:** Concepts of Continuity, Momentum and Energy Equations. Dimensional analysis-Buckingham's Pi Theorem - Application for developing non-dimensional correlation for convective heat transfer **Free Convection:** Development of Hydrodynamic and thermal boundary layer along a vertical plate , Use of empirical relations for Vertical plates and pipes. **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	**10 Hours**	**L1, L2, L3**

Thermal Entry Lengths, use of empirical correlations for Horizontal Pipe Flow and annulus flow.		
Module -4 **Radiation &Heat Exchangers Design: Radiation :** Introduction to physical mechanism - Radiation properties - Radiation shape factors - Heat exchange between non-black bodies - Radiation shields **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 **Heat and Mass Transfer Problems in Aerospace Engineering:** Heat transfer problems in gas turbine combustion chambers - Rocket thrust chambers - Aerodynamic heating -Ablative heat transfer. **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. Describe the fundamental of heat and mass transfer.
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 :

- 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. 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.

AIRCRAFT STRUCTURES - I

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

Subject Code	**15AE54**	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

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 **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 **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 **Loads on Aircraft and Aircraft Materials** **Loads on Aircraft**: Structural nomenclature, Types of loads, load factor, Aerodynamics loads, Symmetric manoeuvre loads, Velocity diagram, Function of structural components.	**10 Hours**	**L1, L2, L3**

Aircraft Materials: Metallic and non-metallic materials, Use of Aluminum alloy, titanium, stainless steel and composite materials. Desirable properties for aircraft application. Fracture and Fatigue, Stress Intensity Factor, Crack Growth Rate Derivation.		
Module -4 **Theory of Elasticity and Structures:** **Theory of Elasticity: and** 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. **Structures:** StaticallyDeterminate 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 **Energy Methods and Columns** **Energy Methods:** Strain Energy due to axial, bending and Torsional loads. Castigliano's theorem, Maxwell's Reciprocal theorem. **Columns**: Columns with various end conditions, Euler's Column curve, Rankine's formula, Column with initial curvature, Eccentric loading, south-well plot, Beam-column.	**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 :

- 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. **V.B. Bhandari,** 'Design of Machine Elements', Tata McGraw Hill Publishing Company Ltd., New Delhi, 2nd Edition 2007.
2. **Megson, T.M.G** 'Aircraft Structures for Engineering Students',., Edward Arnold, 1995.
3. **Timoshenko and Goodier,"** 'Theory of Elasticity', McGraw Hill Co.

Reference Books:

1. **Robert L. Norton ,** Machine Design, , Pearson Education Asia, 2001.
2. **Donaldson, B.K.,** "Analysis of Aircraft Structures – An Introduction",McGraw-Hill, 1993.
3. **Timoshenko, S.,** "Strength of Materials", Vol. I and II, Princeton D.VonNostrand Co, 1990
4. **Joseph E Shigley and Charles R.Mischke**. , Mechanical Engineering Design, McGraw Hill International edition, 6th Edition 2009.
5. **Peery, D.J., and Azar, J.J.,** "Aircraft Structures", 2nd edition, McGraw, Hill, N.Y., 1993.
6. **Bruhn. E.H.** "Analysis and Design of Flight vehicles Structures", Tri – state off set company, USA, 1985.

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Professional Elective

FUELS & COMBUSTION

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

Subject Code	**15AE551**	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

CREDITS – 03

Course Objectives: This course will enable students to

1. Comprehend the basic properties of fuel.
2. Acquire the knowledge of fuel treatment.
3. Understand the combustion fundamentals and performance.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module -1 Fuel Properties: Fuel Properties, Relative Density, API Gravity, Molecular Mass, Distillation Range, Vapor Pressure, Flash Point, Volatility Point, Viscosity, Surface Tension, Freezing Point, Specific Heat, Latent Heat, Thermal Conductivity, Combustion Properties of Fuels, Calorific Value, Enthalpy, Spontaneous-Ignition temperature, Limits of Flammability, Smoke Point, Luminometer Number, Smoke Volatility Index, Pressure and Temperature Effects, Sub atmospheric Pressure, Low Temperature, High Temperature.	**6 Hours**	**L1, L2**
Module -2 Fuel Treatment: Introduction, Types of Hydrocarbons, Paraffins, Olefins, Naphthenes, Aromatics, Production of Liquid Fuels, Removal of Sulfur Compounds, Contaminants, Asphaltenes, Gum, Sediment, Ash, Water, Sodium, Vanadium, Additives, Gum Prevention, Corrosion Inhibition/Lubricity Improvers, Anti-Icing, Antistatic–Static Dissipators, Metal Deactivators, Antismoke.	**6 Hours**	**L1, L2**
Module -3 Alternative Fuels aerospace applications**:** Hydrogen, Methane, Propane, Ammonia, Alcohols, Slurry fuels, Synthetic fuels, Fuels Produced by Fischer–Tropsch Synthesis of Coal/Biomass, Biofuels, Alternative fuel Properties, Combustion and Emissions Performance, Fischer–Tropsch Fuels, Biodiesel Fuels, Highly Aromatic (Broad Specification)	**8 Hours**	**L1, L2, L3**

