RV COLLEGE OF ENGINEERING®

(Autonomous Institution Affiliated to VTU, Belagavi)
R.V. Vidyaniketan Post, Mysore Road
Bengaluru – 560 059

Bachelor of Engineering (B.E.)
Scheme and Syllabus of III & IV Semesters

2018 SCHEME

AEROSPACE ENGINEERING

VISION

Leadership in Quality Technical Education, Interdisciplinary Research & Innovation, with a Focus on Sustainable and Inclusive Technology

MISSION

1. To deliver outcome based Quality education, emphasizing on experiential learning with the state of the art infrastructure.
2. To create a conducive environment for interdisciplinary research and innovation.
3. To develop professionals through holistic education focusing on individual growth, discipline, integrity, ethics and social sensitivity.
4. To nurture industry-institution collaboration leading to competency enhancement and entrepreneurship.
5. To focus on technologies that are sustainable and inclusive, benefiting all sections of the society.

QUALITY POLICY

Achieving Excellence in Technical Education, Research and Consulting through an Outcome Based Curriculum focusing on Continuous Improvement and Innovation by Benchmarking against the global Best Practices.

CORE VALUES

Professionalism, Commitment, Integrity, Team Work, Innovation

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2018 SCHEME

DEPARTMENT OF
AEROSPACE ENGINEERING

Department Vision

Emerge as a centre of excellence in Aerospace Engineering, Imparting Quality Technical Education, Interdisciplinary Research & Innovation with a focus on Societal empowerment through Sustainable & Inclusive Technologies.

Department Mission

- Imparting Quality Technical Knowledge in Basic & Applied areas of Aerospace Engineering incorporating the principles of Outcome Based Education.
- Provide state-of-the art laboratories and infrastructure facilities, conducive to motivate Interdisciplinary Research and Innovation in Aerospace Engineering.
- Develop self-motivated engineers with a blend of Discipline, Integrity, Engineering Ethics and Social Responsibility.
- Strengthening collaboration with industries, research organizations and institutes for Internships, Joint Research and Consultancy.
- Focus towards Integrating Sustainable and Inclusive Technologies for Societal Symbiosis.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1: To provide opportunities for successful professional career with a sound fundamental knowledge in Mathematics, Physical Science & Aerospace Engineering.

PEO2: Motivate innovative research in specialized areas of Aerospace Engineering viz Aerospace structural design, Aerodynamics, Aerospace Propulsion and Guidance & Control systems.

PEO3: Promoting development of problem solving abilities by adopting analytical, numerical and experimental skills with awareness on societal impact.

PEO4: Imbibing sound communication skills, team working ability, professional ethics and zeal for lifelong learning.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO	Description
PSO1	Utilization of the fundamental knowledge and skills of Aerospace Engineering to develop pragmatic solutions for complex Aerospace Engineering problems.
PSO2	Apply Professional Engineering practices and strategies in the development of systems and subsystems for Aerospace Applications.
PSO3	Exhibit Effective Communication skills and a Zeal to function with multi-disciplinary teams
PSO4	Demonstrate Professional Ethics and Responsibilities in Engineering practices towards the achievement of societal symbiosis.

ABBREVIATIONS

Sl. No.	Abbreviation	Meaning
1.	VTU	Visvesvaraya Technological University
2.	BS	Basic Sciences
3.	CIE	Continuous Internal Evaluation
4.	SEE	Semester End Examination
5.	CE	Professional Core Elective
6.	GE	Global Elective
7.	HSS	Humanities and Social Sciences
8.	CV	Civil Engineering
9.	ME	Mechanical Engineering
10.	EE	Electrical & Electronics Engineering
11.	EC	Electronics & Communication Engineering
12.	IM	Industrial Engineering & Management
13.	EI	Electronics & Instrumentation Engineering
14.	CH	Chemical Engineering
15.	CS	Computer Science & Engineering
16.	TE	Telecommunication Engineering
17.	IS	Information Science & Engineering
18.	BT	Biotechnology
19.	AS	Aerospace Engineering
20.	PY	Physics
21.	CY	Chemistry
22.	MA	Mathematics

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AEROSPACE ENGINEERING

THIRD SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			**Total Credits**
				L	**T**	**P**	
1.	18MA31C*	Engineering Mathematics - III	MA	4	1	0	**5**
2.	18ME32**	Engineering Materials (Common to ME, IM & AS)	ME	2	0	0	**2**
3.	18AS33	Introduction to Aerospace Engineering	AS	3	0	0	**3**
4.	18AS34	Thermodynamics	AS	3	0	1	**4**
5.	18AS35	Mechanics of Fluids	AS	4	0	1	**5**
6.	18AS36	Structural Mechanics	AS	3	0	1	**4**
7.	18DMA37***	Bridge Course Mathematics	MA	2	0	0	**0**
8.	18HS38#	Kannada Course	HSS	1	0	0	**1**
Total Number of Credits				**19**	**1**	**3**	**24**
Total number of Hours/Week				**19+3***	**2**	**7.5**	

*Engineering Mathematics - III

Sl.No	COURSE TITLE	COURSE CODE	PROGRAMS
1.	Linear Algebra, Laplace Transform and Combinatorics	18MA31A	CS & IS
2.	Discrete and Integral Transforms	18MA31B	EC, EE, EI & TE
3.	Engineering Mathematics -III	18MA31C	AS, BT, CH, CV, IM & ME

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Sl.No	COURSE TITLE	COURSE CODE	PROGRAMS
1.	Environmental Technology	18BT32A	EE, EC, EI, CS, TE & IS
2.	Biology for Engineers	18BT32B	BT
3.	Engineering Materials	18ME32	ME, IM &AS

*** Bridge Course: Audit course for lateral entry diploma students

Sl.No	COURSE TITLE	COURSE CODE	PROGRAMS
1	Bridge Course Mathematics	18DMA37	AS, BT,CH, CV, EC, EE, EI, IM, ME &TE
2	Bridge Course C Programming	18DCS37	CS & IS

There are two text books prescribed by VTU for the Kannada Course:

1. Samskruthika Kannada **(AADALITHA KANNADA);**
2. Balake Kannada **(VYAVAHARIKA KANNADA);**

The first text book is prescribed for the students who know Kannada to speak, read and write **(KARNATAKA STUDENTS)**. The second text book is for students who do not understand the Kannada language (**NON-KARNATAKA STUDENTS)**

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AEROSPACE ENGINEERING

FOURTH SEMESTER CREDIT SCHEME							
Sl. No	**Course Code**	**Course Title**	**BOS**	**Credit Allocation**			**Total Credits**
				L	**T**	**P**	
1.	18MA41C*	Engineering Mathematics-IV	MA	4	1	0	**5**
2.	18BT42A**	Environmental Technology (Common to CV, ME, IM, CH, BT & AS)	BT	2	0	0	**2**
3.	18AS43	Aerodynamics	AS	3	0	1	**4**
4.	18AS44	Aerospace Structures	AS	3	0	1	**4**
5.	18AS45	Electronics & Communication Systems	AS	3	0	0	**3**
6.	18AS46	Aerospace Manufacturing Technology	AS	3	0	1	**4**
7.	18AS47	Design Thinking lab	AS	0	0	2	**2**
8.	18DCS48***	Bridge Course : C Programming	CS	2	0	0	**0**
9.	18HS49	Professional Practice-I Communication Skills	HSS	0	0	1	**1**
Total Number of Credits				**18**	**1**	**6**	**25**
Total number of Hours/Week				**18+2***	**2**	**15**	

*Engineering Mathematics – IV

Sl.No	COURSE TITLE	COURSE CODE	PROGRAMS
1.	Graph Theory, Statistics and Probability Theory	18MA41A	CS & IS
2.	Linear Algebra, Statistics and Probability Theory	18MA41B	EC, EE, EI, TE
3.	Engineering Mathematics -IV	18MA41C	AS, CH, CV, ME

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Sl.No	COURSE TITLE	COURSE CODE	PROGRAMS
1.	Engineering Materials	18EC42	EC, EE, EI, TE
2.	Biology for Engineers	18BT42B	Circuit branches (CS, IS)
3.	Environmental Technology	18BT42A	CV, ME, IM, CH, BT & AS

*** Bridge Course: Audit course for lateral entry diploma students

Sl.No	COURSE TITLE	COURSE CODE	PROGRAMS
1	Bridge Course Mathematics	18DMA48	CS & IS
2	Bridge Course C Programming	18DCS48	AS, BT, CH,CV,EC, EE,EI,IM,ME & TE

Note: Internship to be taken up during the vacation (After 4th semester)

Semester: III						
ENGINEERING MATHEMATICS – III (Theory) (Common to AS, BT, CH, CV, IM & ME)						
Course Code	**:**	18MA31C		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	4:1:0		**SEE**	**:**	**100 Marks**
Hours	**:**	52L+13T		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The student will be able to	
1	Understand variation and extremal of functionals.
2	Analyze the concept of periodic phenomena and develop Fourier series.
3	Solve initial value problems using Laplace transform.
4	Determine the approximate solutions of algebraic/transcendental and partial differential equations using numerical methods.
5	Use mathematical IT tools to analyze and visualize various concepts.

Unit-I	**10 Hrs**
Calculus of Variations: Introduction to variation of functionals, extremal of a functional, Euler's equation –special cases, problems. Geodesics, Hanging cable and Brachistochrone problems. Exploring geodesics graphically using MATLAB.	
Unit – II	**11 Hrs**
Fourier Series: Introduction, periodic function, even and odd functions. Dirichlet's conditions, Euler's formula for Fourier series, complex Fourier series, problems on time periodic signals (square wave, half wave rectifier, saw-tooth wave and triangular wave), Fourier sine series, Fourier cosine series. Exploring Fourier series using MATLAB.	
Unit –III	**11 Hrs**
Laplace and Inverse Laplace Transform: Existence and uniqueness of Laplace Transform (LT), transform of elementary functions, region of convergence. Properties - Linearity, scaling, s – domain shift, differentiation in the s – domain, division by t, differentiation and integration in the time domain. Transform of periodic functions (square wave, saw-tooth wave, triangular wave, full and half wave rectifier). Inverse Laplace transform – properties, evaluation using different methods. Convolution theorem (without proof), problems. Solution of ordinary differential equations. Exploring Laplace and inverse Laplace transform using MATLAB commands.	
Unit –IV	**10 Hrs**
Numerical Methods – I: Roots of algebraic and transcendental equations. Fixed point iteration method, Newton- Raphson method for multiple roots. Solution to system of linear equations – LU decomposition method, partition method. Sparse linear systems – Thomas algorithm for tridiagonal matrices. Computing numerical solutions **using MATLAB**	
Unit –V	**10 Hrs**
Numerical Methods – II: Numerical solutions to partial differential equations – Finite difference approximation to derivatives, solution of Laplace equation in two dimension, heat and wave equations in one dimension (explicit methods). Exploring solution of PDE using MATLAB.	

Course outcomes: On completion of the course, the student should have acquired the ability to	
CO1:	Understand the fundamental concepts of variation of functionals, periodic phenomena, Laplace and inverse Laplace transforms and numerical techniques.
CO2:	Solve the problems on extremal of functional, Fourier series, Laplace and inverse Laplace transforms and basics of numerical methods.

CO3:	Apply the acquired knowledge to solve variational problems, half range series, differential equations using Laplace transform, system of linear equations and PDEs using finite difference technique.
CO4:	Analyze and interpret applications of functionals, complex Fourier series, IVP and BVP using LT, sparse linear systems and PDEs occurring in Engineering problems.

Reference Books	
1	Higher Engineering Mathematics, B.S. Grewal, 44th Edition, 2015, Khanna Publishers, ISBN: 81-7409-195-5.
2	Higher Engineering Mathematics, B.V. Ramana, 11th Edition, 2010, Tata McGraw-Hill, ISBN: 13-978-07-063419-0; ISBN: 10-0-07-063419-X.
3	Advanced Engineering Mathematics, Erwin Kreyszig, 9th Edition, 2007, John Wiley & Sons, ISBN: 978-81-265-3135-6.
4	Numerical methods for scientific and engineering computation, M.K. Jain, S.R.K. Iyenger and R.K. Jain, 6th Edition, 2012, New Age International Publishers, ISBN: 9788122433234, 8122433235.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20.

Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part A and Part B. Part A consists of objective type questions for 20 marks covering the complete syllabus. Part B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	-	-	-	-	-	-	-	-	1
CO2	3	2	-	-	-	-	-	-	-	-	-	1
CO3	1	2	2	-	-	-	-	-	-	-	-	1
CO4	-	1	1	3	-	-	-	-	-	-	-	1

High-3 : Medium-2 : Low-1

Semester: III						
ENGINEERING MATERIALS (Theory) (Common to ME, CH, IM & AS)						
Course Code	**:**	18ME32		**CIE**	**:**	**50 Marks**
Credits: L:T:P	**:**	2:0:0		**SEE**	**:**	**50 Marks**
Total Hours	**:**	26L		**SEE Duration**	**:**	**02 Hours**

Course Learning Objectives:

1	Understand the behavior of materials for different loading conditions
2	Analyze different phase diagrams, related composition and microstructure
3	Understand heat treatment methods of steel and their properties
4	Understand solidification process in casting and material degradation
5	Discuss Non Destructive methods of testing materials

UNIT-I	**06 Hrs**
Mechanical behaviour of Materials: Plastic deformation of metals, Mechanism of plastic deformation, role of dislocation in plastic deformation and Work Hardening. Fracture- mechanism of Ductile and brittle fracture, Ductile to brittle transition, Fatigue- Types of loading, S-N curve.	
UNIT-II	**07 hrs**
Phase Diagram and Fe-C equilibrium diagram: Phase, Gibbs phase rule, Solid solutions, Hume Rothery Rules, Isomorphous alloy system, (Problems to find chemical composition and relative amount of phases present), Binary eutectic and Eutectoid system. Iron-Iron carbide phase diagram- Invariant reactions, Development of microstructure in iron carbon alloys (Slow cooling of steels). Steel & Cast Iron- composition, properties and applications.	
UNIT-III	**07 hrs**
Phase transformation in steel: Heat treatment of steel, Annealing-Full annealing, spheroidizing, process annealing, Normalizing, Hardening, TTT diagram of eutectoid steel and its phase transformation. Tempering, austempering, martempering, Hardenability, Jominy End quench test. Surface Heat treatment methods- Carburizing, Nitriding and Flame hardening.	
UNIT-IV	**04 hrs**
Foundry Metallurgy: Casting and Solidification process, Nuclei, Dendrite and grain, Nucleation: Homogeneous and Heterogeneous Nucleation, Dendritic growth and Cast structure. Shrinkage of liquids and metals. **Environmental Degradation of Materials**: Different forms of environmental degradation, forms of corrosion- Galvanic, Intergranular, pitting, stress related corrosion. Corrosion control- Materials selection, protective coating.	
UNIT-V	**04 hrs**
Non Destructive Testing: Non Destructive Testing basic principles, Advantages and testing methods like Liquid penetrant inspections, Magnetic particle inspection, Ultrasonic testing, and Eddy current.	

