Visvesvaraya Technological University

"Jnana Sangama", Belagavi - 590 018 Karnataka State

Dr. H.N. Jagannatha Reddy B.E., M.E., Ph.D.
Registrar

Phone: (0831)2498100
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Ref: VTU/Aca/A-9/2018-19/ 4285 Date: 23 AUG 2018

CIRCULAR

Sub: Approved Scheme and Syllabus of Aerospace Engineering (2015-2016 Scheme) W.E.F. 2018-19– reg

Ref: 140th E.C Resolution No. 2.2.3.dated 30-6-2018 and 13-7-2018

Adverting to the above subject, it is hereby informed that, the Scheme and Syllabus of Aerospace Engineering is been approved as per reference. The approved 1st to 8th semester Scheme and 3rd to 4th semester syllabus is placed on the University Website (www.vtu.ac.in)

This may kindly be brought to the notice of all the concerned.

By Order,
Sd/-
REGISTRAR

To,
The Principals of Affiliated Engineering Colleges.
Copy FWCs to:

1. The Secretary to VC, VTU Belagavi, for information.
2. The Registrar (Evaluation), VTU Belagavi, for information
3. The Chairmen BOS of all Boards of VTU.
4. The In-charge Regional Directors,(Bangalore,Belagavi Mysore Kalburgi for circulate the notification
5. CNC to Upload on VTU website

23.08.18
REGISTRAR

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

I SEMESTER B.E./B.TECH.

PHYSICS GROUP

Sl. No.	Subject Code	Subject		Teaching Department	Board	Theory /Lab/ Drawing (Hrs/ Week)	Examination Marks			Credits
							Th./Pr.	I.A.	Total	
1	15MAT11	Engineering Maths-I	BS	Maths	Basic Sc.	4 (T)	80	20	100	4
2	15PHY12	Engineering Physics	BS	Physics	Basic Sc.	**4 (T)**	80	20	100	**4**
3	15CIV13	Elements of Civil Engg. & Engineering Mechanics	ES	Civil Engg.	Civil Engg.	4 (T)	80	20	100	4
4	15EME14	Elements of Mechanical Engg.	ES	Mech. Engg.	Mech. Engg.	4 (T)	80	20	100	4
5	15ELE15	Basic Electrical Engg.	ES	E & E	E & E	4 (T)	80	20	100	4
6	15WSL16	Workshop Practice	ES	Mech., Auto, IP, IEM, Mfg. Engg.	Mech. Engg.	**3(2 hrs lab+ 1 hr instruction)**	80	20	100	2
7	15PHYL17	Engg. Physics Lab	BS	Physics	Basic Sc.	**3(2 hrs lab+ 1 hr instruction)**	80	20	100	2
8	15CIP18	***Constitution of India & Professional Ethics and Human Rights (CPH)**	HS	Humanities		2 (Tutorial)	80	20	100	1
9		Language (Kan.)	Mandatory learning	Humanities		1 (T)	-	-	-	--
						29	640	160	800	25

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

IISEMESTER B.E./B.TECH.

PHYSICS GROUP

Sl. No.	Subject Code	Subject		Teaching Department	Board	Theory /Lab/ Drawing (Hrs/ Week)	Examination Marks			Credits
							Th./Pr.	I.A.	Total	
1	15MAT21	Engineering Maths-I	BS	Maths	Basic Sc.	4 (T)	80	20	100	4
2	15PHY22	Engineering Physics	BS	Physics	Basic Sc.	**4 (T)**	80	20	100	**4**
3	15CIV23	Elements of Civil Engg. & Engineering Mechanics	ES	Civil Engg.	Civil Engg.	4 (T)	80	20	100	4
4	15EME24	Elements of Mechanical Engg.	ES	Mech. Engg.	Mech. Engg.	4 (T)	80	20	100	4
5	15ELE25	Basic Electrical Engg.	ES	E & E	E & E	4 (T)	80	20	100	4
6	15WSL26	Workshop Practice	ES	Mech., Auto, IP, IEM, Mfg. Engg.	Mech. Engg.	**3(2 hrs lab+ 1 hr instruction)**	80	20	100	2
7	15PHYL27	Engg. Physics Lab	BS	Physics	Basic Sc.	**3(2 hrs lab+ 1 hr instruction)**	80	20	100	2
8	15CIP28	***Constitution of India & Professional Ethics and Human Rights**	HS	Humanities		2 (Tutorial)	80	20	100	1
9		Language (Kan.)	MNC	Humanities		1 (T)	-	-	-	--
						29	640	160	800	25

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

I SEMESTER B.E./B.TECH.

CHEMISTRY GROUP

Sl. No.	Subject Code	Subject		Teaching Department	Board	Theory /Lab/ Drawing (Hrs/ Week)	Examination Marks			Credits
							Th./Pr.	I.A.	Total	
1	15MAT11	Engineering Maths-I	BS	Maths	Basic Sc.	4 (T)	80	20	100	4
2	15CHE12	Engineering Chemistry	BS	Chemistry	Basic Sc.	**4 (T)**	80	20	100	**4**
3	15PCD13	Programming in C & Data Structures	ES	Any Engineering Department	CSE	4 (T)	80	20	100	4
4	15CED14	Computer Aided Engineering Drawing	ES	Mech./IP/Auto/ Mfg.Engg./ IEM	Mech. Engg.	**6 (2I+ 4P)**	80	20	100	4
5	15ELN15	Basic Electronics	ES	E & C / E & E / TC / IT	E & C	4 (T)	80	20	100	4
6	15CPL16	Computer Programming Lab	ES	Any Engineering Department	CSE	**3(2 hrs lab+ 1 hr Tutorial)**	80	20	100	2
7	15CHEL17	Engg. Chemistry Lab	BS	Chemistry	Basic Sci.	**3(2 hrs lab+ 1 hr Tutorial)**	80	20	100	2
8	15CIV18	*Environmental Studies	HS	Civil / Environmental	Civil	2 (Tutorial)	80	20	100	1
9		Language (Eng.)	MNC	Humanities		1 (T)	-	-	-	--
					Total	31	640	160	800	25

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

II SEMESTER B.E./B.TECH.