Basic Considerations**:** Introduction to Gas turbine Combustor, Basic Design Features, Combustor Requirements, Combustor Types and parts, Fuel Preparation, Atomizers, liner wall-cooling Techniques, combustor stability limits, combustor exit temperature traverse quality (pattern factors), Combustors for Low Emissions.		
Module -4 Combustion Fundamentals**:** Deflagration, Detonation, Classification of Flames, Physics of combustion Chemistry, Flammability Limits, Global Reaction-Rate Theory, Weak Mixtures, Rich Mixtures, Laminar Premixed Flames, laminar and turbulent flame burning velocity, measurement techniques for flame velocity, Factors Influencing Laminar Flame Speed, Equivalence Ratio, Initial Temperature, Pressure, Laminar Diffusion Flames, Turbulent Premixed Flames, Flame Propagation in Heterogeneous Mixtures of Fuel Drops, Fuel Vapor and Air. Combustion flame characterization: Droplet and Spray Evaporation, Heat-Up Period, Evaporation Constant, Convective Effects, Effective Evaporation Constant, Spray Evaporation, Ignition Theory, Gaseous Mixtures, Heterogeneous Mixtures, Spontaneous Ignition, Flashback, Stoichiometry, Adiabatic Flame Temperature, Factors Influencing the Adiabatic Flame Temperature, Fuel/Air Ratio, Initial Air Temperature, Pressure.	**10 Hours**	**L1, L2, L3**
Module -5 Combustion Performance**:** Combustion Efficiency, The Combustion Process, Reaction-Controlled Systems, Burning Velocity Model, Stirred Reactor Model, Mixing-Controlled Systems, Evaporation-Controlled Systems, Reaction- and Evaporation-Controlled Systems. Flame Stabilization & Fuel Classification: Definition of Stability Performance, Measurement of Stability Performance, Bluff-Body Flame holders, Stabilization, Mechanisms of Flame Stabilization, Flame Stabilization in Combustion Chambers, Classification of Liquid Fuels, Aircraft Gas Turbine Fuels, Engine Fuel System, Aircraft Fuel Specifications, Classification of Gaseous Fuels.	**10 Hours**	**L1, L2, L3**
Course Outcomes: After studying this course, students will be able to: 1. Explain the fuel properties and fuel treatment process. 2. Select the alternative fuels for aerospace applications. 3. Compute the combustion performance.		
Graduate Attributes : o Engineering Knowledge. o Problem Analysis. o 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. Arthur H.Lefebvre&Dilip R. Ballal, Gas Turbine Combustion, CRC Press, 3rd Edition, 2010
2. Minkoff, G.J., and C.F.H. Tipper, Chemistry of Combustion Reaction, London Butterworths, 1962.
3. Samir Sarkar, Fuels & Combustion, Orient Long man 1996.

Reference Books:

1. **Error! Hyperlink reference not valid.**. **Error! Hyperlink reference not valid.**, Macmillan India Limited, 1989
2. Wilson, P.J. and J.H. Wells, Coal, Coke and Coal Chemicals, New York, McGraw-Hill, 1960.
3. Williams, D.A. and G. James, Liquid Fuels, London Pergamon, 1963.
4. Gas Engineers Handbook, New York, Industrial Press, 1966.

GAS DYNAMICS

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

Professional Elective

Subject Code	**15AE552**	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

CREDITS – 03

Course Objectives: This course will enable students to

1. Comprehend the fundamentals of steady, isentropic and adiabatic flow.
2. Acquire the knowledge of wave phenomena.
3. Understand theconcepts of flames and combustion.