Course Outcomes: After completing the course, the students will be able to

CO1:	Understand behavior of various materials such as metals, composites and special materials
CO2:	Analyze materials, composition and their phase transformation
CO3:	Investigate solidification process during casting and materials degradation
CO4:	Recognize different types of Nondestructive testing methods to find subsurface defects in the materials.

Reference Books	
1.	Material Science and Engineering, William D Callister, 6th Edition, 1997, John Wiley and Sons, ISBN 9812-53-052-5
2.	Introduction to Physical Metallurgy, Sydney H Avner, 1994, Mc. Graw Hill Book Company, ISBN 0-07-Y85018-6
3.	Material Science and Engineering, William F Smith, 4th Edition, 2008, Mc. Graw Hill Book Company, , ISBN0-07-066717-9

Continuous Internal Evaluation (CIE); Theory (50 Marks)

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 15 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 30 marks each and the sum of the marks scored from three tests is reduced to 25. The marks component for experiential learning is 20.

Total CIE is 15(Q) +25(T) +10(EL) =50 Marks.

Semester End Evaluation (SEE); Theory (50 Marks)

SEE for 50 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 10 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 8 marks adding up to 40 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	-	-	-	-	-	-	-	-	1
CO2	3	2	-	-	-	-	-	-	-	-	-	1
CO3	1	2	2	-	-	-	-	-	-	-	-	1
CO4	-	1	1	3	-	-	-	-	-	-	-	1

Semester: III						
INTRODUCTION TO AEROSPACE ENGINEERING (Theory)						
Course Code	**:**	18AS33		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Hours	**:**	39L		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: To enable the students to:	
1	Understand the history and basic principles of aviation
2	Demonstrate and explain foundation of flight, aircraft structures, material, aircraft propulsion
3	Explain the working of each component of an aircraft
4	Assess the effect of design parameters on the performance of the aircraft and its components

Unit-I	**08 Hrs**
Preliminary Concepts in Aviation: History of aviation, International Standard atmosphere, Atmosphere and its properties, Temperature, pressure and altitude relationships, Numericals, Anatomy of an aircraft, Basic components and their function. **Introduction to Space Flight:** Evolution of spacecraft technologies, Introduction to basic orbital mechanics, Orbit equation, Space vehicle trajectories, Kepler's Laws of planetary motion.	
Unit – II	**08 Hrs**
Basic Aerodynamics: Airfoil nomenclature, NACA Airfoils Series, Basic characteristics of airfoils, Wing Planform Geometry, Aerodynamic forces and moments on an Airfoil with Derivation, Lift and drag, Aerodynamic Coefficients, Centre of pressure and its significance, Aerodynamic centre, Simple Numericals on lift and drag.	
Unit -III	**08 Hrs**
Aircraft Propulsion: Evolution of Aircraft Propulsion, Illustration of working of gas turbine engine, Comparison of Ideal & Actual Brayton Cycle, Working principle and characteristics of Turbojet, Turboprop, Turbofan, Ramjet, Scramjet, Pulsejet Engines.	

Unit -IV	**08 Hrs**
Aircraft Structures and Materials: Introduction, General types of construction, Monocoque, Semi-Monocoque and Geodesic structures, Typical wing and fuselage structure; Metallic and non-metallic materials for aircraft application. Use of aluminum alloy, titanium, stainless steel and composite materials.	
Unit -V	**07 Hrs**
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.	

Course Outcomes: At the end of this course the student will be able to :	
CO1:	Appreciate and apply the basic principles of aviation
CO2:	Apply the concepts of fundaments of flight, basics of aircraft structures, aircraft propulsion and aircraft materials during the development of an aircraft
CO3:	Comprehend the complexities involved during development of flight vehicles.
CO4:	Evaluate and criticize the design strategy involved in the development of airplanes

Reference Books	
1	Introduction to Flight, John D. Anderson, 7th Edition, 2011, McGraw-Hill Education, ISBN 9780071086059.
2	Rocket Propulsion Elements, Sutton G.P., 8th Edition. 2011, John Wiley, New York, ISBH: 1118174208, 9781118174203.
3	Aircraft structural Analysis, T.H.G Megson, 4th Edition, 20013, Butterworth-Heinemann Publications, ISBN: 978-1-85617-932-4.
4	Flight stability and automatic control, Nelson R.C, 2nd Edition, 1998, McGraw-Hill International Editions, ISBN 9780071158381.
5	Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration, Ian Moir, Allan Seabridge, 3rd Edition, 2008, John Wiley & Sons,. ISBN 978111965006.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20.

Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part A and Part B. Part A consists of objective type questions for 20 marks covering the complete syllabus. Part B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**3**	**1**	**1**	**3**	**2**	**2**				**1**
CO2	**2**	**3**	**3**	**3**	**1**	**1**	**1**	**1**				**2**
CO3	**1**		**3**	**3**								**2**
CO4	**3**	**3**	**3**	**3**		**2**	**1**	**2**				**2**

High-3 : Medium-2: Low-1

Semester: III						
THERMODYNAMICS (Theory & Practice)						
Course Code	**:**	18AS34		**CIE**	**:**	**100+50 Marks**
Credits: L:T:P	**:**	3:0:1		**SEE**	**:**	**100 +50 Marks**
Hours	**:**	39L+32.5P		**SEE Duration**	**:**	**3.00+3.00 Hours**

Course Learning Objectives: To enable the students to:	
1	Understand the influence of thermodynamic properties on processes
2	Apply the thermodynamic laws in practical applications
3	Evaluate the efficiencies and properties of thermodynamic systems
4	Appreciate the practical applications of thermodynamics
5	Build thermodynamic solutions for newly emerging technologies.

Unit-I	**09 Hrs**
Heat &Work: Zeroth Law of thermodynamics and temperature Measurement, Thermodynamic definition of Heat and work. Heat and work transfer, Expressions for displacement work in various processes through P-V diagrams. **First Law Thermodynamic:** First Law of thermodynamics for Closed System, Concept of Internal Energy, Enthalpy, First Law of Thermodynamics for a closed system , Steady flow process, steady flow energy equation and applications, PMMK1	
Unit – II	**09 Hrs**
Second law of Thermodynamics: Limitations of First Law of thermodynamics, Heat engine, Heat pump, Carnot's principle, Carnot cycle and its specialties, Clausius and Kelvin Planck statement, PMMK2, Entropy, Entropy change in non-flow processes.	
Unit -III	**08 Hrs**
Perfect Gas Laws: Equation of State, specific and Universal Gas constant, Mass and Mole Fraction, Properties of Gas Mixtures, Throttling and Free Expansion Processes, Deviations from perfect Gas **Properties of Pure Substances:** Thermodynamic properties of pure substances in solid, liquid and vapor phases, P-V-T behaviour of simple compressible substances, phase rule, thermodynamic property tables and charts. **Gas Mixtures:** Gas Model, Ideal gas mixture; Dalton's laws of partial pressures, Amagat's law of additive volumes, Vander Waal's Equation of State –compressibility factor, use of compressibility charts.	

Unit -IV	**07 Hrs**
Gas Cycles: Efficiency of air-Standard cycles-Carnot cycle, Otto, Diesel, Dual and Brayton cycle, Mean effective pressure, Representation of cycles on P-V and T-s diagrams. **Performance of I.C. Engines**: Air and Fuel measurement, Calculation of IP BP & FP, and Heat Balance sheet calculations.	
Unit -V	**06 Hrs**
Psychrometry: Properties of atmospheric air, Construction and use of psychrometric chart, Analysis of various processes, heating, cooling, dehumidifying and humidifying, Adiabatic mixing of moist air, Analysis of various Air conditioning processes.	

LABORATORY EXPERIMENTS
1. Determination of flash point and fire point of the given fuels/lubricating oils using Abel Pensky and Pensky Martin's apparatus
2. Determination of Calorific Value of Solid & Liquid Fuels using Bomb calorimeter
3. Determination of Calorific Value of gaseous fuel using Junker gas calorimeter
4. Determination of viscosity of various lubricating oils using Redwood, Saybolts Viscometers
5. Determination of viscosity of various lubricating oils using Brookfield Viscometer

6. Study of characteristics and performance of a 4 stroke Diesel Piston engine under various conditions 7. Study of characteristics and performance of a 4 stroke Petrol Piston engine under various conditions 8. Determination of Friction power using Morse test 9. Determination of effectiveness of a parallel and counter flow heat exchangers 10. Determination of constituents of a gas mixture using Orsat apparatus 11. Study the performance of vapor compression air conditioning system Study the performance of vapor compression refrigeration system

Course Outcomes: At the end of this course the student will be able to :	
CO1:	Understand the concepts and definitions of thermodynamics
CO2:	Differentiate thermodynamic work and heat and apply I law and II law of thermodynamics to different processes
CO3:	Comprehend and utilize the principles of Refrigeration and air conditioning
CO4:	Design and Analyze the functioning of various Thermodynamic cycles

Reference Books	
1	Thermodynamics: An Engineering Approach, Yunus A.Cenegal and Michael A.Boles, 4th Edition, 2011, TataMcGraw Hill publications, ISBN: 9780070495036.
2	Engineering Thermodynamics, J.B.Jones and G.A.Hawkins, 2nd Edition, 1986, John Wiley and Sons, ISBN: 978-0471812029.
3	Fundamentals of Classical Thermodynamics, G.J.Van Wylen and R.E.Sonntag, 3rd Edition, 1986, Wiley Eastern, ISBN-13: 978-0-471-61075-5.
4	Basic and Applied Thermodynamics P.K.Nag, 2nd Edition., 2002, Tata McGraw Hill Pub, ISBN-13: 978-0070151314.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20.

Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.

Scheme of Continuous Internal Evaluation (CIE); Practical Test for 50 Marks

The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average marks (AM) over number of weeks is considered for 30 marks. At the end of the semester a test (T) is conducted for 10 marks. The students are encouraged to implement additional innovative experiments (IE) in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.

Total CIE is 30(AM) +10 (T) +10 (IE) =50 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part A and Part B. Part A consists of objective type questions for 20 marks covering the complete syllabus. Part B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Scheme of Semester End Examination (SEE); Practical Exam for 50 Marks
SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Theory (100 Marks) + Practical (50 Marks) = Total 150 Marks

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**3**	**3**	**1**	**3**	**1**					**2**
CO2	**3**	**3**	**3**	**3**	**1**							**2**
CO3	**2**	**2**	**3**	**3**								**1**
CO4	**3**	**3**	**3**	**3**		**1**	**2**					**1**

High-3 : Medium-2: Low-1

Semester: III						
MECHANICS OF FLUIDS (Theory & Practise)						
Course Code	**:**	18AS35		**CIE**	**:**	**100+50 Marks**
Credits: L:T:P	**:**	4:0:1		**SEE**	**:**	**100 +50 Marks**
Hours	**:**	52L+32.5P		**SEE Duration**	**:**	**3.00+3.00 Hours**

Course Learning Objectives: To enable the students to:	
1	Identify the properties of fluid which influence flow characteristics
2	Distinguish fluid flows and evaluate their behaviour using governing equations
3	Apply Dimensional analysis and similarity laws for conducting model tests.
4	Evaluate and comment on the flow using flow measuring devices
5	Discriminate and comment on boundary layer flows
6	Interpret the effect of compressibility on fluid flows

Unit-I	**10 Hrs**
Basic Concepts: Introduction, definition of fluid, concept of continuum, classification of Fluids **Fluid Properties:** Density, Relative Density, Specific Volume, Specific Weight, Pressure, Shear stress, Newton's law of viscosity, Absolute & Kinematic viscosity, Vapour pressure & cavitation, Bulk Modulus & Compressibility, Surface tension & Capillarity.	
Unit – II	**12 Hrs**
Fluid Statics: Pascal's law, Pressure variation with depth, manometers, hydrostatic thrust on submerged plane and curved surfaces, centre of pressure, Buoyancy, Stability of submerged and floating bodies, Metacenter and Meta centric height. **Fluid Kinematics:** Introduction, Lagrangian & Eulerian Description of Fluids, Types of Fluid Flows, Stream line, streak line and path line, circulation and vorticity, stream function and velocity potential function continuity equation in Integral form and 3D Cartesian coordinates.	
Unit -III	**10 Hrs**
Fluid Dynamics: Basic governing equations of fluid flows**,** Reynold's Transport theorem, Mass conservation, Momentum Conservation and Energy conservation equations, and Introduction to Navier –stokes Equations. **Incompressible Inviscid Flow:** Euler's equation of fluid motion (from first principles), Bernoulli's equation, Bernoulli's equation for real fluid flows.	
Unit -IV	**10 Hrs**
Application of Bernoulli's equation: Flow measurement: orifice plate, Venturimeter, Notches: rectangular and V-notch, Pitot tube. **Incompressible Viscous flow:** Boundary layer concept, Boundary layer thickness, displacement thickness and momentum thickness; flow separation, couette flow, poiseuille flow, kinetic Energy correction factor.	
Unit -V	**10 Hrs**
Dimensional Analysis & Model Studies: Units and Dimensions, Dimensional Homogeneity, Dimensional Analysis-Rayleigh's Method, Buckingham's π-Theorem, Dimensionless numbers. Model Analysis, Types of Similarities and Similitude, Similarity Laws. **Introduction to Compressible Flows:** Stagnation Properties, One-Dimensional Isentropic Flow, Mach number, Mach Cone.	

LABORATORY EXPERIMENTS
1. Determination of major losses in fluids flowing through pipes. 2. Determination of minor losses in fluids flowing through pipes 3. Determination of Co-efficient of discharge over a V-notch 4. Determination of force generated by the impact of water jet on the vanes 5. Determination of Co-efficient of discharge through venturimeter 6. Determination of Co-efficient of discharge through orifice meter

7. Determination of type of flow for different Reynolds Number using Reynolds apparatus 8. Study of performance characteristics of a single stage centrifugal pump 9. Study of performance characteristics of a multi-stage centrifugal pump 10. Study of performance characteristics of a Francis turbine 11. Study of performance characteristics of a Pelton wheel 12. Determination of metacentric height of floating bodies 13. Flow Visualization studies using water tunnel

Course Outcomes:	
At the end of this course the student will be able to :	
CO 1:	Identify the properties of fluid which influence flow characteristics
CO 2:	Distinguish fluid flows and evaluate the properties associated with the flow
CO 3:	Apply Dimensional analysis and similarity laws for conducting model tests
CO 4:	Evaluate and comment on the flow using flow measuring devices
CO 5:	Discriminate and comment on boundary layer flows
CO 6:	Interpret the effect of compressibility on fluid flows

Reference Books	
1	Fluid Mechanics, Frank M White, 7th Edition, 2012, McGraw Hill, ISBN 9780073529349
2	Fluid Mechanics and Applications, Yunus A. Cengel & John M Cimbala, 12th Edition, 2009, Tata McGraw- Hill Publishers,. ISBN: 9780070700345
3	Fluid Mechanics, Streeter. V. L., and Wylie, E.B., 9th Edition, 2017, McGraw Hill, 1983 ISBN: 0071156003
4	Mechanics of Fluids, B S Massey, 7th Edition, 1998, ELBS Edition. ISBN-10: 0748740430
5	Fluid Mechanics, Hydraulics and Fluid Machines, Ramamritham. S, 9th Edition, 2014, Dhanpat Rai& Sons, Delhi, 1988.ISBN: 978-93-84378-27-1

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20.

Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.

Scheme of Continuous Internal Evaluation (CIE); Practical Test for 50 Marks

The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average marks (AM) over number of weeks is considered for 30 marks. At the end of the semester a test (T) is conducted for 10 marks. The students are encouraged to implement additional innovative experiments (IE) in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.

Total CIE is 30(AM) +10 (T) +10 (IE) =50 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part A and Part B. Part A consists of objective type questions for 20 marks covering the complete syllabus. Part B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Scheme of Semester End Examination (SEE); Practical Exam for 50 Marks
SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Theory (100 Marks) + Practical (50 Marks) = Total 150 Marks

CO-PO MAPPING												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**2**	**1**	**1**								**2**
CO2	**3**	**3**	**3**	**2**								**3**
CO3	**3**	**3**	**3**	**2**								**2**
CO4	**3**	**3**	**1**	**2**								**1**
CO5	**3**	**3**	**3**	**3**								**3**
CO6	**2**	**1**	**1**	**1**								**3**

High-3: Medium-2: Low-1

Semester: III						
STRUCTURAL MECHANICS (Theory & Practise)						
Course Code	**:**	18AS36		**CIE**	**:**	**100+50 Marks**
Credits: L:T:P	**:**	3:0:1		**SEE**	**:**	**100 +50 Marks**
Hours	**:**	39L+35P		**SEE Duration**	**:**	**3.00+3.00 Hours**

Course Learning Objectives: To enable the students to	
1	Comprehend the basic concepts of strength of materials.
2	Acquire the knowledge of stress, strain under different loadings
3	Understand the behaviour of various structural members under the action of different types of loads
4	Analyse and Interpret the ability of different structures under the action of combined loading
5	Apply the different theories of failures on members

Unit-I	**08 Hrs**
Basic equations of linear elasticity: Stress and Strain, True stress and Engineering Stress, Hooke's Law, Generalized Hooks law, Relationship between Elastic Constants, Thermal Stresses, Compound bars, Principle of Superposition. **Principal Stresses and Strain:** State of Stress, Stress and Strain at a point, Plane Stress and Plane Strain approximations, Stress Tensor.	
Unit – II	**08 Hrs**
Bending Moment and Shear Force Diagram: Sign Convention, Procedure for drawing BMD and SFD, Different types of Loading and their S.F & B.M Diagram, Point of Contra flexure, General expression.	
Unit -III	**08 Hrs**
Euler-Bernoulli beam theory: The Euler-Bernoulli assumptions, Implications of the Euler-Bernoulli assumptions, Beams subjected to axial loads, Beams subjected to transverse loads, Beams subjected to combined axial and transverse loads. **Deflection of Beams:** Equation of Elastic curve, Deflection of Beams, Statically indeterminate beams.	

Unit -IV	**07 Hrs**
Torsion: Torsion of circular shafts, polar moment of inertia and polar section modulus, Comparison of solid and hollow shaft, Torsion combined with axial force and bending moments, Power transmission.	
Unit -V	**08 Hrs**
Failure Theories: Maximum Principal Stress Theory, Maximum Shear Stress, Strain Energy Theory, Shear strain Energy theory, Maximum principal strain theory. **Shells:** Thin cylindrical shell of circular cross section, Thin spherical shell, Cylindrical shell with hemispherical ends, Bending stresses in thin-walled circular cylinders.	

LABORATORY EXPERIMENTS
1. Charpy impact tests for metals
2. Izod Impact test for metals
3. Compression Test for metals
4. Brinell Hardness test for metals (Ferrous and Non Ferrous)
5. Vickers Hardness test for metals (Ferrous and Non Ferrous)
6. Rockwell Hardness test for metals (Ferrous and Non Ferrous)
7. Tension Tests for metals (Ferrous and Non Ferrous)
8. Fatigue Tests for metals (Ferrous & Non Ferrous)
9. Three point Bending tests for metals (Ferrous & Non Ferrous)
10. Tension Characterization using strain gauges

11. Bending Characterization using strain gauges 12. Torsional characterization using strain gauges

Course Outcomes:	
At the end of this course the student will be able to :	
CO 1:	Understand the nature of different types of loads
CO 2:	Describe the behaviour of structures under various loads
CO 3:	Apply various principles to ascertain the character of materials under different loads
CO 4:	Evaluate the stability of various structures under different loading environments

Reference Books	
1	Elements of Strength of Materials, Timoshenko and Young, East-West Press, 5th Edition 2003, ISBN: 978-93-84378-27-1
2	Mechanics of Materials, Beer.F.P. and Johnston.R, 7th Edition, 2014, McGraw Hill Publishers, ISBN: 978-0073398235
3	Structural Mechanics, Bao Shihua, Gong Yaoqing, 1st Edition, 2005, Wuhan University of Technology Press.
4	Aircraft structural Analysis, T.H.G Megson, Butterworth-Heinemann Publications, 1st Edition, 2007. ISBN: 978-1-85617-932-4
5	Strength of Materials, S.Ramamrutham, R Narayanan, 18th Edition, 2014, Dhanapath Rai Publishing Company, New Delhi, ISBN: 978-93-84378-26-4

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20.
Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.

Scheme of Continuous Internal Evaluation (CIE); Practical Test for 50 Marks
The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average marks (AM) over number of weeks is considered for 30 marks. At the end of the semester a test (T) is conducted for 10 marks. The students are encouraged to implement additional innovative experiments (IE) in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.
Total CIE is 30(AM) +10 (T) +10 (IE) =50 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part A and Part B. Part A consists of objective type questions for 20 marks covering the complete syllabus. Part B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Scheme of Semester End Examination (SEE); Practical Exam for 50 Marks
SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Theory (100 Marks) + Practical (50 Marks) = Total 150 Marks

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**2**	**1**	**3**	**1**		**2**		**1**				**1**
CO2	**3**	**2**		**3**		**1**	**1**	**3**				**3**
CO3	**1**	**3**	**3**	**1**		**3**	**1**					**3**
CO4	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**3**				**1**

High-3 : Medium-2: Low-1

Semester- III						
Bridge Course Mathematics (Common to all branches)						
Course Code	**:**	18DMA37		**CIE**	**:**	**50 Marks**
Credits: L:T:P	**:**	2:0:0		**SEE**	**:**	**50 Marks**
Audit Course				**SEE Duration**	**:**	**2.00 Hours**

Course Learning Objectives: The student will be able to	
1	Understand the concept of functions of several variables, types of derivatives involved with these functions and its applications, approximate a function of single variable in terms of infinite series.
2	Acquire concepts of vector functions, scalar fields and differential calculus of vector functions in Cartesian coordinates.
3	Explore the possibility of finding approximate solutions using numerical methods in the absence of analytical solutions of various systems of equations.
4	Recognize linear differential equations, apply analytical techniques to compute solutions.
5	Gain knowledge of multiple integrals and their applications.
6	Use mathematical IT tools to analyze and visualize the above concepts.

Unit – I	**05 Hrs**
Differential Calculus: Taylor and Maclaurin series for function of single variable. Partial derivatives – Introduction, simple problems. Total derivative, composite functions. Jacobians – simple problems.	
Unit – II	**05 Hrs**
Vector Differentiation: Introduction, simple problems in terms of velocity and acceleration. Concepts of gradient, divergence – solenoidal vector function, curl – irrotational vector function and Laplacian, simple problems.	
Unit – III	**06 Hrs**
Differential Equations: Higher order linear differential equations with constant coefficients, solution of homogeneous equations - Complementary functions. Non homogeneous equations –Inverse differential operator method of finding particular integral based on input function (force function).	
Unit – IV	**05 Hrs**
Numerical Methods: Solution of algebraic and transcendental equations – Intermediate value property, Newton-Raphson method. Solution of first order ordinary differential equations – Taylor series and 4^{th} order Runge-Kutta methods. Numerical integration – Simpson's $1/3^{rd}$, $3/8^{th}$ and Weddle's rules. (All methods without proof)**.**	
Unit – V	**05 Hrs**
Multiple Integrals: Evaluation of double integrals, change of order of integration. Evaluation of triple integrals. Applications – Area, volume and mass – simple problems.	

Course outcomes: On completion of the course, the student should have acquired the ability to	
CO 1:	Understand the concept of partial differentiation, double integrals, vector differentiation, solutions of higher order linear differential equations and requirement of numerical methods.
CO 2:	Solve problems on total derivatives of implicit functions, Jacobians, homogeneous linear differential equations, velocity and acceleration vectors.
CO 3:	Apply acquired knowledge to find infinite series expansion of functions, solution of non-homogeneous linear differential equations and numerical solution of equations.
CO 4:	Evaluate triple integrals, area, volume and mass, different operations using del operator on scalar and vector point functions, numerical solution of differential equations and numerical integration.

Reference Books	
1	B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 44th Edition, 2015, ISBN: 978-81-933284-9-1.
2	Higher Engineering Mathematics, B.V. Ramana, 11th Edition, 2010, Tata McGraw-Hill, ISBN: 978-0-07-063419-0.
3	N.P. Bali & Manish Goyal, A Text Book of Engineering Mathematics, Lakshmi Publications, 7th Edition, 2010, ISBN: 978-81-31808320.
4	Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 10th Edition, 2016, ISBN: 978-0470458365.

Continuous Internal Evaluation (CIE); Theory (50 Marks)
CIE is executed by way of quizzes (Q) and tests (T**)**. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. The two tests are conducted for 30 marks each and the sum of the marks scored from two tests is reduced to 30. **Total CIE is 20(Q) +30(T)=50 Marks.**

Semester End Evaluation (SEE); Theory (50 Marks)
SEE for 50 marks is executed by means of an examination. The Question paper for the course consists of five main questions, one from each unit for 10 marks adding up to 50 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Semester: III

VYAVAHARIKA KANNADA
(Common to all branches)

Course Code	**:**	18HS38		**CIE**	**:**	**50 Marks**
Credits: L:T:P	**:**	1:0:0		**SEE**	**:**	**50 Marks**
Total Hours	**:**	16Hrs		**CIE Duration**	**:**	**90 Minutes**

Course Learning Objectives of Vyavaharika Kannada: The students will be able to

1	Motivate students to learn Kannada language with active involvement.
2	Learn basic communication skills in Kannada language (Vyavaharika Kannada).
3	Importance of learning local language Kannada.

VYAVAHARIKA KANNADA (BALAKE Kannada)
(to those students who does not know Kannada)

Unit-I	**4Hrs**

Parichaya(Introduction):
Necessity of learning local language, Tips to learn the language with easy methods, Hints for correct and polite conversation, History of kannada language.

Unit – II	**4Hrs**

Kannada alphabtets and Pronunciation:
Kannada aksharmale, Kannada stress letters (vattakshara), Kannada Khagunitha, Pronunciation, memorisation and usage of the Kannada letters.

Unit – III	**4Hrs**

Kannada vocabulary for communication:
Singular and Plural nouns, Genders, Interrogative words, Antonyms, Inappropriate pronunciation, Number system, List of vegetables, Fractions, Menu of food items, Names of the food items, words relating to time, words relating to directions, words relating to human's feelings and emotion, Parts of the human body, words relating to relationship.

Unit –IV	**4Hrs**

Kannada Grammar in Conversations:
Nouns, Pronouns, Use of pronouns in Kannada sentences, Adjectives and its usage, Verbs, Adverbs, Conjunctions, Prepositions, Questions constructing words, Simple communicative sentences in kannada. Activities in Kannada, Vocabulory, Conversation.

Course Outcomes: After completing the course, the students will be able to

1	Usage of local language in day today affairs.
2	Construction of simple sentences according to the situation.
3	Usage of honorific words with elderly people.
4	Easy communication with everyone.

Reference Books:

1	Vyavaharika Kannada patyapusthaka, L. Thimmesh, and V. Keshavamurthy, Prasaranga Visveshvaraya University, Belgaum.
2	Kannada Kali**,** K. N. Subramanya, S. Narahari, H. G. Srinivasa Prasad, S. Ramamurthy and S. Sathyanarayana, 5th Edition, 2019, RV College of Engineering Bengaluru.
3	Spoken Kannada**,** Kannada Sahithya Parishat, Bengaluru.

