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

Semester IV
Engineering Mathematics IV

Course Code: 15MAT41	**IA Marks: 20**
Hours/Week: 4 hours	**Exam Hours: 03**
Total Hours: 50	**Exam Marks: 80**

Course Learning Objectives:

The objective is to provide students with mathematics fundamental, necessary to formulate, solve and analyze engineering problems by making them to learn the following topics

- Numerical methods to solve ordinary differential equations
- Finite difference method to solve partial differential equations
- Complex analysis
- Sampling theory
- Joint probability distribution and stochastic process

Module 1 — 10 Hrs

Numerical Methods : Numerical solution of ordinary differential equations of first order and first degree, Picard's method, 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).

Numerical solution of simultaneous first order ordinary differential equations, Picard's method, Runge-Kutta method of fourth order.

Module 2 — 10 Hrs

Numerical Methods : Numerical solution of second order ordinary differential equations, Picard's method, Runge-Kutta method and Milne's method

Special Functions: Bessel's functions- basic properties, recurrence relations, orthogonality and generating functions. Legendre's functions - Legendre's polynomial, Rodrigue's formula, problems.

Module 3 — 10 hrs

Complex Variables: 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 with proof and problems.

Transformations: Conformal transformations, discussion of transformations:$w = z^2, w = e^z, w = z + (a^2/z)$ and bilinear transformations.

Module 4 **10 hrs**

Probability Distributions: Random variables(discrete and continuous), probability functions. Binomial distribution, Poisson distribution**,** geometric distribution, uniform distribution, Exponential and normal distributions, Problems.

Joint probability distribution: Joint Probability distribution for two variables, expectation, covariance, correlation coefficient.

Module 5 **10 hrs**

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.

Stochastic process

Stochastic process, probability vector, stochastic matrices, fixed points, regular stochastic matrices, Markov chains, higher transition probability.

Course outcomes:

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

1. Use appropriate numerical methods to solve first and second order ordinary differential equations.
2. Use Bessel's and Legendre's function which often arises when a problem possesses axial and spherical symmetry, such as in quantum mechanics, electromagnetic theory, hydrodynamics and heat conduction.
3. State and prove Cauchy's theorem and its consequences including Cauchy's integral formula, compute residues and apply the residue theorem to evaluate integrals.
4. Analyze, interpret, and evaluate scientific hypotheses and theories using rigorous statistical methods .

TEXT BOOKS:

1. B.V.Ramana "Higher Engineering Mathematics" Tata Mc Graw-Hill, 2006
2. B.S. Grewal – "Higher Engineering Mathematics", Khanna Publishers, 42nd Edition, 2013,

REFERENCE BOOKS

1. N P Bali and Manish Goyal, "A text book of Engineering mathematics" , Laxmi publications, latest edition.
2. Kreyszig, "Advanced Engineering Mathematics " - 9th edition, Wiley, 2013
3. H. K Dass and Er. Rajnish Verma ,"Higher Engineering Mathematics", S. Chand publishing, 1st edition, 2011.

Aerodynamics-I

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

SEMESTER – IV

Subject Code	**15AE42**	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03

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SCHEME OF TEACHING AND EXAMINATION 2015-2016

Total Number of Lecture Hours	50	Exam Marks	80
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 **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 **Airfoil Characteristics** Fundamental aerodynamic variables, Airfoil nomendature, 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 **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	**10 Hours**	**L1, L2, L3, L4, L5**

and generation of Lift, D'Alembert's paradox, Numericals, **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.		
Module -4 **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 **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 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:

1. Anderson J .D, "*Fundamental of Aerodynamics*", 5th edition, McGraw-Hill International Edition, New York **(**2011), ISBN-13: 978-0073398105.
2. E. L. Houghton, P.W. Carpenter, "Aerodynamics for Engineering Students", 5th edition, Elsevier, New York. (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*", Imported Edition, Dover Publications, USA (2011), ISBN 9780486619804.