CHEMISTRY GROUP

Sl. No.	Subject Code	Subject		Teaching Department	Board	Theory /Lab/ Drawing (Hrs/ Week)	Examination Marks			Credits
							Th./Pr.	I.A.	Total	
1	15MAT21	Engineering Maths-I	BS	Maths	Basic Sc.	4 (T)	80	20	100	4
2	15CHE22	Engineering Chemistry	BS	Chemistry	Basic Sc.	**4 (T)**	80	20	100	**4**
3	15PCD23	Programming in C & Data Structures	ES	Any Engineering Department	CSE	4 (T)	80	20	100	4
4	15CED24	Computer Aided Engineering Drawing	ES	Mech./IP/Auto/ Mfg.Engg./ IEM	Mech. Engg.	**6 (2I+ 4P)**	80	20	100	4
5	15ELN25	Basic Electronics	ES	E & C / E & E / TC / IT	E & C	4 (T)	80	20	100	4
6	15CPL26	Computer Programming Lab	ES	Any Engineering Department	CSE	**3(2 hrs lab+ 1 hr Tutorial)**	80	20	100	2
7	15CHEL27	Engg. Chemistry Lab	BS	Chemistry	Basic Sc.	**3(2 hrs lab+ 1 hr Tutorial)**	80	20	100	2
8	15CIV28	Environmental Studies	HS	Civil / Environmental	Civil	2 (Tutorial)	80	20	100	1
9		Language (Eng.)	MNC	Humanities		1 (T)	-	-	-	--
					Total	31	640	160	800	25

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

III SEMESTER

Sl. No	Subject Code	Title	Teaching Dept.	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Drawing	Duration	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15MAT31	ENGINEERING MATHEMATICS-III	Mathematics	04		03	80	20	100	4
2	15AS32	INTRODUCTION TO AEROSPACE ENGINEERING	AS	04		03	80	20	100	4
3	15AS33/15 AE33	AERO-THERMODYNAMICS	AS	04		03	80	20	100	4
4	15AS34/15 AE34	MECHANICS OF MATERIALS	AS	04		03	80	20	100	4
5	15AS35/15 AE35	MECHANICS OF FLUIDS	AS	04		03	80	20	100	4
6	15AS36	AEROSPACE MATERIALS	AS	04		03	80	20	100	3
7	15ASL37	MATERIAL TESTING & METROLOGY LAB	AS		1I+2P	03	80	20	100	2
8	15ASL38	FLUID MECHANICS LAB	AS		1I+2P	03	80	20	100	2
9	15KL/CPH 39/49	Kannada / Constitution of India , Professional Ethics and Human Rights		02		02	40	10	50	1
TOTAL				**26**	**6**	**26**	**680**	**170**	**850**	**28**

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

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

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

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

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

B.E. AEROSPACE ENGINEERING

IV SEMESTER

Sl. No	Subject Code	Title	Teaching Dept.	Teaching Hours /Week		Examination				Credits
				Theory	Practical / Drawing	Duration	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15MAT 41	ENGINEERING MATHAMATICS - IV	Mathematics	04		03	80	20	100	4
2	15AS42/15AE42	AERODYNAMICS - I	AS	04		03	80	20	100	4
3	15AS43	AEROSPACE STRUCTURES-I	AS	04		03	80	20	100	4
4	15AS44/15AE44	MECHANISMS AND MACHINE THEORY	AS	04		03	80	20	100	4
5	15AS 45	HEAT & MASS TRANSFER	AS	04		03	80	20	100	4
6	15AS46	COMPOSITE MATERIALS	AS	04		03	80	20	100	3
7	15ASL47	MANUFACTURING TECHNOLOGY LAB	AS		1I+2P	03	80	20	100	2
8	15ASL48	COMPUTER AIDED AIRCRAFT DRAWING LAB	AS		1I+2P	03	80	20	100	2
9	15KL/CPH39/49	Kannada/Constitution of India , Professional Ethics and Human Rights		02		02	40	10	50	1
TOTAL				**26**	**06**	**26**	**680**	**170**	**850**	**28**

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

V SEMESTER

Sl. No	Subject Code	Title	Teaching Dept.	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Drawing	Duration	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15AS51	AEROSPACE STRUCTURES –II	AS	04		03	80	20	100	4
2	15AS52	AEROSPACE PROPULSION	AS	04		03	80	20	100	4
3	15AS53	AERODYNAMICS - II	AS	04		03	80	20	100	4
4	15AS54X	**FOUNDATION ELECTIVE**	AS	03		03	80	20	100	3
5	15AS55X	**ELECTIVE**	AS	03		03	80	20	100	3
6	15ASL56	HEAT & MASS TRANSFER LAB	AS		1I+2P	03	80	20	100	2
7	15ASL57	AERODYNAMICS LAB	AS		1I+2P	03	80	20	100	2
8	15ASL58	PROPULSION LAB	AS		1I+2P	03	80	20	100	2
TOTAL				**18**	**09**	**24**	**640**	**160**	**800**	**24**

Foundation Elective		**Elective**	
15AS541	THEORY OF VIBRATIONS	15AS551	GAS TURBINE TECHNOLOGY
15AS542	FLIGHT MECHANICS	15AS552/ 15AE552	MECHATRONICS
15AS543	INTRODUCTION TO SPACE TECHNOLOGY	15AS553	INTRODUCTION TO ASTROPHYSICS AND SPACE ENVIRONMENT
15AS544/15AE544	AIRCRAFT ELECTRICAL SYSTEMS & INSTRUMENTATION	15AS554	EXPERIMENTAL STRESS ANALYSIS

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

VI SEMESTER

Sl. No	Subject Code	Title	Teaching Dept.	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Drawing	Dura-tion	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	15AS61	FINITE ELEMENT METHOD	AS	04		03	20	80	100	4
2	15AS62	SPACE MECHANICS	AS	04		03	20	80	100	4
3	15AS63	CONTROL ENGINEERING	AS	04		03	20	80	100	4
4	15AS64X	FOUNDATION ELECTIVE	AS	03		03	20	80	100	3
5	15AS65X	ELECTIVE	AS	03		03	20	80	100	3
6	15ASL66	DESIGN, MODELLING & ANALYSIS LAB	AS		1I+2P	03	20	80	100	2
7	15ASL67	STRUCTURES & VIBRATION LAB	AS		1I+2P	03	20	80	100	2
8	15ASL68	ENERGY CONVERSION LAB	AS		1I+2P	03	20	80	100	2
TOTAL				**18**	**9**	**24**	**160**	**640**	**800**	**24**