ವ್ಯಾವಹಾರಿಕ ಕನ್ನಡ (Kannada Version)

ಅಧ್ಯಾಯ – I	**4Hrs**

ಸ್ಥಳೀಯ ಅಥವಾ ಪ್ರಾದೇಶಿಕ ಭಾಷಾ ಕಲಿಕೆಯ ಅವಶ್ಯಕತೆ, ಭಾಷಾ ಕಲಿಕೆಯ ಸುಲಭ ವಿಧಾನಗಳು, ಸಂಭಾಷಣೆಗಾಗಿ ಸುಲಭ ಸೂಚ್ಯಗಳು ಕನ್ನಡ ಭಾಷೆಯ ಇತಿಹಾಸ.
ಅಧ್ಯಾಯ – II **4Hrs**
ಕನ್ನಡ ಅಕ್ಷರಮಾಲೆ ಹಾಗೂ ಉಚ್ಚಾರಣೆ: ಕನ್ನಡ ಅಕ್ಷರಮಾಲೆ, ಒತ್ತಕ್ಷರ, ಕಾಗುಣಿತ, ಉಚ್ಚಾರಣೆ, ಸ್ವರಗಳು ಉಚ್ಚಾರಣೆ, ವ್ಯಂಜನಗಳ ಉಚ್ಚಾರಣೆ.
ಅಧ್ಯಾಯ – III **4Hrs**
ಸಂಭಾಷಣೆಗಾಗಿ ಕನ್ನಡ ಪದಗಳು: ಏಕವಚನ, ಬಹುವಚನ, ಲಿಂಗಗಳು (ಸ್ತ್ರೀಲಿಂಗ, ಪುಲ್ಲಿಂಗ) ಪ್ರಶ್ನಾರ್ಥಕ ಪದಗಳು, ವಿರುದ್ಧಾರ್ಥಕ ಪದಗಳು, ಅಸಮಂಜಸ ಉಚ್ಚಾರಣೆ, ಸಂಖ್ಯಾ ವ್ಯವಸ್ಥೆ, ಗಣಿತದ ಚಿಹ್ನೆಗಳು, ಭಿನ್ನಾಂಶಗಳು. ತರಕಾರಿಗಳ ಹೆಸರುಗಳು, ತಿಂಡಿಗಳ ಹೆಸರುಗಳು, ಆಹಾರಕ್ಕೆ ಸಂಬಂಧಿಸಿದ ಪದಗಳು, ಕಾಲ/ಸಮಯಕ್ಕೆ ಸಂಬಂಧಿಸಿದ ಪದಗಳು, ದಿಕ್ಕುಗಳ ಹೆಸರುಗಳು, ಭಾವನೆಗೆ ಸಂಬಂಧಿಸಿದ ಪದಗಳು, ಮಾನವ ಶರೀರದ ಭಾಗಗಳು, ಸಂಬಂಧದ ಪದಗಳು, ಸಾಮಾನ್ಯ ಸಂಭಾಷಣೆಯಲ್ಲಿ ಬಳಸುವಂತಹ ಪದಗಳು.
ಅಧ್ಯಾಯ – IV **4Hrs**
ಸಂಭಾಷಣೆಯಲ್ಲಿ ಕನ್ನಡ ಬಳಕೆ: ನಾಮಪದಗಳು, ಸರ್ವನಾಮಗಳು, ನಾಮವಿಶೇಷಣಗಳು, ಕ್ರಿಯಾಪದಗಳು, ಕ್ರಿಯಾವಿಶೇಷಣಗಳು, ಕನ್ನಡದಲ್ಲಿ ಸಂಯೋಜನೆಗಳು, ಉಪಸರ್ಗಗಳು, ಪ್ರಶ್ನಾರ್ಥಕ ಪದಗಳು, ವಿಚಾರಣೆಯ / ವಿಚಾರಿಸುವ / ಬೇಡಿಕೆಯ ವಾಕ್ಯಗಳು. ಕನ್ನಡದಲ್ಲಿ ಚಟುವಟಿಕೆಗಳು, ಶಬ್ದಕೋಶ, ಸಂಭಾಷಣೆ.

ವ್ಯವಹಾರಿಕ ಕನ್ನಡದ ಕಲಿಕಾ ಫಲಿತಾಂಶಗಳು :	
CO1:	ನಿತ್ಯ ಜೀವನದಲ್ಲಿ ಆಡುಭಾಷೆಯ ಬಳಕೆ.
CO2:	ಸಂದರ್ಭ, ಸನ್ನಿವೇಶಕ್ಕನುಗುಣವಾಗಿ ಸರಳ ಕನ್ನಡ ವಾಕ್ಯಗಳ ಬಳಕೆ.
CO3:	ಗೌರವ ಸಂಬೋಧನೆಯ ಬಳಕೆ.
CO4:	ಇತರರೊಡನೆ ಸುಲಭ ಸಂವಹನ.

ಆಧಾರ ಪುಸ್ತಕಗಳು :	
1	ವ್ಯವಹಾರಿಕ ಕನ್ನಡ ಪಠ್ಯಪುಸ್ತಕ, ಎಲ್.ತಿಮ್ಮೇಶ್ ಮತ್ತು ವಿ.ಕೇಶವಮೂರ್ತಿ, ಪ್ರಸಾರಾಂಗ, ವಿಶ್ವೇಶ್ವರಯ್ಯ ತಾಂತ್ರಿಕ ವಿದ್ಯಾಲಯ, ಬೆಳಗಾಂ.
2	ಕನ್ನಡ ಕಲಿ, ಕೆ.ಎನ್.ಸುಬ್ರಹ್ಮಣ್ಯಂ, ಎನ್.ಎಸ್.ನರಹರಿ, ಎಚ್.ಜಿ.ಶ್ರೀನಿವಾಸ ಪ್ರಸಾದ್, ಎಸ್.ರಾಮಮೂರ್ತಿ ಮತ್ತು ಎಸ್.ಸತ್ಯನಾರಾಯಣ, 2ನೇ ಮುದ್ರಣ 2019, ರಾ.ವಿ.ತಾಂತ್ರಿಕ ಮಹಾವಿದ್ಯಾಲಯ, ಬೆಂಗಳೂರು.
3	ಮಾತನಾಡುವ ಕನ್ನಡ, ಕನ್ನಡ ಸಾಹಿತ್ಯ ಪರಿಷತ್, ಬೆಂಗಳೂರು.

Continuous Internal Evaluation (CIE); (50 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Activity. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks and the sum of the marks scored from two quizzes is reduced to 10. The two tests are conducted for 50 marks each and the sum of the marks scored from two tests is reduced to 30. The marks component for Activity is 10. **Total CIE is 10(Q) +30(T) +10(A) = 50 Marks.**

Semester End Evaluation (SEE); Theory (50 Marks)

SEE for 50 marksis executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 25 marks covering the complete syllabus. Part – B consists of essay type questions, one from each unit for 5 marks adding up to 25 marks.

AADALITHA KANNADA
(Common to all branches)

ಆಡಳಿತ ಕನ್ನಡ (ಕನ್ನಡಿಗರಿಗಾಗಿ)

ಆಡಳಿತ ಭಾಷಾ ಕಲಿಕೆಯ ಉದ್ದೇಶಗಳು: ವಿದ್ಯಾರ್ಥಿಗಳಲ್ಲಿ

1	ಆಡಳಿತ ಕನ್ನಡದ ಪರಿಚಯ ಮಾಡಿಕೊಡುವುದು.
2	ಕನ್ನಡ ಭಾಷೆಯ ವ್ಯಾಕರಣದ ಬಗ್ಗೆ ಅರಿವು ಮೂಡಿಸುವುದು.
3	ಕನ್ನಡ ಭಾಷಾ ಬರಹದಲ್ಲಿ ಕಂಡುಬರುವ ದೋಷಗಳು ಹಾಗೂ ಅವುಗಳ ನಿವಾರಣೆ ಮತ್ತು ಲೇಖನ ಚಿಹ್ನೆಗಳನ್ನು ಪರಿಚಯಿಸುವುದು.
4	ಸಾಮಾನ್ಯ ಅರ್ಜಿಗಳು, ಸರ್ಕಾರಿ ಮತ್ತು ಅರೆಸರ್ಕಾರಿ ಪತ್ರ ವ್ಯವಹಾರದ ಬಗ್ಗೆ ಅರಿವು ಮೂಡಿಸುವುದು.
5	ಭಾಷಾಂತರ, ಪ್ರಬಂದ,ರಚನೆ, ಕನ್ನಡ ಭಾಷಾಭ್ಯಾಸ ಮತ ್ತುಆಡಳಿತ ಕನ್ನಡದ ಪದಗಳ ಪರಿಚಯ ಮಾಡಿಕೊಡುವುದು.

ಆಡಳಿತ ಕನ್ನಡ
(ಕನ್ನಡ ಕಲಿತವರಿಗೆ)

ಅಧ್ಯಾಯ –I	**4Hrs**

ಕನ್ನಡ ಭಾಷೆ – ಸಂಕ್ಷಿಪ್ತ ವಿವರಣೆ:

ಪ್ರಸ್ತಾವನೆ–ಕನ್ನಡ ಭಾಷೆ, ಶ್ರಾವಣ (ಕವನ)– ದ.ರಾ.ಬೇಂದ್ರೆ (ಕವಿ), ಬೆಲ್ಜಿಯ ಹಾಡು (ಕವನ) –ಸಿದ್ದಲಿಂಗಯ್ಯ (ಕವಿ)
ಆಡಳಿತ ಭಾಷೆಕನ್ನಡ, ಆಡಳಿತ ಭಾಷೆಯ ಲಕ್ಷಣಗಳು, ಆಡಳಿತ ಭಾಷೆಯ ಪ್ರಯೋಜನಗಳು.

ಅಧ್ಯಾಯ –II	**4 Hrs**

ಭಾಷಾ ಪ್ರಯೋಗದಲ್ಲಾಗುವ ಲೋಪದೋಷಗಳು ಮತ್ತು ಅವುಗಳ ನಿವಾರಣೆ:

ಪ್ರಸ್ತಾವನೆ– ಕಾಗುಣಿತದತಪ್ಪು ಬಳಕೆಯಿಂದಾಗುವ ಲೋಪದೋಷಗಳು ಅಥವಾ ಸಾಧುರೂಪಗಳ ಬಳಕೆ, ಅಲ್ಪ ಪ್ರಾಣ ಮತ್ತು ಮಹಾಪ್ರಾಣಗಳ ಬಳಕೆಯಲ್ಲಿನ ವ್ಯತ್ಯಾಸದಿಂದಾಗುವ ಲೋಪದೋಷಗಳು, ಲೇಖನ ಚಿಹ್ನೆಗಳು, ಕನ್ನಡ ಭಾಷೆಯಲ್ಲಿನ ಲೋಪದೋಷಗಳು ಗೌರವ ಸೂಚಕಗಳ ಬಳಕೆ, ಭಾಷಾ ಬರದಲ್ಲಿ ಅನುಸರಿಸಬೇಕಾದ ಇನ್ನಿತರಕ್ರಮ, ಲೇಖನ ಚಿಹ್ನೆಗಳು ಮತ್ತು ಅವುಗಳ ಉಪಯೋಗ.

ಅಧ್ಯಾಯ –III	**4Hrs**

ಪತ್ರ ವ್ಯವಹಾರ:

ಪ್ರಸ್ತಾವನೆ– ಖಾಸಗಿ ಪತ್ರ ವ್ಯವಹಾರ, ಆಡಳಿತ ಪತ್ರಗಳು, ಅರ್ಜಿಯ ವಿವಿಧ ಬಗೆಗಳು ಮತ್ತು ಮಾದರಿಗಳು.

ಅಧ್ಯಾಯ –IV	**4Hrs**

ಪ್ರಬಂಧ, ಸಂಕ್ಷಿಪ್ತ ಪ್ರಬಂಧರಚನೆ ಮತ್ತು ಭಾಷಾಂತರ:

ಕನ್ನಡ ಶಬ್ಧಸಂಗ್ರಹ, ಜೋಡಿನುಡಿಗಳು, ಅನುಕರಣಾವ್ಯಯಗಳು, ಸಮಾನಾರ್ಥಕ ಪದಗಳು, ನಾನಾರ್ಥಗಳು, ವಿರುದ್ಧಪದಗಳು, ತತ್ಸಮ–ತದ್ಭವಗಳು, ದ್ವಿರುಕ್ತಿಗಳು, ನುಡಿಗಟ್ಟುಗಳು, ಶಬ್ಧಸಮೂಹಕ್ಕೆ ಒಂದು ಶಬ್ಧ, ಅನ್ಯದೇಶೀಯ ಪದಗಳು, ದೇಶೀಯಪದಗಳು.

ಆಡಳಿತ ಕನ್ನಡದ ಕಲಿಕಾ ಫಲಿತಾಂಶಗಳು:

CO1:	ಕನ್ನಡ ಬರಹದಲ್ಲಿ ವ್ಯಾಕರಣದ ಬಳಕೆ.
CO2:	ಕನ್ನಡದಲ್ಲಿ ಪತ್ರ ಬರೆಯುವಿಕೆ.
CO3:	ಕನ್ನಡ ಸಾಹಿತ್ಯ ಹಾಗೂ ಸಂಸ್ಕೃತಿಯ ಬಗ್ಗೆ ಆಸಕ್ತಿ ಮೂಡುವುದು.

ಆಧಾರ ಪುಸ್ತಕಗಳು :

1	ಆಡಳಿತ ಕನ್ನಡ ಪಠ್ಯಪುಸ್ತಕ, ಎಲ್.ತಿಮ್ಮೇಶ್ ಮತ್ತು ವಿ.ಕೇಶವಮೂರ್ತಿ, ಪ್ರಸಾರಾಂಗ, ವಿಶ್ವೇಶ್ವರಯ್ಯ ತಾಂತ್ರಿಕ ವಿದ್ಯಾಲಯ, ಬೆಳಗಾಂ.
2	ಕನ್ನಡ ಅನುಭವ, ಕೆ.ಎನ್.ಸುಬ್ರಹ್ಮಣ್ಯಂ, ಎನ್.ಎಸ್.ನರಹರಿ, ಎಚ್.ಜಿ.ಶ್ರೀನಿವಾಸಪ್ರಸಾದ್, ಎಸ್.ರಾಮಮೂರ್ತಿ ಮತ್ತು ಎಸ್.ಸತ್ಯನಾರಾಯಣ, 2ನೇ ಮುದ್ರಣ 2019, ರಾ.ವಿ.ತಾಂತ್ರಿಕ ಮಹಾವಿದ್ಯಾಲಯ, ಬೆಂಗಳೂರು.

Continuous Internal Evaluation (CIE); (50 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Activity. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks and the sum of the marks scored from two quizzes is reduced to 10. The two tests are conducted for 50 marks each and the sum of the marks scored from two tests is reduced to 30. The marks component for Activity is 10. **Total CIE is 10(Q) +30(T) +10(A) = 50 Marks.**

Semester End Evaluation (SEE); Theory (50 Marks)

SEE for 50 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 10 marks covering the complete syllabus. Part – B is for 40 marks. It consists of essay type questions. Student has to answer any 4 questions out of 5 questions, each question carries 10 marks.

Semester: IV						
ENGINEERING MATHEMATICS – IV (Theory) (Common to AS, CH, CV & ME)						
Course Code	**:**	18MA41C		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	4:1:0		**SEE**	**:**	**100 Marks**
Hours	**:**	52L+13T		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The student will be able to	
1	Understand practical situations in various areas of engineering and science to formulate linear programming problems to get optimum solution.
2	Apply the knowledge of differential and integral calculus to functions of complex variables.
3	Analyze the set of data and fit suitable approximating curves.
4	Interpret concept of probability to solve random physical phenomena and implement the proper distribution model.
5	Use mathematical IT tools to analyze and visualize the above concepts.

Unit-I	**10 Hrs**
Linear Programming: Mathematical formulation of Linear Programming Problem (LPP). Solving LPP using Graphical, Simplex and Big M methods. Exploring optimization techniques using MATLAB.	
Unit –II	**11 Hrs**
Complex Analysis: Analytic function – Cauchy-Riemann equations in Cartesian and polar forms, harmonic functions. Construction of analytic functions by Milne-Thomson method. Complex potential, stream and potential functions. Complex integration – Cauchy's theorem, Taylor's and Laurent's series, singularities, poles, residues, residue theorem, problems (all theorems without proof).	
Unit –III	**11 Hrs**
Statistics: Central moments, mean, variance, coefficients of skewness and kurtosis in terms of moments. Curve fitting by method of least squares, fitting of curves – polynomial, exponential and power functions. Correlation and linear regression analysis, application problems. Simulation using MATLAB.	
Unit –IV	**10 Hrs**
Probability and Distributions: Random variables – discrete and continuous. Probability distribution function, cumulative distribution function. Binomial, Poisson, Exponential and Normal distributions. Simulation using MATLAB.	
Unit –V	**10 Hrs**
Joint Probability Distribution and Markov Chain: Joint distribution of random variables – Expectation, covariance and correlation. Markov chain – Stochastic matrices, higher transition probabilities, regular stochastic matrices, probability vector.	