Aircraft Propulsion

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

SEMESTER – IV

Subject Code	**15AE43**	IA Marks	20

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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 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 **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.	**10 Hours**	**L1, L2**
Module -2 **Propeller Theories & Jet propulsion** Types of propeller, Propeller thrust: momentum theory, Blade element theories, propeller blade design, propeller selection. **Jet Propulsion:** Illustration of working of gas turbine engine – The thrust equation – Factors affecting thrust – Effect of pressure, velocity and temperature changes of air entering compressor – Methods of thrust augmentation – Characteristics of turboprop, turbofan and turbojet – Performance characteristics.	**10 Hours**	**L1, L2, L3, L4**
Module -3 **Inlets & Nozzles**	**10 Hours**	**L1, L2**

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. **Supersonic inlets:** Supersonic inlets, starting problem in supersonic inlets, Shock swallowing by area variation, External deceleration. Modes of inlet operation. **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.		
Module -4 **Gas Turbine Engine Compressors** **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. **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.	**10 Hours**	**L1, L2, L3, L4**
Module -5 **Combustion chambers and Turbines** 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 **Axial Flow Turbines:** Introduction, Turbine stage, Multi-staging of turbine, Exit flow conditions, Turbine cooling, Heat transfer in turbine cooling.	**10 Hours**	**L1, L2, L3, L4**

Radial turbine: Introduction, Thermodynamics of radial turbines, Losses and efficiency		

Course outcomes:

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 PublishingCo.Ltd. Print 2003, ISBN-13: 978-0028018287
4. S. M. Yahya(2010), "*Fundamentals of Compressible Flow with Aircraft and Rocket propulsion*", 4th Edition, New Age International Publications, New Delhi 2014, ISBN 13: 9788122426687.

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

Mechanisms and Machine Theory

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

SEMESTER – IV

Subject Code	**15AE44**	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 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 **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 Ratchet and Pawl mechanism, Ackerman steering gear mechanism.	**10 Hours**	**L1, L2**

Module -2 **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. **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 **Spur Gears and Gear Trains** **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. **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 **Balancing of Rotating and Reciprocating Masses** **Balancing of Rotating Masses:** Balancing of Several Masses Rotating in the Same Plane, Balancing of Several Masses Rotating in Different Planes (only Graphical Methods). **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	**10 Hours**	**L1, L2, L3, L4**

Multi-cylinder In-line Engines, Balancing of Radial Engines (only Graphical Methods)		
Module -5 **Governors and Gyroscope** **Governors:** Types of governors; force analysis of Porter and Hartnell governors, Controlling force, stability, sensitiveness, isochronism, effort and power of Porter and Hartnell governors. **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, and 3rd edition -2009, ISBN: 007014477X, 9780070144774.
2. **J.J. Uicker, G.R. Pennock, J.E. Shigley.** "*Theory of Machines & Mechanisms*", OXFORD 3rd Ed. 2009, ISBN-13: 978-0195371239

Reference Books:

1. **R. S. Khurmi, J.K. Gupta,** "*Theory of Machines*", Eurasia Publishing House, 2008, ISBN 13: 9788121925242.
2. **Robert L Norton,** "*Design of Machinery*" by McGraw Hill, 2001, **ISBN-13:** 978-0077421717.
3. Ambekar, "*Mechanism and Machine theory*", PHI Learning Pvt. Ltd., 2007, ISBN 13: 9788120331341

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

Aircraft Material Science

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

SEMESTER – IV

Subject Code	**15AE45**	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. Acquire knowledge on aircraft materials- metallic and non-metallic
2. Understand the properties of super alloys, ablative materials and high energy material.
3. Study material corrosion and prevention

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module -1 **Introduction to Aircraft Materials** General properties of materials, Definition of terms, Requirements of aircraft materials, Testing of aircraft materials, Inspection methods, Application and trends in usage in aircraft structures and engines, Selection of materials for use in aircraft. **Aircraft Metal Alloys** Aluminum alloys, Magnesium alloys, Titanium alloys, Plain carbon and Low carbon Steels, Corrosion and Heat resistant steels, Maraging steels, Copper alloys, Producibility and Surface treatments aspects for each of the above;	**10 Hours**	**L1, L2**
Module -2	**10 Hours**	**L1, L2**