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

Module -1 **Fundamental Equations Of Steady Flow:** Continuity and momentum equations, The thrust function, The dynamic equation and Euler's Equation. Bernoulli's Equation. Steady flow energy equation.	**6 Hours**	**L1, L2**
Isentropic Flow: Acoustic velocity, Mach number, Mach cone and Mach angle. Flow parameters, stagnation temperature, pressure, and density. **Adiabatic Flow:** Stagnation temperature change. Rayleigh line, Pressure ratio and temperature ratio, Entropy considerations, maximum heat transfer **Flow With Friction:** The fanning equation, Friction factor and friction parameter, Fanno line, Fanno equations.	**10 Hours**	**L1, L2**
Module -3 **Wave Phenomena**: Classification of wave phenomena, analysis of shock phenomena, Hugoniot equation. Weak waves, compression waves, Normal shock waves, oblique shock waves, Entropy considerations, Rayleigh Pilot equations, detonation and deflageration.	**8 Hours**	**L1, L2, L3**
Module -4 **Variable Area Flow:** Velocity variation with Isentropic flow, Criteria for acceleration and deceleration. Effect of pressure ratio on Nozzle operation. Convergent nozzle and convergent divergent nozzle. Effect of back pressure on nozzle flow. Isothermal flow functions. Comparison of flow in nozzle. Generalized one dimensional flow.	**8 Hours**	**L1, L2, L3**
Module -5 **Applications of dimensional analysis** and similitude to gas dynamic problems. **Introduction To Flames And Combustion:** Flame propagation, diffusion flames, premixed flames, flame velocity, theories of flame propagation, ignition for combustible mixture, flame stabilization.	**8 Hours**	**L1, L2, L3**
Course Outcomes: After studying this course, students will be able to: 1. Apply the equations of steady flow. 2. Explain the isentropic flow, adiabatic flow and wave phenomena. 3. Describe the flames and combustion.		
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. **Fundamentals of Compressible flow**: Yahya, 2nd Edn. 1991; Wieley Eastern.
2. **Gas Dynamics,** E Radhakrishnan PHI-2006

Reference Books:

1. **Introduction to Gas Dynamics:**Rolty, Wiley 1998
2. **Elements of Gas Dynamics:**Liepmann and Roshko, Wiley 1994.
3. **The dynamics and thermodynamics of compressible fluid flow:** Shapiro Ronold press. 1994.
4. **Compressible Fluid Flow**, J. F. Anderson

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
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SCHEME OF TEACHING AND EXAMINATION 2015-2016

THEORY OF VIBRATIONS

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

Open Elective

Subject Code	**15AE553**	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

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 **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 **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. **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 **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 isolation, transmissibility ratio. due to harmonic exitation and support motion. **Vibration Measuring Instruments & Whirling Of Shafts:** Vibration of elastic bodies – Vibration of strings – Longitudinal, lateral and torsional Vibrations	**8 Hours**	**L1, L2, L3**
Module -4 **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	**10 Hours**	**L1, L2, L3**

excitation. Applications: a) Vehicle suspension. b) Dynamic vibration absorber. c) Dynamics of reciprocating Engines. **Continuous Systems:** Introduction, vibration of string, longitudinal vibration of rods, Torsional vibration of rods, Euler's equation for beams.		
Module -5 **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 :

- 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, DhanpatRai& 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.GrahamKelly,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. LeonanrdMeirovitch ,Elements of Vibrations Analysis,Tata McGraw Hill, Special Indian edition, 2007.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

AIRCRAFT ELECTRICAL SYSTEMS & INSTRUMENTATION

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

Professional Elective

Subject Code	**15AE554**	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

CREDITS – 03

Course Objectives:
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 **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 **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 **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 **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 :

- Engineering Knowledge.
- 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. IanMoirandAllanSeabridge,'AircraftSystems:Mechanical,Electricaland Avionics-SubsystemIntegration',Wiley India Pvt Ltd, 3rd edition,2012,ISBN-13: 978-8126535217.
2. Pallet,E.H.J.,"AircraftInstrumentsandIntegratedSystems",Longman Scientificand Technical,Indianreprint1996.