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the concept of linear programming problems (LPP), analytic functions, statistical measures, curve fitting and random variables.
CO2	Solve problems on LPP graphically, analytic functions, correlation between two variables and probability distribution functions.
CO3	Apply gained knowledge for curve fitting, solution of LPP using simplex method, Taylor's and Laurent's series and different distributions.
CO4	Estimate optimal solution of LPP using Big M method, regression lines, residues and regular

	stochastic matrices.

Reference Books	
1	Higher Engineering Mathematics, B.S. Grewal, 44th Edition, 2015, Khanna Publishers, ISBN: 81-7409-195-5.
2	Higher Engineering Mathematics, B.V. Ramana, 11th Edition, 2010, Tata McGraw-Hill, ISBN: 13-978-07-063419-0; ISBN: 10-0-07-063419-X.
3	Advanced Engineering Mathematics, Erwin Kreyszig, 9th Edition, 2007, John Wiley & Sons, ISBN: 978-81-265-3135-6.
4	Probability, Statistics and Random Processes, T. Veerarajan, 3rd Edition, 2008, Tata McGraw-Hill, ISBN: 978-0-07- 066925-3.

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20. **Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.**

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	-	-	-	-	-	-	-	-	1
CO2	3	2	-	-	-	-	-	-	-	-	-	1
CO3	1	2	2	-	-	-	-	-	-	-	-	1
CO4	-	1	1	3	-	-	-	-	-	-	-	1

High-3 : Medium-2 : Low-1

Semester: III		
ENVIRONMENTAL TECHNOLOGY **(Theory)** **(Common to CV, ME, IM, CH, BT & AS)**		
Course Code: 18BT42A		**CIE Marks: 50**
Credits: L:T:P: 2:0:0		**SEE Marks: 50**
Hours: 27L		**SEE Duration (Theory): 90 min**

Course Learning Objectives:	
1	Understand the various components of environment and the significance of the sustainability of healthy environment.
2	Recognize the implications of different types of the wastes produced by natural and anthropogenic activity.
3	Learn the strategies to recover the energy from the waste.
4	Design the models that help mitigate or prevent the negative impact of proposed activity on the environment.

Unit I	**06 Hrs**

Introduction:
Environment - Components of environment, Ecosystem. Impact of anthropogenic activities on environment (agriculture, mining and transportation), Environmental education, Environmental acts & regulations, role of non-governmental organizations (NGOs), EMS: ISO 14000, Environmental Impact Assessment. Environmental auditing.

Unit II	**06 Hrs**

Environmental pollution:
Air pollution:
Point and non-point sources of air pollution and their controlling measures (particulate and gaseous contaminants). Noise pollution, Land pollution (sources, impacts and remedial measures).
Water management:
Water conservation techniques, water borne diseases & water induced diseases, arsenic & fluoride problems in drinking water and ground water contamination, advanced waste water treatment techniques.

Unit III	**06 Hrs**

Waste management:
Solid waste management, e waste management & biomedical waste management – sources, characteristics & disposal methods. Concepts of Reduce, Reuse and Recycling of the wastes.
Energy:
Different types of energy, conventional sources & non-conventional sources of energy, solar energy, hydro electric energy, wind energy, Nuclear energy, Biomass & Biogas Fossil Fuels, Hydrogen as an alternative energy.

Unit IV	**05 Hrs**

Environmental Design:
Principles of Environmental design, Green buildings, green materials, Leadership in Energy and Environmental Design (LEED), soilless cultivation (hydroponics), organic farming, use of biofuels, carbon credits, carbon foot prints, Opportunities for green technology markets, carbon sequestration.

Unit V	**04 Hrs**

Resource Recovery System:
Processing techniques, materials recovery systems, biological conversion (composting and anaerobic digestion). Thermal conversion products (combustion, incineration, gasification, pyrolysis, use of Refuse Derived Fuels). Case studies of Biomass conversion, e waste.

Course Outcomes: After completing the course, the students will be able to	
CO1:	Identify the components of environment and exemplify the detrimental impact of

	anthropogenic activities on the environment.
CO2:	Differentiate the various types of wastes and suggest appropriate safe technological methods to manage the waste.
CO3:	Aware of different renewable energy resources and can analyse the nature of waste and propose methods to extract clean energy.
CO4:	Adopt the appropriate recovering methods to recover the essential resources from the wastes for reuse or recycling.

Text Books

1.	Gilbert, M.M. Introduction to environmental engineering and science, Pearson Education. India: 3rd Edition (2015). ISBN: 9332549761, ISBN-13: 978-9332549760.
2.	Howard S. Peavy, Donald R. Rowe and George Tchobanoglous. 2000. Environmental Engineering, McGraw Hill Education, First edition (1 July 2017). ISBN-10**:** 9351340260, ISBN-13**:** 978-9351340263

Reference Books	
1.	Environmental Science, G. Tyler Miller and Scott Spoolman, 15th Edition, 2012, Brooks Cole, ISBN-13: 978-1305090446 ISBN-10: 130509044
2.	Environment Management, Vijay Kulkarni and T V Ramachandra, 2009, TERI Press, ISBN: 8179931846, 9788179931844
3.	Environmental Engineering and Management, Suresh K. Dhameja, S.K. Kataria and sons, 2010, ISBN-10**:** 8185749450**,** ISBN-13: 978-8185749457
4.	Environmental Systems Engineering, Linvil Gene Rich, 2003,McGraw-Hill ISBN: 9780070522503

Continuous Internal Evaluation (CIE); Theory (50 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks which will be reduced to 15marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 25 marks each and the sum of the marks scored from three tests is reduced to 30. The marks component for assignment is 05.

The total marks of CIE is 15(Q) + 30(T) + 05(A) = 50 marks.

Semester End Evaluation (SEE); Theory (50 Marks)

SEE for 50 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 10 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 08 marks adding up to 40 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO PO mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**L**						**H**		**M**	**-**		**-**
CO2	**M**	**H**	**H**	**M**	**L**		**H**	**H**	**M**	**-**	**M**	**L**
CO3		**H**	**L**	**H**		**M**	**H**	**H**	**M**	**-**	**L**	**M**
CO4	**L**		**M**	**L**	**H**		**M**		**M**	**-**		**M**

Semester: IV						
AERODYNAMICS (Theory & Practice)						
Course Code	**:**	18AS43		**CIE**	**:**	**100+50 Marks**
Credits: L:T:P	**:**	3:0:1		**SEE**	**:**	**100 +50 Marks**
Hours	**:**	39L+32.5P		**SEE Duration**	**:**	**3.00+3.00 Hours**

Course Learning Objectives: To enable the students to:	
1	Extend the fundamentals of fluid mechanics to analyze different aerodynamic problems
2	Understand the importance of potential flows in assessing the flows over various bodies
3	Assess the behaviour of various airfoils and wings subjected to incompressible flows
4	Familiarize with types of wind tunnels, instrumentation and measurement techniques

Unit-I	**09 Hrs**
Fundamentals of Aerodynamics : Basic Governing Equations: Continuity, Momentum, Energy and Navier-Stokes equation, Angular velocity, Vorticity, Strain, Circulation, Stream Function, Velocity Potential, Coefficient of Pressure, Pressure Distribution on Airfoil.	

Unit -II	**09 Hrs**
Potential Flows : Governing Equation: Laplace Equation, 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.	

Unit -III	**07 Hrs**
Incompressible Flow over Airfoils: Airfoil characteristics, Vortex Sheet, The Kutta Condition, Kelvin's circulation theorem and the starting vortex, Classical thin airfoil theory for symmetric Airfoil and cambered airfoil, Effect of Airfoil Thickness, Camber on the Airfoil Aerodynamic Characteristics.	

Unit -IV	**08 Hrs**
Incompressible Flow Over Finite Wings : Downwash and induced drag on wings, Vortex Filament, Biot-Savart law and Helmholtz's theorems, Infinite and semi-infinite vortex filament, Prandtl's classical lifting line theory, Limitations of Prandtl's lifting line theory, Lifting surface theory: Vortex Lattice Method, Panel Method.	

Unit -V	**06 Hrs**
Introduction to Aerodynamic Testing: Flow Similarity, Principles of wind tunnel operation: Low speed, Transonic, supersonic and Hypersonic wind tunnels, Measurement Techniques in Wind Tunnels: Pressure Measurements, Force Balance, Hot wire anemometer.	

LABORATORY EXPERIMENTS

1. Calibration of a subsonic wind tunnel
2. Smoke flow visualization studies on a two-dimensional bluff and streamlined bodies at low speeds.
3. Tuft flow visualization on a wing model at different angles of incidence at low speeds.
4. Surface pressure distributions on a two-dimensional circular cylinder at low speeds and calculation of pressure drag
5. Surface pressure distributions on a two-dimensional symmetric airfoil at zero incidences at low speeds
6. Surface pressure distributions on a two-dimensional cambered airfoil at different angles of

incidence and calculation of lift and pressure drag. 7. Calculation of total drag of a two-dimensional circular cylinder at low speeds using pitot-static probe wake survey technique 8. Calculation of total drag of a two-dimensional cambered airfoil at low speeds at incidence using wake survey technique 9. Measurement of typical wall boundary layer characteristics 10. Measurement of turbulence intensity using hot wire anemometer 11. Measurement of flow angularity Study of potential flow using Hele-Shaw Apparatus

Course Outcomes:	
At the end of this course the student will be able to :	
CO 1:	Apply the principles of Fluid Mechanics in designing & developing highly efficient aerodynamic bodies
CO 2:	Signify the role of various fundamental potential flows in assessing the aerodynamic behaviour of various bodies
CO 3:	Determine the Aerodynamic characteristics of airfoils and wings subjected to incompressible flows
CO 4:	Evaluate aerodynamic performance characteristics of various aerodynamic bodies using wind tunnel measurement techniques

Reference Books	
1	Fundamentals of Aerodynamics, Anderson J .D, 5th Edition, 2011, McGraw-Hill International Edition, New York ISBN:9780073398105.
2	Aerodynamics for Engineering Students, E. L. Houghton, P.W, Carpenter 5th Edition, 2010, Elsevier, New York. ISBN: 9780080493855.
3	Aerodynamics, Clancy L. J., Sterling book house, 5th Edition, 2006, New Delhi. ISBN: 9788175980570.
4	Theoretical Aerodynamics, Louis M. Milne-Thomson, Imported Edition,. 4th Edition, 2011, Dover Publications, USA, ISBN: 080-075961980.
5	Low-Speed Wind Tunnel Testing, Jewel B Barlow, William H Rae, Alan Pope. 3rd Edition, 1999, John Wiley & Sons, ISBN-10: 0471557749 ISBN-13: 978-0471557746.

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20.

Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.

Scheme of Continuous Internal Evaluation (CIE); Practical Test for 50 Marks

The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average marks (AM) over number of weeks is considered for 30 marks. At the end of the semester a test (T) is conducted for 10 marks. The students are encouraged to implement additional innovative experiments (IE) in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.

Total CIE is 30(AM) +10 (T) +10 (IE) =50 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part A and Part B. Part A consists of objective type questions for 20 marks covering the complete syllabus. Part B consists of five main questions, one from each unit for 16

marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Scheme of Semester End Examination (SEE); Practical Exam for 50 Marks
SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Theory (100 Marks) + Practical (50 Marks) = Total 150 Marks

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**1**	**2**	**3**	**2**		**2**	**2**	**3**	**1**			**3**
CO2	**3**	**2**	**3**	**3**		**2**	**2**	**2**				**2**
CO3	**3**	**3**	**3**	**3**		**3**						**3**
CO4	**3**	**3**	**3**	**3**	**3**	**1**	**3**	**1**				**2**

High-3 : Medium-2: Low-1

Semester-IV						
AEROSPACE STRUCTURES (Theory & Practice)						
Course Code	**:**	18AS44		**CIE**	**:**	**100+50 Marks**
Credits: L:T:P	**:**	3:0:1		**SEE**	**:**	**100 +50 Marks**
Hours	**:**	39L+32.5P		**SEE Duration**	**:**	**3.00+3.00 Hours**

Course Learning Objectives: To enable the students to:	
1	Assess load characteristics on different aerospace structures and suggest suitable design considerations
2	Understand and comprehend behaviour of aerospace structures under different loading conditions
3	Quantitatively analyse the loads acting on the fuselage and the wings
4	Design effective solutions for practical problems

Unit-I	**08 Hrs**
Loads on Aircrafts: Structural nomenclature, Load Factors, Wing Design Loads, Empennage Loads, and Fuselage loads, Propulsion Loads, landing gear loads, Miscellaneous loads, Velocity diagram V-n diagram for the loads acting on the aircraft, salient features of the V-n diagram. Flight envelope for different flying conditions	

Unit -II	**09 Hrs**
Shear Flow in Open & Closed Sections: Open Sections: Concept of shear flow, Shear Flow in Thin walled beams, the shear centre and Elastic axis. **Closed Sections***:* Bredt - Batho theory, shear centre of closed sections, Torsion of closed section box beams, shear flow in closed section box beams	

Unit -III	**08 Hrs**
Buckling of Columns : Introduction, Critical Load, Euler's Critical Load for various end conditions, Slenderness ratio, Rankine's Crippling Load, Design of columns under centric and eccentric loading	
Unit -IV	**07 Hrs**
Design of Aircraft Structures: Design criteria, Safety Factor, Life Assessment procedures, Damage tolerance and Fail safe Design. High strain rate response of materials, creep and fatigue failure in aircraft components	

Unit -V	**07 Hrs**
Bolted Riveted and Welded Connections: Failure of single bolt fitting, Lug strength analysis under Axial, Transverse and Oblique Loading, Riveted Connections, Welded Connections.	