Super Alloys General introduction to super alloys, Nickel based super alloys, Cobalt based super alloys, and Iron based super alloys, manufacturing processes associated with super alloys, Heat treatment and surface treatment of super alloys. **Composite Materials:** Definition and comparison of composites with conventional monolithic materials, Reinforcing fibers and Matrix materials, Fabrication of composites and quality control aspects, Carbon-Carbon Composites production, properties and applications, inter metallic matrix composites, ablative composites based on polymers, ceramic matrix, metal matrix composites based on aluminum, magnesium, titanium and nickel based composites for engines.		
Module -3 **Polymers, Polymeric Materials & Plastics and Ceramics & Glass** Knowledge and identification of physical characteristics of commonly used polymeric material: plastics and its categories, properties and applications; commonly used ceramic, glass and transparent plastics, properties and applications, adhesives and sealants and their applications in aircraft.	**10 Hours**	**L1, L2**
Module -4 **Ablative Materials** Ablation process, ablative materials and applications in aerospace. **Aircraft Wood, Rubber, Fabrics & Dope And Paint:** Classification and properties of wood, Seasoning of wood, Aircraft woods, their properties and applications, Joining processes for wood, Plywood; Characteristics and definition of terminologies pertaining to aircraft fabrics and their applications, Purpose of doping and commonly used dopes; Purpose of painting, Types of aircraft paints, Aircraft painting process.	**10 Hours**	**L1, L2**
Module -5 **Corrosion and its Prevention**	**10 Hours**	**L1, L2**

Knowledge of the various methods used for removal of corrosion from common aircraft metals and methods employed to prevent corrosion. **High Energy Materials:** Materials for rockets and missiles. Types of propellants and its general and desirable properties, insulating materials for cryogenic engines. Types of solid propellants: Mechanical characterization of solid propellants using uni-axial, strip-biaxial and tubular tests.		

Course outcomes:

After studying this course, students will be able to:

1. Identify appropriate aircraft materials for a given application.
2. Explain the properties of super alloys, ablative materials and high energy material.
3. Understand material corrosion process and apply prevention technique.

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. **Titterton G F** , "*Aircraft Material and Processes*", English Book Store, New Delhi, 1998, ISBN 13: 9788175980136

2. **H Buhl**, "*Advanced Aerospace Material*", Spring Berlin 1992, ISBN: 978-3-642-50161-6

Reference Books:

1. **C G Krishnadas Nair,** "*Handbook of Aircraft materials*", Interline publishers, Bangalore, 1993, ISBN 13: 9788172960032.
2. **Balram Gupta, S**, "*Aerospace material"* Vol. 1,2,3 ARDB, Chand & Co 1996, ISBN: 9788121922005
3. **Parker E R**, "*Materials for Missiles and Space*", John Wiley, McGraw-Hill, 1963,
4. 4.**Hill E T**, The "*Materials of Aircraft Construction*", Pitman London.

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

Turbomachines

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

SEMESTER – IV

Subject Code	**15AE46**	IA Marks	20
Number of Lecture Hours/Week	03	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 basics of turbomachines, the energy transfer and energy transformation in them.
2. Acquire the knowledge on design of centrifugal and axial turbomachines
3. Study hydraulic pumps and turbines.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module -1 **Introduction to turbomachines:** Classification and parts of a turbo machines; comparison with positive displacement machines; dimensionless parameters and their physical significance; specific speed; illustrative examples on dimensional analysis and model studies. **Energy transfer in turbomachines:** Basic Euler turbine equation and its alternate form; components of energy transfer; general expression for degree of reaction; construction of velocity triangles for different values of degree of reaction. .	**10 Hours**	**L1, L2**
Module -2 **Compression process:** Overall isentropic efficiency of compression; stage efficiency; comparison and relation between overall efficiency and stage efficiency;	**10 Hours**	**L1, L2, L3, L4**