Reference Books:

1. LalitGuptaandOPSharma,'AircraftSystems(FundamentalsofFlight Vol.IV)',HimalayanBooks;2006.
2. Treager,S.,"GasTurbineTechnology",McGraw-Hill, 3rd edition,2013,ISBN-13: 978-1259064876.
3. R.W.SloleyandW.H.Coulthard,'TheaircraftEngineersHandbook,No4, INSTRUMENTS',Shroff,6thEdition,2005,ISBN-13: 978-8175980518
4. SRMajumdar,'Pneumatic Systems',TataMcGrawHillPublishing Co,1st edition,2001,ISBN-13: 978-0074602317.
5. WilliamANeese,'AircraftHydraulicSystems',HimalayanBooks;2007

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016
Open Electives

HISTORY OF FLIGHT & TECHNOLOGY FORECAST

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

SEMESTER – V

Open Elective

Subject Code	**15AE561**	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

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 **Introduction** 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 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 **Aircraft Configurations:** 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 **Airplane Structures and Materials:** 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 **Power Plants:** 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**

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

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	**15AE562**	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

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 **Introduction to Aircrafts** 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. **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.	**08 Hours**	**L1, L2**
Module -2 **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 **Aircraft Propulsion:** 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 **Aircraft Stability :** 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 on performance; correct and incorrect angles of bank; aerobatics, inverted manoeuvre, manoeuvrability. Simple problems.	**08 Hours**	**L1, L2**
Module -5 **Aircraft Systems:** Mechanical systems and their components; hydraulic and pneumatic systems; oxygen System; environmental Control System; fuel system.	**08 Hours**	**L1, L2**

Electrical systems, flight deck and cockpit systems; navigation system, communication system. **Aircraft systems (Mechanical)** – hydraulic and pneumatic systems and their applications; environment control system; fuel system, oxygen system. **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.		

Course outcomes:

After studying this course, students will be able to:

1. Appreciate and apply the basic principle of aviation
2. Apply the concepts of fundaments of flight, basics of aircraft structures , aircraft propulsion and aircraft materials during the development of an aircraft
3. 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:

1. John D. Anderson, *"Introduction to Flight"*, McGraw-Hill Education, 2011. ISBN 9780071086059.
2. 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.
3. Ian Moir, Allan Seabridge, *"Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration"*, John Wiley & Sons, 2011. ISBN 978111965006.
4. Sutton G.P., "*Rocket Propulsion Elements*", John Wiley, New York, 8th Ed., 2011; ISBN: 1118174208, 9781118174203.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

AIRCRAFT TRANSPORTATION SYSTEMS

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

Open Elective

Subject Code	**15AE563**	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

CREDITS – 03

Course Objectives: This course will enable students to

1. Understand the air transport systems.
2. Acquire the knowledge of aircraft characteristics, airlines and airport.
3. Understand the navigation and environmental systems.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module –I Air Transport Systems –Introduction Environment, transport and mobility. Systematic description and current challenges. Development of aircraft design driver-speed and range. Development of Airport, Airlines, ICAO, Regulatory Frame work and Market Aspects.	**10 Hours**	**L1, L2**
Module –II Aircraft Characteristics and Manufacturers Classification of flight vehicles, cabin design, basics of flight physics- structures, mass and balance. Flight performance and mission. Aircraft manufacturers, development process, production process, supply chain.	**08 Hours**	**L1, L2**
Module –III Airlines, Airport and Infrastructure Airline types, Network management. Flight strategy and aircraft selection, flight operations, MRO. Role of Airport, Regulatory Issues, Airport operation and services. Airport planning - infrastructure.	**8Hours**	**L1, L2, L3**
Module -4 **Module –IV Air Navigation System & Environmental Systems** Principle of operation- Role of Air Navigation services. Air space structures, Airspace and Airport capacity, Aircraft separation. Flight guidance system. Communication system. Integrated air traffic management and working system. Environmental aspects-emission, noise, and sound.	**8 Hours**	**L1, L2, L3**

Module -5 **Module –V Managerial Aspects of Airlines** Airline passenger marketing, forecasting methods, pricing and demand. Air cargo-market for air freight. Principles of airline scheduling. Fleet planning.	**6 Hours**	**L1, L2, L3**

Course Outcomes:

After studying this course, students will be able to:

1. Explain the air transport systems.
2. Describe the aircraft characteristics, airlines and airport operation.
3. Apply the Air Navigation System & Environmental Systems.

Graduate Attributes :

- Engineering Knowledge.
- 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. Dieter Shmitt , and ValkerGollnick, Air Transport System, Springer, 2016.