LABORATORY EXPERIMENTS
1. Measurement of Creep rates at room temperature in Aerospace Alloys 2. Measurement of Creep rates at elevated temperature in Aerospace Alloys 3. Characterization of Aerospace Alloys under impact velocity 4. Energy absorbed of axial structures under an impact velocity 5. Geometry cleanup for FE modelling 6. 2D Meshing of Aerospace Component 7. Solid and 3D meshing of Aerospace Component 8. Failure of a circular plate subjected to the impact of an infinite rigid sphere 9. Introduction on how to simulate a bird strike on the windshield 10. Study of the stress wave propagation and the strain rate effect on the Hopkinson bar 11. Topology Optimization of Aerospace Components 12. Shape Optimization of Aerospace Components

Course Outcomes: At the end of this course the student will be able to :	
CO 1:	Understand and comprehend the loading behaviour on aircrafts.
CO 2:	Develop solutions to analyse the structures response to load.
CO 3:	Assess the influence of shear flow in open and closed sections
CO 4:	Quantitatively analyse the loads acting on the fuselage and the wings

Text Books	
1	Aircraft Structures for Engineering Students, Megson, T.M.G, 3rd Edition, 1995, Edward Arnold ISBN: 978-0-75066-7395
2	Analysis of Aircraft Structures – An Introduction, Donaldson, B.K., 2nd Edition 2012, McGraw-Hill, ISBN:978-0521865838
3	Aircraft Structures, Peery, D.J., and Azar, J.J., 2nd Edition, 1993, McGraw, Hill, N.Y. ISBN-10:0486485803
4	Mechanics of Aircraft Structures, C. T. Sun, 1st Edition, March 1998, Wiley-Interscience, ISBN-13: 9780471178774

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20.
Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.

Scheme of Continuous Internal Evaluation (CIE); Practical Test for 50 Marks
The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average marks (AM) over number of weeks is considered for 30 marks. At the end of the semester a test (T) is conducted for 10 marks. The students are encouraged to implement additional innovative experiments (IE) in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.
Total CIE is 30(AM) +10 (T) +10 (IE) =50 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part A and Part B. Part A consists of objective type questions for 20 marks covering the complete syllabus. Part B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Scheme of Semester End Examination (SEE); Practical Exam for 50 Marks
SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Theory (100 Marks) + Practical (50 Marks) = Total 150 Marks

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**1**	**2**	**3**	**2**		**2**	**2**	**3**	**1**			**3**
CO2	**3**	**2**	**3**	**3**		**2**	**2**	**2**				**2**
CO3	**3**	**3**	**3**	**3**		**3**						**3**
CO4	**3**	**3**	**3**	**3**	**3**	**1**	**3**	**1**				**2**

High-3 : Medium-2: Low-1

Semester: VI						
ELECTRONICS & COMMUNICATION SYSTEMS (Theory)						
Course Code	**:**	18AS45		**CIE**	**:**	**100 Marks**
Credits: L:T:P	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Hours	**:**	39L		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: To enable the students to:	
1	Acquire In-depth knowledge of Electronic components and circuits as modules
2	Understand the Fundamentals of Analog & Digital Communication.
3	Acquire In-depth knowledge of Digital Communication Techniques.
4	Understand the Manufacturing of Electronic components and circuits as modules.

Unit-I	**09 Hrs**
Electronic Circuits: Basics of Semiconductors; Diode/Transistor basics and characteristics; Diodes for different uses; Junction & Field Effect Transistors (BJTs, JFETs, MOSFETs); Transistor amplifiers of different types, oscillators and other circuits; Basics of Integrated Circuits (ICs); Bipolar, MOS and CMOS ICs; Basics of linear ICs, operational amplifiers and their applications-linear/non-linear; Optical sources/detectors; Basics of Optoelectronics and its applications. Analysis/design of Amplifiers, Oscillators, Mixers & Modulators / Demodulators - single/multi-stage; Feedback & uses; Active filters, Timers, Multipliers, Wave shaping, A/D-D/A converters; Boolean Algebra& uses; Logic gates, Digital IC families, Combinatorial/sequential circuits; Basics of multiplexers, counters/registers/ memories /microprocessors, design& applications.	

Unit -II	**09 Hrs**
Electronic Manufacturing: Crystal structure & defects; Ceramic materials-structures, composites, processing and uses; Insulating laminates for electronics, structures, properties and uses; Magnetic materials, basics, classification, ferrites, ferro/para-magnetic materials and components; Nano materials-basics, preparation, purification, sintering, nanoparticles and uses; Nano-optical/magnetic/electronic materials and uses; Superconductivity, uses. **VLSI Technology**: Processing, lithography, interconnects, packaging, testing; VLSI design: Principles, MUX/ROM/PLA-based design, Moore & Mealy circuit design; Pipeline concepts & functions; Design for testability, examples.	

Unit -III	**08 Hrs**
Elements of Communication Systems: Definition of Signal & System, Types of Signals, Classification of Signals, Classification of Systems; Signals – Amplitude, Frequency & Phase. Gain, Attenuation & Decibels; Tuned Circuits & Filters, Electromagnetic Spectrum; Basics of E M Wave, Polarization, Types of Polarization, Noise; Modulator / Demodulator, Transmitter/Receiver, Phase lock loop demodulator. **Propagation of EM Waves**: Different mode of radio wave Propagation, surface wave troposphere duct Propagation, Tropo-scatter Propagation, ionosphere Propagation, magneto-ionic theory secant law, MUF, critical frequency, skip distance. **Transmission lines & Antenna**: Oscillating dipole: Electromagnetic radiation, retarding potential, Antenna parameters: directivity, beam width, gain, radiation, thin linear antenna, loop antenna, long wire antenna, rhombic antenna. Antenna array: broadside and fire array, pattern multiplication, Ground proximity effect, Two and Three-dimensional arrays. Array pattern synthesis: Binomial array, Techebyshev array. Broadband antenna: Yagi-Uda array, log periodic array, disc one and helical antenna turn style antenna. Aperture antenna, abinet's principle.	

Unit -IV	**07 Hrs**
Analog and Digital Communication Systems: Random signals, noise, probability theory, information theory; Analog versus digital communication & applications: Systems- AM, FM,	

transmitters/receivers, theory/practice/ standards, SNR comparison.
Digital Communication Basics: Sampling, quantizing, coding, PCM, DPCM, multiplexing-audio/video; Digital modulation: ASK, FSK, PSK; Multiple access: TDMA, FDMA, CDMA.
Digital Signal Processing: Discrete time signals/systems, uses; Digital filters: FIR/IIR types, design, speech/audio/radar signal processing uses.
Embedded systems.- Introduction & Concepts

Unit -V	**6 Hrs**
Components of Microwave Communication: Wave Guides: Rectangular and circular type, TE and TM waves in wave guides, their transmission properties and attenuation. Transmission line of wave guide, Wave guide resonator, loaded and unloaded, Q. Dielectric slab wave guide. **Microwave generation and amplification**: Two-cavity klystron, Magnetron, TWT amplifier, solid state parametric amplifier, Tunnel diode amplifier and oscillator, Gno oscillator, IMPATT, TRAPATT AND Baritt, oscillator, Maser. **Microwave components**: Adaptor, Attenuator, Directional coupler, Tee, Wave meter, Circulator, filter, TR and ATR cells. **Microwave Antenna:** Open wave-guide, Horn, Parabolic Reflector and its feed, Cassegrain antenna, wave-guide, slot array, lens antenna. Receiving antenna: reciprocity theorem, effective aperture. Friss transmission formula, antenna noise temperature. noise temperature.	

Course Outcomes:	
At the end of this course the student will be able to :	
CO 1:	Summarize importance of electronic devices and their applications in communication systems.
CO 2:	Explain the process of E M Wave propagation and its application in Radar & Communication.
CO 3:	Understand the processes of manufacturing electronics & microwave devices.
CO 4:	Develop understanding for different types of communicational techniques.

Reference Books	
1	Integrated Electronics , Millman & Halkias, 2nd Edition, 1 July 2017, McGraw Hill Education, ISBN-13: 978-0070151420
2	Microelectronics, Millman & Grabel, , 2nd Edition, 2017, McGraw Hill Education,ISBN-13: 978-0074637364
3	Digital Signal Processing Signals, Systems and Filters, A. Antoniou, 1st Edition, October 10, 2005, McGraw-Hill Education, ISBN-13: 978-0071454247
4	CMOS VLSI Design : A circuits &Systems Perspective, Neil H.E Weste, Kim Haase, David Harris, A. Banerjee, 2nd Edition, 1st March 2010, Pearson Education , ISBN-13: 978-0321547743
5	VLSI Design techniques for Analog and Digital Circuits, R. L. Geiger, P.E.Allen, Noel R. Strader,, 1st Edition, 23rd April 2010, McGraw-Hill International Edition, ISBN-13: 978-0070702486

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20.
Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part A and Part B. Part A consists of objective type questions for 20 marks covering the complete syllabus. Part B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**1**	**3**	**1**	**3**	**1**	**1**	**1**	**-**	**-**	**-**	**2**
CO2	**3**	**2**	**3**	**1**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**1**
CO3	**3**	**3**	**3**	**2**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**2**
CO4	**3**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**-**	**-**	**-**	**1**

High-3 : Medium-2 : Low-1

Semester: IV						
AEROSPACE MANUFACTURING TECHNOLOGY (Theory & Practice)						
Course Code	**:**	18AS46		**CIE**	**:**	**100+50 Marks**
Credits: L:T:P	**:**	3:0:1		**SEE**	**:**	**100 +50 Marks**
Hours	**:**	39L+32.5P		**SEE Duration**	**:**	**3.00+3.00 Hours**

Course Learning Objectives: To enable the students to:	
1	Acquire knowledge of limits, fits and tolerances
2	Understand the processes of casting, forging and extrusion
3	Familiarise with numerous machining and Finishing operations employed in the manufacturing industries.
4	Outline the different types of sheet metal processes
5	Identify and utilize suitable fabrication technique for a given application

Unit-I	**08 Hrs**
Limits, Fits and Tolerances: Introduction, Concept of interchangeability, Selective assembly, System Assembly, System Terminologies, Limits and Tolerances, Systems of Fit, Geometrical Tolerances, Types of Gauges **Casting Processes:** Types of Pattern, Moulding Material and Properties, Sand moulding, Centrifugal casting, Pressure casting, Continuous casting; Advantages, Die Casting, Investment Casting, Evaporative Pattern Casting, Application in aerospace	
Unit – II	**08 Hrs**
Metal Cutting: Orthogonal and Oblique Cutting, Mechanics of Chip Formation, Types of Chips, Merchants theory, Thermodynamics in Metal Cutting, Cutting Parameters- Materials & Tool wear and Tool Life, Machining of Various Metals Used in aerospace materials-Aluminium, Titanium, Steel-composite.	
Unit -III	**08 Hrs**
Sheet Metal Working: Shearing mechanism, Processes like blanking, piercing, punching, trimming. Forming processes like bending, cup drawing, coining, embossing. Presses for sheet metal working; Part feeding systems; Elements of die; punch and die clearances; Progressive, compound and combination dies. High energy rate forming processes. Applications of sheet formed products in Aerospace **Powder Metallurgy:** Introduction. Production of metal powders. Compaction and sintering processes. Secondary and finishing operations. Economics, advantages, and applications of powder metallurgy in Aerospace Parts.	

Unit -IV	**07 Hrs**
Processing of Composite: Role of Composites in Major Aircraft Components, Hand Layup Machine Layup, Filament Winding, Tape Lamination, Fiber Placement, Drape Forming, Liquid Composite Molding -Resin Transfer Molding, Vacuum-Assisted RTM, Resin Film Infusion, Pultrusion.	
Unit -V	**08 Hrs**
Welding & Joining Technologies: Types of Electrodes, specification of electrodes, Friction Welding (Rotary, Linear, Friction-Stir Welding) Types of Welding -Laser, Electron Beam, TIG, MIG, Welding Defects. **Surface Technology:** Surface Smoothing, Surface Cleaning, Surface Protection, Roll Burnishing and Ballizing, Deburring. **Advanced Manufacturing Processes:** Rapid Prototyping, Direct Metal Deposition, Fine blanking, Immersive Virtual Reality.	

LABORATORY EXPERIMENTS
PART-I SAND TESTING, FOUNDRY & FORGING 1. Preparation of Green Sand Mould specimen and determination of Mechanical Properties using Universal Sand Testing Machine 2. Determination of Permeability of Green Sand. 3. Forging and Microstructural analysis of mild steel 4. Composite Preparation using Hand Lay-up Process 5. Preparation of moulds using two moulding boxes With Patterns Without Patterns **PART –II MACHINING PROCESS** 6. Preparation of Model Involving different lathe operation Thread Cutting Knurling 7. Measurement of Cutting Forces using Lathe Tool Dynamometer 8. Surface Milling & Step Milling in Vertical Milling Machine **PART-III METROLOGY** 9. Measurement of Angle using Sine Bar, Sine Centre and Bevel Protractor 10. Measurement of Gear Tooth Profile using Profile Projector 11. Calibration of LVDT and Thermocouple 12. Calibration of Load Cell and Pressure Gauge **DEMONSTRATION EXERCISES** 13. Electric Discharge Machining &Rapid Prototyping Process 14. Tungsten Inert-Gas Welding Preparation of Casting. (Aluminum or Cast iron)

Course Outcomes: At the end of this course the student will be able to :	
CO 1:	Comprehend the concept of Limits, Fits and tolerances and their influence in manufacturing processes.
CO 2:	Design and examine the influence of stresses developed during the metal cutting and Heat Treatment.
CO 3:	Classify and categorize Composite Manufacturing with respect to different processes.
CO 4:	Analysing various Welding technologies and Advanced Manufacturing Process implemented in the Aerospace industries

Reference Books	
1	Aerospace Manufacturing Processes, Pradip K. Saha, 1st Edition, 2016, CRC Press, ISBN: 9781315367965
2	Fundamental of Metal Machining, G.Boothroyd, 2nd Edition, 1975 McGraw Hill, ISBN:824778529
3	Manufacturing Engineering & Technology, Serope Kalpakjian, 11th Edition, 2013, Pearson Publishers ISBN-10: 8177581708.
4	Manufacturing Technology Materials, Processes, and Equipment, Helmi A. Youssef, Hassan A. El-Hofy, Mahmoud H. Ahmed, 4th Edition 2011 CRC Press, ISBN:978143981085
5	Metrology & Measurement, Anand K Bewoor, Vinay A Kulkarni, 4th Edition, 2009, McGraw-Hill. ISBN 10-0-07-014000-6
6	Advanced Manufacturing Technologies, Stephen F. Krar and Arthur R, 1st Edition, 2003 Gill Industrial Press Inc. ISBN:0831131500

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and experiential learning (EL). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for experiential learning is 20.
Total CIE is 30(Q) +50(T) +20(EL) =100 Marks.