Foundation Elective		**Elective**	
15AS641	HYDRAULICS & PNEUMATICS	15AS651	SATELLITE COMMUNICATION
15AS642/15AE642	DIGITAL ELECTRONICS SYSTEMS	15AS652	EXPERIMENTAL AERODYNAMICS
15AS643	HIGH PERFORMANCE COMPUTING	15AS653	HYPERSONICS
15AS644	NETWORK ANALYSIS AND CONTROLS	15AS654/15AE654	MISSILES AND LAUNCH VEHICLES

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

VII SEMESTER

Sl. No	Subject Code	Title	Teaching Dept.	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Drawing	Duration	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	15AS71	AVIONICS SYSTEMS	AS	04		03	20	80	100	4
2	15AS72/15AE72	COMPUTATIONAL FLUID DYNAMICS	AS	04		03	20	80	100	4
3	15AS73/	SPACE VEHICLE DESIGN	AS	04		03	20	80	100	4
4	15AS74X	FOUNDATION ELECTIVE	AS	03		03	20	80	100	3
5	15AS75X	ELECTIVE	AS	03		03	20	80	100	3
6	15ASL76	AEROSPACE SYSTEMS LAB	AS		1I+2P	03	20	80	100	2
7	15ASL77	COMPUTATIONAL FLUID DYNAMICS LAB	AS		1I+2P	03	20	80	100	2
8	15ASL78	SPACE SIMULATION LAB	AS		1I+2P	03	20	80	100	2
TOTAL				**18**	**9**	**24**	**160**	**640**	**800**	**24**

Foundation Elective		**Elective**	
15AS741/15AE741	FATIGUE AND FRACTURE MECHANICS	15AS751	WIND TUNNEL TECHNIQUES
15AS742	TOTAL QUALITY MANAGEMENT	15AS752	ADVANCED MANUFACTURING TECH.
15AS743	THEORY OF ELASTICITY & PLASTICITY	15AS753/ 15AE753	SMART MATERIALS & CONTROLS
15AS744/15AE744	AERO-ELASTICITY	15AS754/ 15AE754	GUIDANCE, NAVIGATION & CONTROL

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

VIII SEMESTER

Sl. No	Subject Code	Title	Teaching Dept.	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Drawing	Duration	I.A. Marks	Theory/ Practical Marks	Total Marks	
1	15AS81	SATELLITE DESIGN	AS	4	-	3	20	80	100	4
2	15AS82X	Elective-I	AS	3	-	3	20	80	100	3
3	15AS83X	Elective-II	AS	3	-	3	20	80	100	3
4	15AS84	Internship	AS	Industry Oriented		3	100	--	100	3
5	15ASP85	Project Work	AS	-	6	3	50	50	100	10
6	15ASS86	Seminar	AS	-	3	-	100	-	100	1
TOTAL				**10**	**09**	**15**	**310**	**290**	**600**	**24**

Elective-I		**Elective-II**	
15AS821	ARTIFICIAL INTELLIGENCE	15AS831	QUALITY ASSURANCE
15AS822	CRYOGENICS	15AS832/15AE832	OPTIMIZATION TECHNIQUES
15AS823	ROBOTICS	15AS833/15AE833	OPERATIONS RESEARCH
15AS824	SPACE CRAFT SYSTEMS	15AS834	MISSILE DESIGN

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

Curriculum and Syllabus (1^{st} to 4^{th} Semester) for the Proposed UG Program in Aerospace Engineering.

Submitted To

VTU-Belgaum

For Granting Approval

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

AEROSPACE ENGINEERING

(3rd to 8th Semester as per VTU Format)

Draft Curriculum & Syllabus Enclosed

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

First Year Curriculum and Syllabus Common to All Engineering Branches

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

Curriculum and Syllabus for 3rd Semester, Aerospace Engineering

B.E. AEROSPACE ENGINEERING

III SEMESTER

Sl.	Subject	Title	Teaching	Teaching Hours /Week	Examination	Credits

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

No	Code		Dept.	Theory	Practical/ Drawing	Duration	Theory / Practical Marks	I.A. Marks	Total Marks	
1	15MAT31	ENGINEERING MATHEMATICS-III	Mathematics	04		03	80	20	100	4
2	15AS32	INTRODUCTION TO AEROSPACE ENGINEERING	AS	04		03	80	20	100	4
3	15AS33/ 15AE33	AERO-THERMODYNAMICS	AS	04		03	80	20	100	4
4	15AS34/ 15AE34	MECHANICS OF MATERIALS	AS	04		03	80	20	100	4
5	15AS35/ 15AE35	MECHANICS OF FLUIDS	AS	04		03	80	20	100	4
6	15AS36	AEROSPACE MATERIALS	AS	04		03	80	20	100	3
7	15ASL37	MATERIAL TESTING & METROLOGY LAB	AS		1I+2P	03	80	20	100	2
8	15ASL38	FLUID MECHANICS LAB	AS		1I+2P	03	80	20	100	2
9	15KL/ CPH39/49	Kannada / Constitution of India , Professional Ethics and Human Rights		02		02	40	10	50	1
TOTAL				**26**	**6**	**26**	**680**	**170**	**850**	**28**

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

Engineering Mathematics - III

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

SEMESTER – III

Subject Code	**15MAT31**	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. The student should be able to analyze periodic phenomena using concept of Fourier series.
2. Understand the basics of matrix theory and its applications for finding solution of system of linear equations.
3. Finding the approximate solutions using numerical methods, for problems, which do not have analytical solutions.
4. Approximating functional values with different curves.
5. Optimizing real functional with various applications

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module -1 **Fourier Series and Fourier Transforms:** Introduction, periodic functions, Even and odd functions, properties. Special waveforms - Square wave, half wave rectifier, saw-tooth wave and triangular wave. Euler's formula for Fourier series, Fourier series for functions of period 2L (particular cases), Dirichlet's conditions - problems. Half Range Fourier series- Construction of Half range cosine and sine series, Complex form of Fourier series. Complex Fourier Transforms – Properties & simple problems.	**10 Hours**	**L1, L2**
Module -2 **Matrices and Linear Equations:** Elementary transformation, rank of matrix by using Echelon form, consistency of system of linear equations and solutions, solution of system of linear equations using Gauss elimination method, Gauss Jordan method, Gauss Seidel method, Eigenvalues and Eigenvectors, finding largest eigenvalue by using Power method.	**10 Hours**	**L1, L2**
Module -3 **Curve Fitting and Interpolation:** Method of Least squares - fitting of the curves of the form $y = ax + b$, $y = ae^{bx}$, $y = ax^b$ and $y = ax^2 + bx + c$, Correlation and Regression analysis. Finite differences-forward and backward differences, Interpolation-Newton's forward and backward interpolation formulae, Lagrange's interpolation formula.	**10 Hours**	**L1, L2, L3**
Module -4 **Numerical Methods:** Numerical integration– Simpson's rules, Weddle's rule and Gaussian quadrature (two point & three point formula). Numerical methods for first order ODE – Single step & Multistep methods-Taylor's series method, Runge-Kutta fourth order method, Adam-Bash forth's method, BVP for ODE – Shooting methods for second order ODE (All methods without proof).	**10 Hours**	**L1, L2**