polytropic efficiency; pre heat factor. **Expansion process :** Overall isentropic efficiency for a turbine; stage efficiency for a turbine; comparison and relation between stage efficiency and overall efficiency, polytropic efficiency; reheat factor for expansion process.		
Module -3 **Design and performance analysis of Centrifugal compressors:** Types, design parameters, flow analysis in impeller blades, volutes and diffusers, losses, slip factor, characteristic curves, surging, choking. Construction details. **Design and performance analysis of axial fans and compressors:** Stage velocity diagrams, enthalpy-entropy diagrams, stage losses and efficiency, work done, simple stage design problems, performance characteristics, instability in axial compressors. Construction details.	**10 Hours**	**L1, L2, L3, L4**
Module -4 **Design and performance analysis of axial flow turbines:** Turbine stage, work done, degree of reaction, losses and efficiency, flow passage; subsonic, transonic and supersonic turbines, multi-staging of turbine; exit flow conditions; turbine cooling **Design and performance analysis of radial turbines:** Thermodynamics and aerodynamics of radial turbines; radial turbine characteristics; losses and efficiency; design of radial turbine.	**10 Hours**	**L1, L2, L3, L4**
Module -5 **Hydraulic pumps:** Centrifugal and axial pumps. Manometric head, suction head, delivery head; manometric efficiency, hydraulic efficiency, volumetric efficiency, overall efficiency; multi stage pumps. Characteristics of pumps. **Hydraulic turbines:** Classification; Module quantities; Pelton wheel, Francis turbine, Kaplan turbine and their velocity triangles. Draft tubes and their function.	**10 Hours**	**L1, L2, L3, L4, L5**

Characteristics of hydraulic turbines.		

Course outcomes:

After studying this course, students will be able to:

1. Compute the energy transfer and energy transformation in turbomachines.
2. Analyse the design of turbomachine blades.
3. Apply hydraulic pumps and turbines for specific requirements

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. S.M. Yahya, *"Turbines, Compressors & Fans"*, Tata-McGraw Hill Co., 2nd Edition (2002), ISBN 13: 9780070707023.
2. D.G. Shephered, *"Principles of Turbo Machinery"*, The Macmillan Company (1964), ISBN-13: 978-0024096609.

Reference Books:

1. V.Kadambi and Manohar Prasad, *"An introduction to Energy conversion, Volume III, Turbo machinery ",* Wiley Eastern Ltd. (1977), ISBN: 9780852264539.

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

MATERIAL TESTING LAB

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

SEMESTER – IV

Subject Code	**15AEL47A**	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	42	Exam Marks	80

CREDITS – 04

Course objectives: This course will enable students to

1. Understand the relations among materials and their properties.
2. Understand the formation, properties and significance of the alloys through different experiments.
3. Understand the types, advantages and applications of various NDT methods.

MODULES	**Revised Bloom's Taxonomy (RBT) Level**
PART-A: MATERIAL TESTING	
1. Hardness Testing – Vicker's, Brinell, Rockwel	**L1, L2, L3**
2. Tensile Test	**L1, L2, L3, L4, L5**
3. Flexural Test	**L1, L2, L3, L4, L5**
4. Tensional Test	**L1, L2, L3**
5. Impact Test	**L1, L2, L3**
6. Shear Test	**L1, L2, L3**
7. Fatigue Test	**L1, L2, L3, L4, L5**
PART-B: METALLOGRAPHY	
8. Preparation of specimen for metallographic examination of different engineering materials. Identification of microstructures of plain carbon steel, tool steel, gray C.I, SG iron, Brass, Bronze & metal matrix composites	**L1, L2, L3**
9. Heat treatment: Annealing, normalizing, hardening and tempering of steel. Hardness studies of heat-treated samples.	**L1, L2, L3**
10. To study the wear characteristics of ferrous, non-ferrous and composite materials for different parameters.	**L1, L2, L3**

11. Visual Testing Technique, Dye penetration testing. To study the defects of Cast and Welded specimens.	**L1, L2, L3**
12. Magnetic Particle Inspection.	**L1, L2, L3**
13. Ultrasonic Inspection.	**L1, L2, L3**
14. Eddy Current Inspection	**L1, L2, L3**

Course outcomes:

After studying this course, students will be able to:

1. Apply the relations among materials and their properties.
2. Differentiate the formation, properties and significance of the alloys through different experiments.
3. Understand the different types, advantages and applications of various NDT methods

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.