Scheme of Continuous Internal Evaluation (CIE); Practical Test for 50 Marks
The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average marks (AM) over number of weeks is considered for 30 marks. At the end of the semester a test (T) is conducted for 10 marks. The students are encouraged to implement additional innovative experiments (IE) in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.
Total CIE is 30(AM) +10 (T) +10 (IE) =50 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part A and Part B. Part A consists of objective type questions for 20 marks covering the complete syllabus. Part B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Scheme of Semester End Examination (SEE); Practical Exam for 50 Marks
SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Theory (100 Marks) + Practical (50 Marks) = Total 150 Marks

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**2**	**3**	**2**		**2**	**2**					**2**
CO2	**1**	**1**	**3**	**3**		**1**	**1**					**2**
CO3	**3**	**2**	**3**	**1**		**1**	**1**					**1**
CO4	**3**	**2**	**3**	**1**		**2**	**2**					**1**

High-3 : Medium-2: Low-1

Semester: IV						
Design Thinking Lab						
Course Code	**:**	**18AS47**		**CIE**	**:**	**50 Marks**
Credits: L:T:P	**:**	**0:0:2**		**SEE**	**:**	**50 Marks**
Hours	**:**	**26P**		**SEE Duration**	**:**	**02 Hours**

Course Learning Objectives: To enable the students to:

1	***Knowledge Application:*** Acquire the ability to make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to provide solutions of societal concern
2	***Communication:*** Acquire the skills to communicate effectively and to present ideas clearly and coherently to a specific audience in both the written and oral forms.
3	***Collaboration:*** Acquire collaborative skills through working in a team to achieve common goals.
4	***Independent Learning:*** Learn on their own, reflect on their learning and take appropriate action to improve it.

Guidelines for Design Thinking Lab:

1. The Design Thinking Lab (DTL) is to be carried out by a team of two-three students.
2. Each student in a team must contribute equally in the tasks mentioned below.
3. Each group has to select a theme that will provide solutions to the challenges of societal concern. Normally three to four themes would be identified by the by the department
4. Each group should follow the stages of Empathy, Design, Ideate, prototype and Test for completion of DTL.
5. After every stage of DTL, the committee constituted by the department along with the coordinators would evaluate for CIE. The committee shall consist of respective coordinator & two senior faculty members as examiners. The evaluation will be done for each student separately.
6. The team should prepare a Digital Poster and a report should be submitted after incorporation of any modifications suggested by the evaluation committee.

The Design Thinking lab tasks would involve:

1. Carry out the detailed questionnaire to arrive at the problem of the selected theme. The empathy report shall be prepared based on the response of the stake holders.
2. For the problem identified, the team needs to give solution through thinking out of the box innovatively to complete the ideation stage of DTL
3. Once the idea of the solution is ready, detailed design has to be formulated in the Design stage considering the practical feasibility.
4. If the Design of the problem is approved, the team should implement the design and come out with prototype of the system.
5. Conduct thorough testing of all the modules in the prototype developed and carry out integrated testing.
6. Demonstrate the functioning of the prototype along with presentations of the same.
7. Prepare a Digital poster indicating all the stages of DTL separately. A Detailed project report also should be submitted covering the difficulties and challenges faced in each stage of DTL.
8. Methods of testing and validation should be clearly defined both in the Digital poster as well as the report.

The students are required to submit the Poster and the report in the prescribed format provided by the department.

Course Outcomes: After completing the course, the students will be able to	
CO 1:	Interpreting and implementing the empathy, ideate and design should be implemented by applying the concepts learnt.
CO 2:	The course will facilitate effective participation by the student in team work and development of communication and presentation skills essential for being part of any of the domains in his / her future career.
CO 3:	Appling project life cycle effectively to develop an efficient prototype.
CO 4:	Produce students who would be equipped to pursue higher studies in a specialized area or carry out research work in an industrial environment.

Scheme of Evaluation for CIE Marks:

Evaluation will be carried out in three phases:

Phase	**Activity**	**Weightage**
I	Empathy, Ideate evaluation	10M
II	Design evaluation	15M
III	Prototype evaluation, Digital Poster presentation and report submission	25M
	Total	**50M**

Scheme of Evaluation for SEE Marks:

Sl. No.	**Evaluation Component**	**Marks**
1.	Written presentation of synopsis: Write up	5M
2.	Presentation/Demonstration of the project	15M
3.	Demonstration of the project	20M
4.	Viva	05M
5.	Report	05M
	Total	**50M**

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**H**	**H**	**H**	**H**	**M**	**M**	**L**	**M**	**M**	**M**	**M**	**M**
CO2	**H**	**H**	**H**	**H**	**M**	**M**	**L**	**M**	**M**	**M**	**M**	**M**
CO3	**H**	**H**	**H**	**H**	**M**	**M**	**L**	**M**	**M**	**M**	**M**	**M**
CO4	**L**	**L**	**L**	**L**	**L**	**L**	**L**	**M**	**L**	**M**	**L**	**L**

Semester: III/IV						
C PROGRAMMING **Bridge Course** **(Common to all branches)**						
Course Code	**:**	18DCS37/48		**CIE Marks**	**:**	**50**
Credits: L:T:P	:	2:0:0		**SEE Marks**	**:**	**50**
Audit Course				**SEE Duration**	**:**	**2.00 Hours**

Course Learning Objectives: The students will be able to

1.	Develop arithmetic reasoning and analytical skills to apply knowledge of basic concepts of programming in C.
2.	Learn basic principles of problem solving through programming.
3.	Write C programs using appropriate programming constructs adopted in programming.
4.	Solve complex problems using C programming.

Unit – I	**4 Hrs**
Introduction to Reasoning, Algorithms and Flowcharts: Skill development – Examples related to Arithmetical Reasoning and Analytical Reasoning. Fundamentals of algorithms and flowcharts **Introduction to C programming:** Basic structure of C program, Features of C language, Character set, C tokens, Keywords and Identifiers, Constants, Variables, Data types.	
Unit – II	**4 Hrs**
Handling Input and Output Operations Formatted input/output functions, Unformatted input/output functions with programming examples using different input/output functions. **Operators and Expressions** Arithmetic operators, Relational operators, Logical Operators, Assignment operators, Increment and decrement operators, Conditional operators, Bit-wise operators, Arithmetic expressions. Evaluation of expressions, Precedence of arithmetic operators, Type conversion in expressions, Operator precedence and associativity.	
Unit – III	**6 Hrs**
Programming Constructs **Decision Making and Branching** Decision making with 'if' statement, Simple 'if' statement, the 'if…else' statement, nesting of 'if…else' statements, The 'else if' ladder, The 'switch' statement, The '*?:'* operator, The '*goto'* statement. **Decision making and looping** The while statement, The do while statement, The 'for' statement, Jumps in loops**.**	
Unit – IV	**6 Hrs**
Arrays One dimensional arrays, Declaration of one dimensional arrays. Initialization of one dimensional arrays, Two dimensional arrays, Initializing two dimensional arrays. **Character Arrays and Strings** Declaring and Initializing String Variables, Reading Strings from Terminal, Writing strings to screen, String handling functions.	

Unit – V	8 Hrs
User-defined functions Need for User Defined Functions, Definition of functions, Return values and their types, Function calls, Function declaration. Examples. **Introduction to Pointers:** Introduction, Declaration and initialization of pointers. Examples **Structures and Unions:** Introduction, Structure and union definition, Declaring structure and union variables, Accessing structure members. Example programs.	

PRACTICE PROGRAMS	
1.	Familiarization with programming environment, concept of naming the program files, storing, compilation, execution and debugging. Taking any simple C- code.(Example programs having the delimeters, format specifiers in printf and scanf)
2.	Debug the errors and understand the working of input statements in a program by compiling the C-code.
3.	Implement C Program to demonstrate the working of operators and analyze the output.
4.	Simple computational problems using arithmetic expressions and use of each operator (+,-,/,%) leading to implementation of a Commercial calculator with appropriate message: a)Read the values from the keyboard b) Perform all the arithmetic operations. c) Handle the errors and print appropriate message.
5.	Write a C program to find and output all the roots if a given quadratic equation, for non-zero coefficients. (Using if…*else* statement).
6a. **6b.**	Write a C program to print out a multiplication table for a given NxN and also to print the sum table using skip count 'n' values for a given upper bound. Write a C program to generate the patterns using for loops. Example: (to print * if it is even number) 1 ** 333 **** 55555
7a. **7b.**	Write a C program to find the Greatest common divisor(GCD)and Least common multiplier(LCM) Write a C program to input a number and check whether the number is palindrome or not.
8.	Develop a C program for one dimensional, demonstrate a C program that reads N integer numbers and arrange them in ascending or descending order using bubble sort technique.
9.	Develop and demonstrate a C program for Matrix multiplication: a) Read the sizes of two matrices and check the compatibility for multiplication. b) Print the appropriate message if the condition is not satisfied and ask user to re-enter the size of matrix. c) Read the input matrix d) Perform matrix multiplication and print the result along with the input matrix.
10.	Using functions develop a C program to perform the following tasks by parameter passing concept: a) To read a string from the user Print appropriate message for palindrome or not palindrome

11a.1 **1b.**	Write a C program to find the length of the string without using library function. Write a program to enter a sentence and print total number of vowels.
12.	Design a structure 'Complex' and write a C program to perform the following operations: i. Reading a complex number. ii. Addition of two complex numbers. iii. Print the result
13.	Create a structure called student with the following members student name, rollno, and a structure with marks details in three tests. Write a C program to create N records and a) Search on roll no and display all the records. b) Average marks in each test. c) Highest marks in each test

Course Outcomes: After Completing the course, the students will be able to	
CO 1:	Understand and explore the fundamental computer concepts and basic programming principles like data types, input/output functions, operators, programming constructs and user defined functions.
CO 2:	Analyze and Develop algorithmic solutions to problems.
CO 3:	Implement and Demonstrate capabilities of writing 'C' programs in optimized, robust and reusable code.
CO 4:	Apply appropriate concepts of data structures like arrays, structures implement programs for various applications

Reference Books	
1.	Programming in C , P. Dey, M. Ghosh, First Edition, 2007, Oxford University press, ISBN (13): 9780195687910.
2.	The C Programming Language, Kernighan B.W and Dennis M. Ritchie, Second Edition, 2005, Prentice Hall, ISBN (13): 9780131101630.
3.	Turbo C: The Complete Reference, H. Schildt, 4th Edition, 2000,Mcgraw Hill Education, ISBN-13: 9780070411838.
4.	Understanding Pointers in C, Yashavant P. Kanetkar, 4th edition, 2003, BPB publications, ISBN-13: 978-8176563581
5.	C IN DEPTH, S.K Srivastava, Deepali Srivastava, 3rd Edition, 2013, BPB publication, ISBN9788183330480

Continuous Internal Evaluation (CIE); Theory (50 Marks)
CIE is executed by way of quizzes (Q), tests (T**)** and lab practice (P). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks the sum of the marks scored from quizzes would be reduced to 10 marks. The two tests are conducted for 30 marks each and the sum of the marks scored from two tests is reduced to 30. The programs practiced would be assessed for 10 marks (Execution and Documentation).
Total CIE is 10(Q) + 30(T) + 10(P) = 50 Marks.

Semester End Evaluation (SEE); Theory (50 Marks)
SEE for 50 marks is executed by means of an examination. The Question paper for the course consists of five main questions, one from each unit for 10 marks adding up to 50 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units

II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	-	1	-	-	-	1	-	-	1
CO2	3	3	3	2	2	-	-	-	1	-	-	1
CO3	3	3	3	-	-	-	-	-	2	2	1	2
CO4	3	3	3	-	-	-	1	-	2	2	1	2

High-3: Medium-2 : Low-1

Semester: III and IV						
PROFESSIONAL PRACTICE – I COMMUNICATION SKILLS (Common to all Programmes)						
Course Code	**:**	**18HS49**		**CIE**	**:**	**50**
Credits: L:T:P	**:**	0:0:1		**SEE**	**:**	**50**
Total Hours	**:**	18 hrs /Semester		**SEE Duration**	**:**	**2 Hours**

Course Learning Objectives: The students will be able to

1	Understand their own communication style, the essentials of good communication and develop their confidence to communicate effectively.
2	Manage stress by applying stress management skills.
3	Ability to give contribution to the planning and coordinate Team work.
4	Ability to make problem solving decisions related to ethics.

III Semester	**6 Hrs**
Communication Skills: Basics, Method, Means, Process and Purpose, Basics of Business Communication, Written & Oral Communication, Listening. **Communication with Confidence & Clarity**- Interaction with people, the need the uses and the methods, Getting phonetically correct, using politically correct language, Debate & Extempore.	
	6 Hrs
Assertive Communication- Concept of Assertive communication, Importance and applicability of Assertive communication, Assertive Words, being assertive. **Presentation Skills-** Discussing the basic concepts of presentation skills, Articulation Skills, IQ & GK, How to make effective presentations, body language & Dress code in presentation, media of presentation.	
	6 Hrs
Team Work- Team Work and its important elements Clarifying the advantages and challenges of team work Understanding bargains in team building Defining behaviour to sync with team work Stages of Team Building Features of successful teams.	
IV Semester	**6 Hrs**
Body Language & Proxemics - Rapport Building - Gestures, postures, facial expression and body movements in different situations, Importance of Proxemics, Right personal space to maintain with different people.	
	6Hrs
Motivation and Stress Management: Self-motivation, group motivation, leadership abilities, Stress clauses and stress busters to handle stress and de-stress; Understanding stress - Concept of sound body and mind, Dealing with anxiety, tension, and relaxation techniques**.** Individual Counseling & Guidance, Career Orientation. Balancing Personal & Professional Life-	
	6 Hrs
Professional Practice - Professional Dress Code, Time Sense, Respecting People & their Space, Relevant Behavior at different Hierarchical Levels. Positive Attitude, Self Analysis and Self-Management. **Professional Ethics** - values to be practiced, standards and codes to be adopted as professional engineers in the society for various projects. Balancing Personal & Professional Life	