Module -5 **Calculus of Variation:** Introduction, Variation of functions and functional, extremal of a functional, variational problem, Euler's equation and special cases. Examples - Geodesics, Hanging cable, and Brachistochrome problem.	**10 Hours**	**L1, L2**

Course outcomes:

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

1. Apply knowledge of linear algebra for finding the solution of system of linear equations.
2. Analyze and interpret physical phenomena, which are periodic in nature by applying Fourier series.
3. Solve Algebraic and transcendental equations using effective numerical methods.

Graduate Attributes (as per NBA):

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

Question paper pattern:

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

Text Books:

1. B.S. Grewal - Higher Engineering Mathematics, Khanna Publishers, 40th Edition, 2007, ISBN: 81-7409-195-5, Chapters 2, 10, 24, 28, 29, 31, 34.
2. N.P Bali & Manish Goyal - A Text Book of Engineering Mathematics, Lakshmi Publications, 7th Edition, 2010, ISBN: 978-81-7008-992-6, Chapters: 3(3.34-3.40,3.46, 3.47), 10 (10.1-10.7-10.10), 2 (2.24 -2.26).

Reference Books:

1. Erwin Kreyszig - Advanced Engineering Mathematics, John Wiley & Sons, 9th Edition, 2007, ISBN: 978-81-265-3135-6, Chapters: 6, 7.1, 7.2, 10 (10.1-10.5, 10.9-10.11), 17, 18, 19.
2. Murray R Spiegel -Fourier Analysis with Applications to Boundary Value problems, Schaum's Outline Series,McGraw Hill Professional,ISBN : 0070602190, 9780070602199.

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

INTRODUCTION TO AEROSPACE ENGINEERING

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

SEMESTER – III

Subject Code	**15AS32**	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 basic principles of aviation and the history of space vehicles.
2. Acquire the basic knowledge of aircraft structures, aerodynamics, propulsion, materials and aircraft systems & instrumentation.
3. Understand the basics of space propulsion, spacecrafts and their orbits.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module -1 **Introduction to Aircrafts:** History of aviation, International Standard atmosphere, Atmosphere and its properties, Temperature, pressure and altitude relationships, Classification of aircrafts, V/STOL machines, Modern developments in Aviation like UAV. **Introduction to Space Flight:** History of Space Flight & spacecraft technologies Difference between space and atmosphere, upper atmosphere, Introduction to basic orbital mechanics, types of Orbits (LEO, MEO, Geosynchronous and Geostationary, Polar orbits), Kepler's Laws of planetary motion.	**10 Hours**	**L1, L2**
Module -2 **Basic principles of flight :** Significance of speed of sound, Propagation of sound, Mach number, subsonic, transonic, supersonic, hypersonic flows, Bernoulli's theorem, Aerodynamic forces and moments on an Airfoil, Lift and drag components, lift curve, drag curve, types of drag, factors affecting lift and drag; Centre of pressure and its significance, Aerodynamic centre, Aspect ratio, Airfoil nomenclature, Basic characteristics of airfoils, NACA nomenclature, Simple problems on lift and drag.	**10 Hours**	**L1, L2**
Module -3 **Aircraft Propulsion :** Introduction, Classification, Piston Engine & its application, Brayton cycle, Principle of operation of Turboprop, turbojet and turbofan engines, Introduction to ramjets and scramjets; performance characteristics, **Rocket Propulsion :** Principles of operation of rocket, Classification of Rockets, Types of rockets and typical applications, Introduction to Space Exploration.	**10 Hours**	**L1, L2**
Module -4 **Aircraft Structures and Materials :** Introduction, General types of construction, Monocoque, Semi-Monocoque and Geodesic structures, Typical wing and fuselage structure; Metallic and non-metallic materials for aircraft application. Use of aluminum alloy, titanium,	**10 Hours**	**L1, L2**

stainless steel and composite materials.		
Module -5 **Aircraft Instruments :** Instrument Displays, Introduction to Navigation Instruments, Basic Air data systems & Probes, Mach meter, Air speed indicator, Vertical speed indicator, Altimeter, Gyro based instruments. **Aircraft Systems :** Introduction to Hydraulic and pneumatic systems, Air Conditioning and Cockpit pressurization system, Generation and distribution of Electricity on board the airplane, Aircraft Fuel System, Fire Protection, Ice and Rain Protection System.	**10 Hours**	**L1, L2**

Course outcomes:

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

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

Graduate Attributes (as per NBA):

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

Question paper pattern:

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

Text Books:

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

Reference Books:

1. Ian Moir, Allan Seabridge, "Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration", John Wiley & Sons, 3rd edition, 2011, ISBN: 9781119965206
2. Sutton G.P., "Rocket Propulsion Elements", John Wiley, New York, 9th edition,2016,ISBN: 9781118753910
3. A.C. Kermode, "Flight without formulae", Pearson Education India,5th edition,1989,ISBN: 9788131713891
4. Nelson R.C., "Flight stability and automatic control", McGraw-Hill,2nd edition,1998,ISBN: 9780071158381

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

AERO-THERMODYNAMICS

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

SEMESTER – III

Subject Code	**15AS33/15AE33**	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 various concepts and definitions of thermodynamics.
2. Comprehend the I law and II law of thermodynamics.
3. Acquire the knowledge of various types of gas cycles