Scheme of Examination:

One question from PART A:	**1 x 30 =**	**30 Marks**
One question from PART B:	**1 x 40 =**	**40 Marks**
Viva-Voce :		**10 Marks**
	Total	**= 80 Marks**

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 2015-2016

MEASUREMENTS AND METROLOGY LAB

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

SEMESTER – IV

Subject Code	**15AEL47B**	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	42	Exam Marks	80

CREDITS – 04

Course objectives: This course will enable students to

1. Learn the concepts of mechanical measurements and metrology
2. Use the concept of accuracy, error and calibration
3. Use the basic metrological instruments

Modules	Revised Bloom's Taxonomy (RBT) Level
PART-A: MEASUREMENTS	
1. Calibration of Pressure Gauge	**L1, L2, L3, L4**
2. Calibration of Thermocouple	**L1, L2, L3, L4**
3. Calibration of LVDT	**L1, L2, L3, L4**
4. Calibration of Load cell	**L1, L2, L3, L4**
5. Determination of modulus of elasticity of a mild steel specimen using strain gauges.	**L1, L2, L3, L4, L5**
PART-B: METROLOGY	
6. Comparison and measurements using vernier caliper and micrometer	**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. Identify and classify different measuring tools related to experiments.
2. Identify, define, and explain accuracy, resolution, precision, and some additional terminology.
3. Conduct, Analyze, interpret, and present measurement data from measurements experiments.

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.

Scheme of Examination:

One question from PART A:	**1 x 30 =**	**30 Marks**
One question from PART B:	**1 x 40 =**	**40 Marks**
Viva-Voce :		**10 Marks**
	Total	**= 80 Marks**

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 2015-2016

COMPUTER AIDED AIRCRAFT DRAWING

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

SEMESTER – IV

Subject Code	**15AEL48**	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	42	Exam Marks	80

CREDITS – 04

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**
PART A	
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**
PART B	
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:	**L1, L2, L3**

Split Muff coupling, protected type flanged coupling, pin (bush) type flexible coupling, Oldham's coupling and universal coupling (Hooks' Joint)	
PART C	
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:

Internal Assessment: 20 Marks

Sketches shall be in sketch books and drawing shall be drawn through the use of software on A3/A4 sheets. Sketch book and all the drawing printouts shall be submitted.

Scheme of Evaluation for Internal Assessment (20 Marks)

(a) Class work (Sketching and Computer Aided Aircraft Drawing printouts in A4/A3 size sheets): 10Marks.

(b) Internal Assessment test in the same pattern as that of the main examination (Better of the two Tests): 10 marks.

Scheme of Examination:

Two questions are to be set from each Part-A, Part-B and Part-C.

Student has to answer one question each from Part A and Part B for 15 marks each and one question from Part C for 50 marks.

i.e. **Part A 1 x 15 = 15 Marks**

Part B 1 x 15 = 15 Marks

Part C 1 x 50 = 50 Marks

Total = 80 Marks

INSTRUCTION FOR COMPUTER AIDED AIRCRAFT DRAWING (**15AEL48**) EXAMINATION

1. There is no restriction of timing for sketching/ computerization of solutions. The total duration is 3 hours.

2. It is desirable to do sketching of all the solutions before computerization.

3. Drawing instruments may be used for sketching.
4. For Part A and Part B 2D drafting environment should be used.
5. For Part C 3D part environment should be used for parts assembly drawing and extract 2D views.

Graduate Attributes (as per NBA):

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