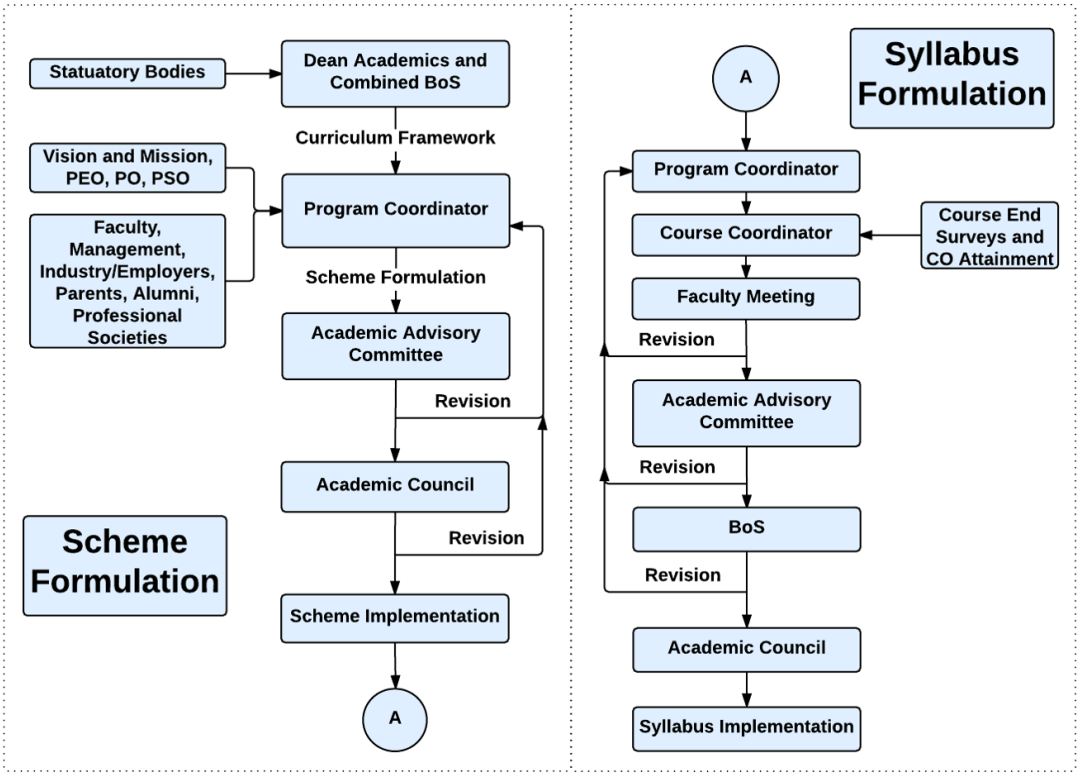
Course Outcomes: After completing the course, the students will be able to	
CO1:	Inculcate skills for life, such as problem solving, decision making, stress management
CO2:	Develop leadership and interpersonal working skills and professional ethics.
CO3:	Apply verbal communication skills with appropriate body language.
CO4:	Develop their potential and become self-confident to acquire a high degree of self

Reference Books	
1.	The 7 Habits of Highly Effective People, Stephen R Covey, Free Press, 2004 Edition, ISBN: 0743272455
2.	How to win friends and influence people, Dale Carnegie, General Press, 1st Edition, 2016, ISBN: 9789380914787
3.	Crucial Conversation: Tools for Talking When Stakes are High, Kerry Patterson, Joseph Grenny, Ron Mcmillan, McGraw-Hill Publication, 2012 Edition, ISBN: 9780071772204
4.	Aptimithra: Best Aptitude Book, Ethnus,Tata McGraw Hill, 2014 Edition, ISBN: 9781259058738

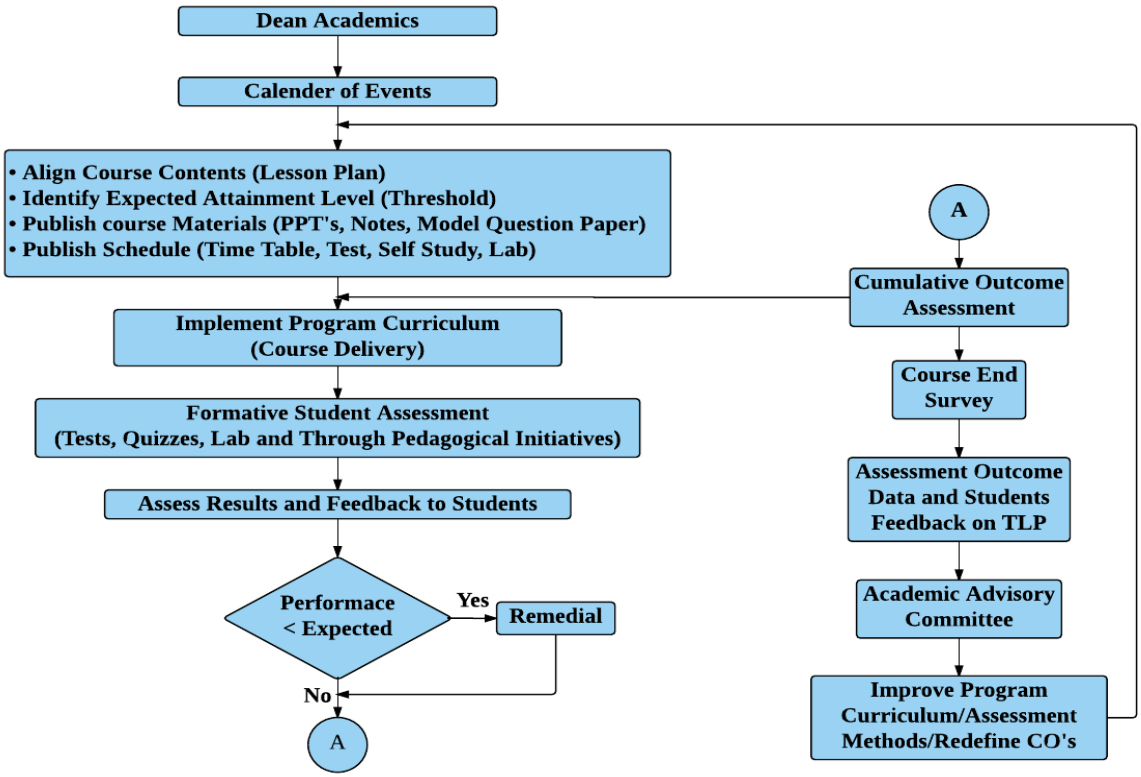
Scheme of Continuous Internal Examination and Semester End Examination

Phase	Activity	Weightage
Phase I III Sem	CIE will be conducted during the 3rd semester and evaluated for 50 marks. The test will have two components. The Quiz is evaluated for 15 marks and second component consisting of questions requiring descriptive answers is evaluated for 35 marks. The test & quiz will assess the skills acquired through the training module. SEE is based on the test conducted at the end of the 3rd semester The test will have two components a Quiz evaluated for 15 marks and second component consisting of questions requiring descriptive answers is evaluated for 35 marks.	50%
Phase II IV Sem	During the 4th semester a test will be conducted and evaluated for 50 marks. The test will have two components a Short Quiz and Questions requiring descriptive answers. The test & quiz will assess the skills acquired through the training module. SEE is based on the test conducted at the end of the 4th semester The test will have two components. The Quiz evaluated for 15 marks and second component consisting of questions requiring descriptive answers is evaluated for 35 marks	50%
Phase III At the end of IV Sem	At the end of the IV Sem Marks of CIE (3rd Sem and 4th Sem) is consolidated for 50 marks (Average of Test1 and Test 2 (CIE 1+CIE2)/2. At the end of the IV Sem Marks of SEE (3rd Sem and 4th Sem) is consolidated for 50 marks (Average of CIE 1 and CIE 2 (CIE 1+CIE2)/2.	

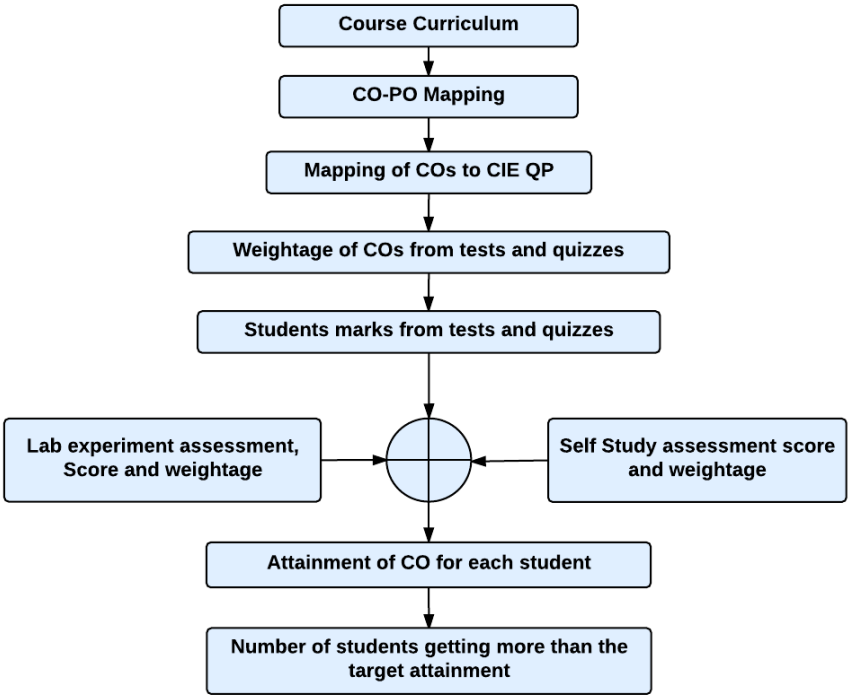
Curriculum Design Process



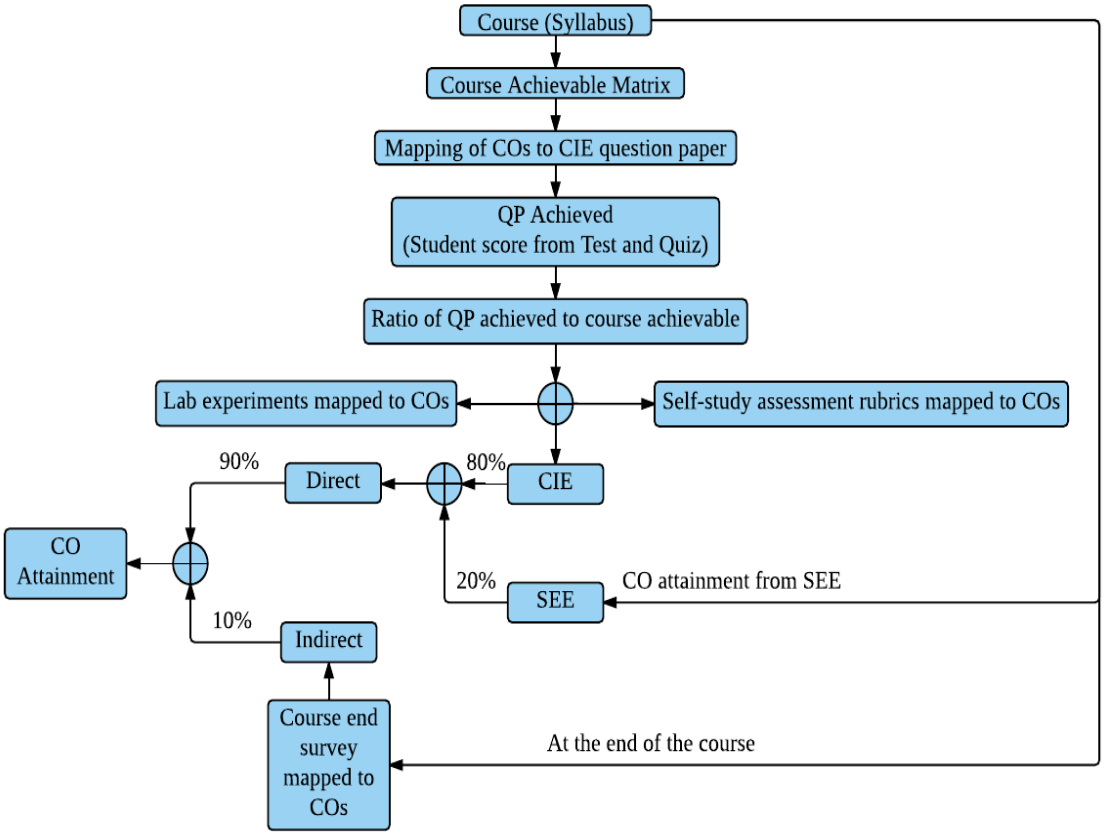
Academic Planning And Implementation



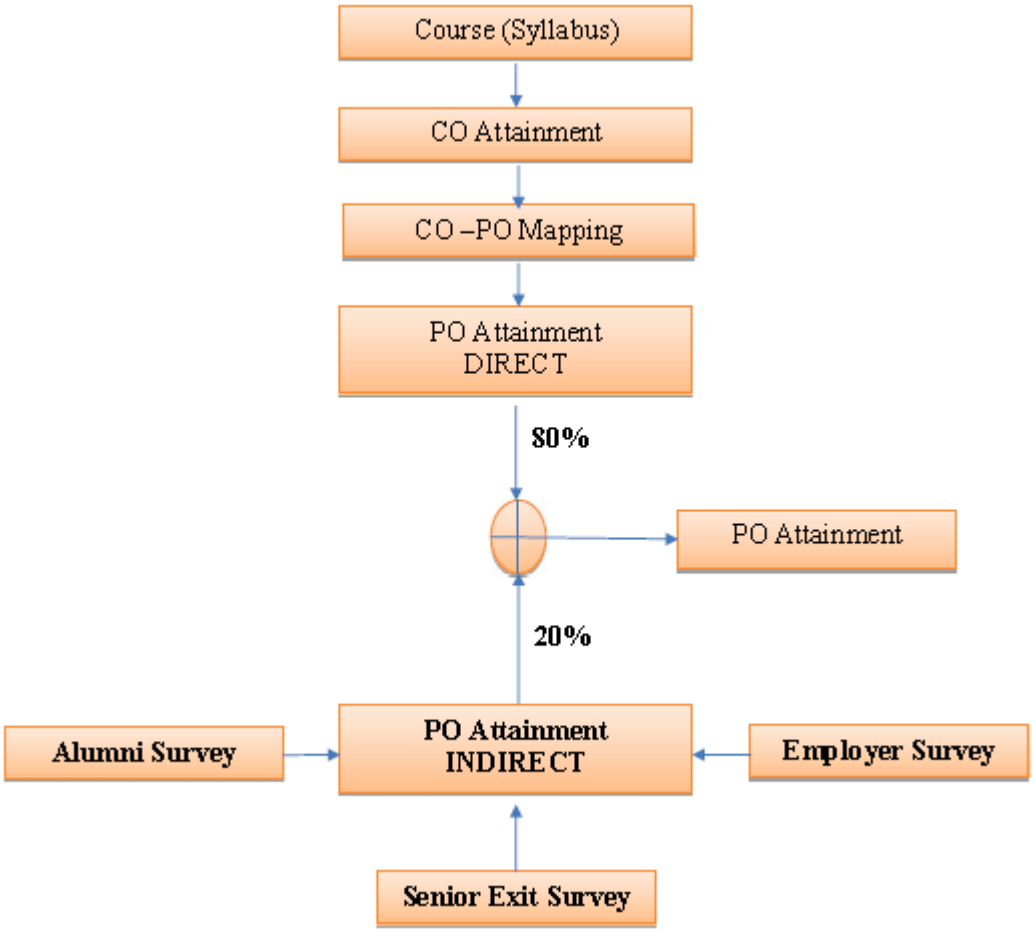
Process For Course Outcome Attainment



Final CO Attainment Process



Program Outcome Attainment Process



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PROGRAM OUTCOMES (POs)

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation for the solution of complex engineering problems.

2. **Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling to complex engineering activities, with an understanding of the limitations.

6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning:** Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.