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module -1 **Fundamental Concepts & Definitions:** Thermodynamics definition and scope, Microscopic and Macroscopic approaches. Some practical applications of engineering thermodynamic Systems, Characteristics of system boundary and control surface, examples. Thermodynamic properties; definition and Modules, intensive and extensive properties. Thermodynamic state, state point, state diagram, path and process, quasi-static process, cyclic and non-cyclic ;processes; Thermodynamic equilibrium; definition, mechanical equilibrium; diathermic wall, thermal equilibrium, chemical equilibrium. Zeroth law of thermodynamics, Temperature; concepts, scales, fixed points and measurements. **Work and Heat:** Mechanics-definition of work and its limitations. Thermodynamic definition of work; examples, sign convention. Displacement work; as a part of a system boundary, as a whole of a system boundary, expressions for displacement work in various processes through p-v diagrams. Shaft work; Electrical work. Other types of work. Heat.	**10 Hours**	**L1, L2**
Module -2 **First Law of Thermodynamics:** Joules experiments, equivalence of heat and work. Statement of the First law of thermodynamics, extension of the First law to non - cyclic processes, energy, energy as a property, modes of energy, pure substance; definition, two-property rule, Specific heat at constant volume, enthalpy, specific heat at constant pressure. Extension of the First law to control volume; steady state-steady flow energy equation, important applications, analysis of unsteady processes such as film and evacuation of vessels with and without heat transfer.	**10 Hours**	**L1, L2, L3**
Module -3	**10 Hours**	**L1, L2**

Second Law of Thermodynamics: Devices converting heat to work; (a) in a thermodynamic cycle, (b) in a mechanical cycle. Thermal reservoir. Direct heat engine; schematic representation and efficiency. Devices converting work to heat in a thermodynamic cycle; reversed heat engine, schematic representation, coefficients of performance. Kelvin - Planck statement of the Second law of Thermodynamics; PMM I and PMM II, Clausius statement of Second law of Thermodynamics, Equivalence of the two statements; Reversible and Irreversible processes; factors that make a process irreversible, reversible heat engines, Carnot cycle, Carnot principles. **Entropy:** Clasius inequality; Statement, proof, application to a reversible cycle. Entropy; definition, a property, change of entropy, principle of increase in entropy, entropy as a quantitative test for irreversibility, calculation of entropy using Tds relations, entropy as a coordinate. Available and unavailable energy.		
Module -4 **Pure Substances & Ideal Gases**: Mixture of ideal gases and real gases, ideal gas equation, compressibility factor use of charts. P-T and P-V diagrams, triple point and critical points. Sub-cooled liquid, Saturated liquid, mixture of saturated liquid and vapour, saturated vapour and superheated vapour states of pure substance with water as example. Enthalpy of change of phase (Latent heat). Dryness fraction (quality), T-S and H-S diagrams, representation of various processes on these diagrams. **Thermodynamic relations:** Maxwells equations, Tds relations, ratio of heat capacities, evaluation of thermodynamic properties from an equation of state.	**10 Hours**	**L1, L2, L3**
Module -5 **Gas Cycles:** Efficiency of air standard cycles, Carnot, Otto, Diesel cycles, P-V & T-S diagram, calculation of efficiency; Carnot vapour power cycle, simple Rankine cycle, Analysis and performance of Rankine Cycle, Ideal and practical regenerative Rankine cycles – Reheat and Regenerative Cycles, Binary vapour cycle.	**10 Hours**	**L1, L2, L3**

Course outcomes:

After studying this course, students will be able to:

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

Graduate Attributes (as per NBA):

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

Question paper pattern:

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

Text Books:

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

Reference Books:

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

MECHANICS OF MATERIALS

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

Subject Code	**15AS34/15AE34**	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 strength of materials.
2. Acquire the knowledge of stress, strain under different loadings.
3. Understand the different failure theory.

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

Module -1 **Basic equations of linear elasticity:** The concept of stress, Analysis of the state of stress at a point, Equilibrium equations, The state of plane stress, The concept of strain, Analysis of the state of strain at a point, Plane strain and plane stress in polar coordinates, Problem featuring cylindrical symmetry. **Constitutive behaviour of materials:** Constitutive laws for isotropic materials, Allowable stress, Yielding under combined loading, Material selection for structural performance, Composite materials, Constitutive laws for anisotropic materials, Strength of a transversely isotropic lamina. **Engineering structural analysis**: Solution approaches, Bar under constant axial force, Pressure vessels.	**10 Hours**	**L1, L2**
Module -2 **Euler-Bernoulli beam theory:** The Euler-Bernoulli assumptions, Implications of the Euler-Bernoulli assumptions, Stress resultants Beams subjected to axial loads, Beams subjected to transverse loads, Beams subjected to combined axial and transverse loads. **Three-dimensional beam theory:** Kinematic description, Sectional constitutive law, Sectional equilibrium equations, Governing equations, Decoupling the three-dimensional problem, The principal centroidal axes of bending. The neutral axis, Evaluation of sectional stiffness.	**10 Hours**	**L1, L2. L3**
Module -3 **Torsion:** Torsion of circular cylinders , Torsion combined with axial force and bending moments, Torsion of bars with arbitrary cross-sections, Torsion of a thin rectangular cross-section, Torsion of thin-walled open sections. **Thin-walled beams:** Basic equations for thin-walled beams, Bending of thin-walled beams, Shearing of thin-walled beams. The shear centre. Torsion of thin-walled beams, Coupled bending-torsion problems Warping of thin-walled beams under torsion. Equivalence of the shear and twist centres, Non-uniform torsion, Structural idealization.	**10 Hours**	**L1, L2, L3**
Module -4 **Virtual work principles:** Introduction, Equilibrium and work fundamentals, Principle of virtual work, Principle of virtual work applied to mechanical systems, Principle of virtual work applied to truss structures. Principle of complementary virtual work, internal virtual work in beams and solids. **Energy methods:** Conservative forces, Principle of minimum total potential energy, Strain energy in springs, Strain energy in beams, Strain energy in solids, Applications to trusses, Development of a finite element formulation for trusses, Principle of minimum complementary, Energy theorems, Reciprocity theorems, Saint-Venant's principle.	**10 Hours**	**L1, L2, L3, L4**

Module -5	**10 Hours**	**L1, L2, L3**
Yielding: Yielding under combined loading, Applications of yield criteria to structural, Application to bars, trusses and beams. Buckling of beams: Rigid bar with root torsion spring, buckling of beams, buckling of sandwich beams. Shearing deformations in beams, Shear deformable beams: an energy approach. **Kirchhoff plate theory:** Governing equations of Kirchhoff plate theory, The bending problem, Anisotropic plates, Solution techniques for rectangular plates, Circular, Energy formulation of Kirchhoff plate theory, Buckling of plates.		