2. Jhon G Wensveen, Air Transportation-A Management Prospective, Ashgate Publishing Ltd, 2011.

Reference Books:

1. Mike Hirst, The Air Transportation System, Woodhead Publishing Ltd, England, 2008.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

BASICS OF ROCKETS & MISSILES

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

SEMESTER – V

Open Elective

Subject Code	**15AE564**	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	40	Exam Marks	80

CREDITS – 03

Course Objectives:

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 **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 **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 **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 **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	**8 Hours**	**L1, L2, L3**

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.		
Module -4 **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. **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 **Rocket Testing:** Ground Testing and Flight Testing, Types of Tests 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. **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.	**8 Hours**	**L1, L2**

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 :

- 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. GeorgePSuttonandOscarBiblarz,'RocketPropulsionElement',JohnWileyandSonsInc,7th edition,2010,ISBN-13: 978-8126525775.
2. JackNNeilson,'MissileAerodynamics',AIAA,1st edition, 1988,ISBN-13: 978-0962062902.

Reference Books:

1. SSChin,'MissileConfigurationDesign'.
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.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

AERODYNAMICS LAB

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

SEMESTER – V

Subject Code	**15AEL57**	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	42	Exam Marks	80

CREDITS – 02

Course Objectives: This course will enable students to

1. Be acquainted with basic principles of aerodynamics using 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, L4**
2. Smoke flow visualization studies on a two-dimensional circular cylinder at low speeds.	**L1, L2, L3, L4**
3. Smoke flow visualization studies on a two dimensional airfoil at different angles of incidence at low speeds	**L1, L2, L3, L4**
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, L4**
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, L4, L5**
6. Surface pressure distributions on a two-dimensional smooth circular cylinder at low speeds and calculation of pressure drag.	**L1, L2, L3, L4**
7. Surface pressure distributions on a two-dimensional rough circular cylinder at low speeds and calculation of pressure drag.	**L1, L2, L3, L4**
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	**L1, L2, L3**

using force balance at various angles of incidence, speed.	
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 aretobeincludedforpracticalexamination.
2. Studentsare allowed to pick one experimentfrom the lot.
3. Strictlyfollow theinstructions 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 :

- 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 2015-2016

ENERGY CONVERSION AND FLUID MECHANICS LAB

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

SEMESTER – V

Subject Code	**15AEL58**	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	42	Exam Marks	80

CREDITS – 02

Course Objectives: This course will enable students to

1. Familiarize with the flash point, fire point and viscosity of lubricating oils.
2. Study IC engine parts, opening and closing of valves to draw the valve-timing diagram.
3. Gain the knowledge of various flow meters and the concept of fluid mechanics.
4. Understand the Bernoulli's Theorem.

Modules	Revised Bloom's Taxonomy (RBT) Level
1. Determination of Flash point and Fire point of lubricating oil using Abel Pensky and Pensky Martins Apparatus.	**L1, L2, L3, L4**
2. Determination of Calorific value of solid, liquid and gaseous fuels	**L1, L2, L3, L4**
3. Determination of Viscosity of lubricating oil using Torsion viscometers	**L1, L2, L3, L4**
4. Valve Timing diagram of 4-stroke IC Engine	**L1, L2, L3, L4**
5. Calculation of work done and heat transfer from PV and TS diagram using Planimeter	**L1, L2, L3, L4, L5**
6. Performance Test on **Four stroke Petrol Engine** and calculations of IP, BP, Thermal efficiencies, SFC, FP and to draw heat balance sheet.	**L1, L2, L3, L4**
7. Performance Test on Four stroke Multi-cylinder Engine and calculations of IP, BP, Thermal efficiencies, SFC, FP and to draw heat balance sheet.	**L1, L2, L3, L4**
8. Calibration of Venturimeter	**L1, L2, L3**
9. Determination of Coefficient of discharge for a small orifice by a constant head method.	**L1, L2, L3**
10. Determination of Viscosity of a Fluid	**L1, L2, L3**
11. Calibration of contracted Rectangular Notch	**L1, L2, L3**

12. Verification of Bernoulli's equation.	**L1, L2, L3**
13. Pipe friction apparatus with loss of head on pipe fittings	**L1, L2, L3**
14. Determination of Coefficient of loss of head in a sudden contraction and friction factor.	

Course Outcomes:

After studying this course, students will be able to:

1. Operate the instrument and measure the BP, FP, IP and AF ratio.
2. Find the efficiency of the engine and Estimate the calorific value of the given fuel.
3. Verify the Bernoulli's equation.
4. Evaluate the viscosity of fluid.

Conduct of Practical Examination:

1. All laboratory experiments aretobeincludedforpracticalexamination.
2. Studentsare allowed to pick one experimentfrom the lot.
3. Strictlyfollow theinstructions 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 :

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