Course outcomes:

After studying this course, students will be able to:

1. Apply the basic concepts of strength of materials.
2. Compute stress, strain under different loadings.
3. Distinguish the different failure theories.

Graduate Attributes (as per NBA):

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

Question paper pattern:

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

Text Books:

1. S.S. Bhavaikatii, "*Strength of Materials*", Vikas Publications House, New Delhi, 2013, ISBN-978-9325971578.
2. Timoshenko and Young "*Elements of Strength of Materials*', East-West Press, 5th edition, 2003, ISBN-13: 978-8176710190.

Reference Books:

1. Beer.F.P. and Johnston.R, "*Mechanics of Materials*", McGraw Hill Publishers, 7th edition, 2016, ISBN-13: 978-9339217624.
2. S.Ramamrutham, R Narayanan, "*Strength of Materials"*, Dhanapath Rai Publishing Company, New Delhi, 2012, ISBN 13: 9789384378264
3. Bao Shihua, Gong Yaoqing "*Structural Mechanics*" Wuhan University of Technology Press, 2005, ISBN: 7562924074 9787562924074
4. T.H.G Megson "*Introduction to Aircraft Structural Analysis*", Elsevier Exclusive Publications, 2nd edition, 2014, ISBN 13: 978-9351071860.

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

MECHANICS OF FLUIDS

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

SEMESTER – III

Subject Code	**15AS35/15AE35**	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 fluid properties.
2. Understand the governing laws of fluid flow.
3. Acquire the knowledge of types of fluid flows.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module -1 **Basic Considerations:** Introduction, Dimensions- Modules and physical quantities, Continuum view of gases and liquids, Pressure and Temperature scales, Physical properties of fluids. **Fluid Statics:** Pressure distribution in a static fluid, Pressure and its measurement, hydrostatic forces on plane and curved surfaces, buoyancy, illustration by examples.	**10 Hours**	**L1, L2**
Module -2 **Fluids in motion:** Methods of describing fluid motion, types of fluid flow, continuity equation in 3 dimensions, velocity potential function and stream function. Types of motion, Source sink, doublet, plotting of streamlines and potential lines Numerical problems. **Fluid Kinematics:** Kinematics of fluid motion and the constitutive equations, Integral (global) form of conservation equations (mass, momentum, energy) and applications, Differential form of conservation equations (continuity, Navier-Stokes equations, energy equation).	**10 Hours**	**L1, L2**
Module -3 **Fluid Dynamics:** Equations of motion: Euler's and Bernoulli's equation of motion for ideal and real fluids. Momentum equation, Fluid flow measurements. Numerical problems. **Dimensional analysis and similarity:** Dimensional homogeneity, methods of dimensional analysis, model analysis, types of similarity and similitude. Dimensionless numbers. Model laws. Numerical problems.	**10 Hours**	**L1, L2**
Module -4 **Flow past Immersed bodies:** Introduction to boundary layer, boundary layer thickness, karman's integral momentum theory, drag on a flat plate for laminar and turbulent flow, Drag on immersed bodies.	**10 Hours**	**L1, L2, L3**

Expression for drag and lift. Kutta –joukowsky theorem; Fundamentals of aerofoil theory Numerical problems.		
Module -5 **Compressible flow and Boundary Layers theory**: Steady, one-dimensional gas dynamics, Propagation of pressure waves in a compressible medium, velocity of sound , Mach number, Mach cone, Stagnation properties , Bernoulli's eqn for isentropic flow, normal shock waves . Numerical Problem; Laminar and turbulent boundary layers.	**10 Hours**	**L1, L2, L3. L4**

Course outcomes:
After studying this course, students will be able to:
1. Evaluate the effect of fluid properties.
2. Apply the governing laws of fluid flow.
3. Classify different types of fluid flows.

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

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

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

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

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

AEROSPACE MATERIALS

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

SEMESTER – III

Subject Code	**15AS36**	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	42	Exam Marks	80

CREDITS – 03

Course objectives: This course will enable students to

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

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

Module -4 **Ceramics and Composites:** Introduction, modern ceramic materials, cermets, glass ceramic, production of semi fabricated forms, Carbon/Carbon composites, Fabrication processes involved in metal matrix composites, polymer composites, applications in aerospace vehicle design.	**08 Hours**	**L1, L2**
Module -5 **High Temperature Materials Characterization:** Classification, production and characteristics, Methods and testing, Determination of mechanical and thermal properties of materials at elevated temperatures, Application of these materials in Thermal protection systems of Aerospace vehicles, High temperature material characterization.	**08 Hours**	**L1, L2**

Course outcomes:

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

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

Graduate Attributes (as per NBA):

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

Question paper pattern:

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

Text Books:

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

Reference Books:

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

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

MATERIAL TESTING AND METROLOGY LAB

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

Subject Code	**15ASL37**	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. Understand the relations among materials and their properties.
2. Learn the concepts of mechanical measurements and metrology
3. Use the concept of accuracy, error, calibration.

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

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

1. Apply the relations among materials properties.

2. Identify and classify different measuring tools related to experiments and Identify, define, and explain accuracy, precision.
3. Conduct, Analyze, interpret, and present measurement data from measurements experiments.

Conduct of Practical Examination:

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

Graduate Attributes (as per NBA):

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

FLUID MECHANICS LAB

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

Subject Code	**15ASL38**	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. Gain the knowledge of various flow meters and the concept of fluid mechanics.
2. Understand the Bernoulli's Theorem.
3. Measure the pressure using Manometers.

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

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

Course outcomes:

After studying this course, students will be able to:

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

Conduct of Practical Examination:

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

Graduate Attributes (as per NBA):

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

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

Curriculum and Syllabus for 4th Semester, Aerospace Engineering

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

B.E. AEROSPACE ENGINEERING

IV SEMESTER

Sl. No	Subject Code	Title	Teaching Dept.	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Drawing	Duration	Theory/ Practical Marks	I.A. Marks	Total Marks	
1	15MAT 41	ENGINEERING MATHAMATICS - IV	Mathematics	04		03	80	20	100	4
2	15AS42/ 15AE42	AERODYNAMICS - I	AS	04		03	80	20	100	4
3	15AS43	AEROSPACE STRUCTURES-I	AS	04		03	80	20	100	4
4	15AS44/ 15AE44	MECHANISMS AND MACHINE THEORY	AS	04		03	80	20	100	4
5	15AS 45	HEAT & MASS TRANSFER	AS	04		03	80	20	100	4
6	15AS46	COMPOSITE MATERIALS	AS	04		03	80	20	100	3
7	15ASL47	MANUFACTURING TECHNOLOGY LAB	AS		1I+2 P	03	80	20	100	2
8	15ASL48	COMPUTER AIDED AIRCRAFT DRAWING LAB	AS		1I+2 P	03	80	20	100	2
9	15KL/CPH39/49	Kannada/Constitution of India , Professional Ethics and Human Rights		02		02	40	10	50	1
TOTAL				**26**	**06**	**26**	**680**	**170**	**850**	**28**

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

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

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

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

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ENGINEERING MATHEMATICS - IV

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

SEMESTER – IV

Subject Code	**15MAT41**	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

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

1. Numerical methods to solve ordinary differential equations
2. Finite difference method to solve partial differential equations
3. Complex analysis & Sampling theory
4. Joint probability distribution and stochastic process

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module -1 **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.	**10 Hours**	**L1, L2**
Module -2 **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.	**10 Hours**	**L1, L2**
Module -3 **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.	**10 Hours**	**L1, L2, L3**
Module -4 **Probability Distributions:** Random variables(discrete and continuous), probability functions. Binomial distribution, Poisson distribution**,** geometric distribution, uniform distribution, Exponential and normal distributions, Problems.	**10 Hours**	**L1, L2**

Joint probability distribution: Joint Probability distribution for two variables, expectation, covariance, correlation coefficient.		
Module -5 **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.	**10 Hours**	**L1, L2**

Course outcomes:

After the end of the course students 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.

Graduate Attributes (as per NBA):

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

Question paper pattern:

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

Text Books:

1. B.V. Ramana "Higher Engineering Mathematics" Tata Mc Graw-Hill, 2006,ISBN-13: 978-0070634190
2. B.S. Grewal – "Higher Engineering Mathematics", Khanna Publishers, 43rd Edition, 2014,ISBN-13: 978-8174091956

Reference Books:

1. N P Bali and Manish Goyal, "A text book of Engineering mathematics" , Laxmi publications, 9th edition,2016,ISBN-13: 978-8131808320
2. Kreyszig, "Advanced Engineering Mathematics " ,Wiley, 10th edition , 2015, ISBN-13: 978-8126554232
3. H. K Dass and Er. Rajnish Verma ,"Higher Engineering Mathematics", S. Chand publishing, 2nd edition, 2014,ISBN-13: 978-8121938907

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
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AERODYNAMICS - I

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

Subject Code	**15AS42/15AE42**	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 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 nomenclature, airfoil characteristics. wing planform geometry, aerodynamic forces and moments, centre of pressure, pressure coefficient, aerodynamic center, calculation of airfoil lift and drag from measured surface pressure distributions, typical airfoil aerodynamic characteristics at low speeds. Types of drag-Definitions.	**10 Hours**	**L1, L2**
Module -3 **Two Dimensional Flows & Incompressible Flow Over Airfoil:** Uniform flow, Source flow, Sink flow, Combination of a uniform flow with source and sink. Doublet flow . Non-lifting flow over a circular cylinder. Vortex flow. Lifting flow over a circular cylinder. Kutta-Joukowski theorem and generation of Lift, D'Alembert's paradox, Numericals. **Incompressible flow over airfoils:** Kelvin's circulation theorem and the starting vortex, vortex sheet, Kutta condition, Classical thin airfoil theory for symmetric and cambered airfoils. Kutta-Joukowski theorem and generation of Lift, Numericals.	**10 Hours**	**L1, L2, L3, L4, L5**

Module -4 **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 analyze the incompressible flow over finite wings
3. Apply finite wing theory and design high lift systems from the aerodynamics view point.

Graduate Attributes (as per NBA):

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

Question paper pattern:

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

Text Books:

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

Reference Books:

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

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AEROSPACE STRUCTURES – I

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

SEMESTER – IV

Subject Code	**15AS43**	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**: Structural nomenclature, Types of loads, load factor, Aerodynamics loads, Symmetric manoeuvre loads, Velocity diagram, Function of structural components. **Aircraft Materials:** Metallic and non-metallic materials, Use of Aluminium alloy, titanium, stainless steel and composite materials. Desirable properties for aircraft application. Fracture and Fatigue, Stress Intensity Factor, Crack Growth Rate Derivation.	**10 Hours**	**L1, L2, L3**
Module -4 **Theory of Elasticity:** Theory of Elasticity: Concept of stress and strain,	**10 Hours**	**L1, L2, L3**

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:** Statically Determinate and Indeterminate structures, Analysis of plane truss, Method of joints, 3D Truss, Plane frames, Composite beam, Clapeyron's Three Moment Equation.		
Module -5 **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. **Fundamentals:** Different modes of heat transfer and mass and momentum transfer, elements of mass diffusion and boundary layer theory. Mass transfer definition and terms used in mass transfer analysis, Ficks First law of diffusion (no numerical).	**10 Hours**	**L1, L2, L3**

Course outcomes:

After studying this course, students will be able to:

1. Apply the basic concepts of stress and strain analysis.
2. Compute the impact stress.
3. Identify appropriate materials for suitable application based on properties.

Graduate Attributes (as per NBA):

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

Question paper pattern:

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

Text Books:

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

Reference Books:

1. Robert L. Norton , Machine Design, , Pearson Education Asia,2nd edition, 2002,ISBN-13: 978-8131705339.
2. V.B. Bhandari, 'Design of Machine Elements', Tata McGraw Hill Publishing Company Ltd., New Delhi, 2nd Edition, 2007.
3. Timoshenko and Goodier," 'Theory of Elasticity', McGraw Hill Co,3rd edition,2010,ISBN-

13: 978-0070701229
4. Timoshenko, S., "Strength of Materials", Vol. I and II, CBS,3rd edition,2004,ISBN-13: 978-8123910307
5. Joseph E Shigley and Charles R.Mischke. , Mechanical Engineering Design, McGraw Hill International edition, 6th Edition ,2009.
6. Peery, D.J., and Azar, J.J., "Aircraft Structures", McGraw, Hill, N.Y, 2nd edition, 1993.
7. Bruhn. E.H. "Analysis and Design of Flight vehicles Structures", Tri – state off set company, USA, 1985.

DESIGN DATA HANDBOOK:

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

MECHANISMS AND MACHINE THEORY

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

Subject Code	**15AS44/15AE44**	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	**10 Hours**	**L1, L2, L3, L4**

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.		
Module -3 **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 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 Multi-cylinder In-line Engines, Balancing of Radial Engines (only Graphical Methods)	**10 Hours**	**L1, L2, L3, L4**
Module -5 **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,3rd edition ,2009, ISBN: 007014477X, 9780070144774.
2. J.J. Uicker, G.R. Pennock, J.E. Shigley, "Theory of Machines & Mechanisms", OXFORD, 3rd edition, 2009, ISBN-13: 978-0195371239

Reference Books:

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

HEAT & MASS TRANSFER

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

Subject Code	**15AS45**	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, Ficks 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	**10 Hours**	**L1, L2**

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.		
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 Thermal Entry Lengths, use of empirical correlations for Horizontal Pipe Flow and annulus flow.	**10 Hours**	**L1, L2, L3**
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. Evaluate the effect of fluid properties.
2. Familiarize the student in the area of conduction, convection and radiation.
3. Analyze the problems due to heat transfer in several areas.

Graduate Attributes (as per NBA):

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

Question paper pattern:

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

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

Text Books:

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

Reference Books:

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

COMPOSITE MATERIALS

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

Subject Code	**15AS46**	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	42	Exam Marks	80

CREDITS – 03

Course Learning Objectives (CLO) :
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.	**9 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 reinforcement.	**9 Hours**	**L2, L3, L4**
Module -4 **Failure Analysis:** Failure Theory – Tsai-Hill, Tsai-Wu, Max Stress and Max Strain Classical plate theory- Stress and strain variation in a laminate- Resultant forces and moments- A B & D matrices- Strength analysis of a laminate.	**8 Hours**	**L3,L4,L5**
Module -5 **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.	**8 Hours**	**L2, L3**

Course Outcomes (CO):

After studying this course, students will be able to:

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

Graduate Attributes (as per NBA):

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

Question paper pattern:

- The question paper will have ten questions.

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

Text Books:

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

Reference Books:

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

MANUFACTURING TECHNOLOGY LAB

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

Subject Code	**15ASL47**	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. Learn the different methods of prepare the moulds.
2. Understand the functions of the lathe, milling, Shaping, Boring & Drilling machines.
3. Familiarize with different machining process.

Modules	**Revised Bloom's Taxonomy (RBT) Level**
1. Preparation of Green Sand Mould specimen and determination of Mechanical Properties using Universal Sand Testing Machine	**L1, L2, L3**
2. Determination of Permeability of Green Sand	**L1, L2, L3**
3. Forging and Microstructural analysis of mild steel	**L1, L2, L3**
4. Composite Preparation using Hand Lay-up Process	**L1, L2, L3**
5. Preparation of moulds using two moulding boxes. With Patterns. Without Patterns.	**L1, L2, L3**
6. Preparation of Model Involving different lathe operations. Thread Cutting.	**L1, L2, L3**

Knurling.	
7. Surface Milling & Step Milling in Vertical Milling Machine.	**L1, L2, L3**
8. Machining and time estimation for drilling operation	**L1, L2, L3**
9. Machining and time estimation for boring operation	**L1, L2, L3**
10. Machining and time estimation for eccentric turning	**L1, L2, L3**
11. Machining of square in shaping machine	**L1, L2, L3**
12. Electric Discharge Machining.	**L1, L2, L3**
13. Tungsten Inert-Gas Welding.	**L1, L2, L3**
14. Preparation of Casting.	**L1, L2, L3**

Course outcomes:

After studying this course, students will be able to:

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

Conduct of Practical Examination:

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

Graduate Attributes (as per NBA):

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

COMPUTER AIDED AIRCRAFT DRAWING

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

SEMESTER – IV

Subject Code	**15ASL48/15AEL48**	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
1. Sections of Solids: Sections of Pyramids, Prisms, Cubes, Tetrahedrons, Cones and Cylinders resting only on their bases (No problems on axis inclinations, spheres and hollow solids). True shape of sections.	**L1, L2, L3, L6**
2. **Orthographic Views:** Conversion of pictorial views into orthographic projections. of **simple machine parts** with or without section. (Bureau of Indian Standards conventions are to be followed for the drawings) Hidden line conventions. Precedence of lines.	**L1, L2, L3**
3.Thread Forms: Thread terminology, sectional views of threads. ISO Metric (Internal & External) BSW (Internal & External) square and Acme. Sellers thread, American Standard thread.	**L1, L2, L3**
4.Fasteners: Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly) simple assembly using stud bolts with nut and lock nut. Flanged nut, slotted nut, taper and split pin for locking, counter sunk head screw, grub screw, Allen screw.	**L1, L2, L3**
5.Keys & Joints: Parallel key, Taper key, Feather key, Gibhead key and Woodruff key	**L1, L2, L3**
6.Riveted Joints: Single and double riveted lap joints, butt joints with single/double cover straps (Chain and Zigzag, using snap head rivets). Cotter joint (socket and spigot), knuckle joint (pin joint) for two rods.	**L1, L2, L3**
7. Couplings: Split Muff coupling, protected type flanged coupling, pin (bush) type flexible coupling, Oldham's coupling and universal coupling (Hooks' Joint)	**L1, L2, L3**
8. Design of propeller and hub assembly	**L1, L2, L3**
9. Design of wing assembly	**L1, L2, L3**
10. Design of fuselage assembly	**L1, L2, L3**
11. Design of Engine Mounts	**L1, L2, L3**
12. Design of main rotor blade assembly of helicopter	**L1, L2, L3, L4, L5, L6**
13. Design of UAV assembly	**L1, L2, L3, L4, L5, L6**
14. Design of Landing Gear Assembly	**L1, L2, L3, L4, L5, L6**

Course outcomes: After studying this course, students will be able to: 1. Distinguish drawings of machine and aircraft components 2. Identify assembly drawings either manually or by using standard CAD packages. 3. Practise with standard components and their assembly of an aircraft..	
Conduct of Practical Examination: 1. All laboratory experiments are to be included for practical examination. 2. Students are allowed to pick one experiment from the lot. 3. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks. 4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.	
Graduate Attributes (as per NBA): • Engineering Knowledge. • Problem Analysis. • Design / development of solutions (partly) • Interpretation of data.	

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