Course Title	TECHNICALMANAGEMENT &ENTREPRENEURSHIP	Semester	V
Course Code	MVJ19TEM51	CIE	50
Total No. of Contact Hours	40 L: T: P:: 3: 1 :0	SEE	50
No. of Contact Hours/week	4	Total	100
Credits	3	Exam. Duration	3 Hours

Course objective is to: This course will enable students to

- Introduce the field of management, task of the manager, importance of planning and types of planning, staff recruitment and selection process.
- Explain need of coordination between the manager and staff, the social responsibility of business and leadership.
- Explain the role and importance of the entrepreneur in economic development and the concepts of entrepreneurship.
- Discuss the importance of Small Scale Industries and the related terms and problems involved.
- Explain project feasibility study and project appraisal and discuss project financing.

Module-1	L1., L2	8Hours

Management: Definition, Importance – Nature and Characteristics of Management, Management Functions, Roles of Manager, Levels of Management, Managerial Skills, Management & Administration, Management as a Science, Art &Profession.

Planning: Nature, Importance and Purpose Of Planning, Types of Plans, Steps in Planning, Limitations of Planning, Decision Making – Meaning, Types of Decisions- Steps in Decision Making.

Laboratory Sessions/ Experimental learning: Case study on decision making process in a corporate.

Applications: Planning in engineering field.

Web Link and Video Lectures

https://nptel.ac.in/courses/110/105/110105146/

https://nptel.ac.in/courses/122/108/122108038/

Module-2	L1., L2	8Hours
Organizing and Staffing: Meaning, Nature and Characteristics of Organization – Process of Organization, Principles of Organization, Departmentalization, Committees – meaning, Types of Committees, Centralization Vs Decentralization of Authority and Responsibility, Span of Control, Nature and Importance of Staffing, Process of Selection and Recruitment. **Directing and Controlling**: Meaning and Nature of Directing-Leadership Styles, Motivation Theories, Communication – Meaning and Importance, Coordination- Meaning and Importance, Techniques of Coordination. Controlling – Meaning, Steps in Controlling. Laboratory Sessions/ Experimental learning Case study of steel plant departmentalization. Applications: Effective communication in a corporate. Web Link and Video Lectures https://nptel.ac.in/content/storage2/courses/122106031/slides/3_2s.pdf https://www.slideshare.net/100005130728571/27-nature-of-directing		
Module-3	**L1., L2**	**8Hours**
Social Responsibilities of Business: Meaning of Social Responsibility, Social Responsibilities of Business towards Different Groups, Social Audit, Business Ethics and Corporate Governance. **Entrepreneurship**: Definition of Entrepreneur, Importance of Entrepreneurship, concepts of Entrepreneurship, Characteristics of successful Entrepreneur, Classification of Entrepreneurs, Intrapreneur – An Emerging Class, Comparison between Entrepreneur and Intrapreneur, Myths of Entrepreneurship, Entrepreneurial Development models, Entrepreneurial development cycle, Problems faced by Entrepreneurs and capacity building for Entrepreneurship. Laboratory Sessions/ Experimental learning Case study of a startup. Application: Social auditing in a software company Web Link and Video Lectures https://nptel.ac.in/courses/110/106/110106141/ https://nptel.ac.in/courses/127/105/127105007/		
Module-4	**L1., L2**	**8Hours**
Modern Small Business Enterprises: Role of Small Scale Industries, Concepts and definitions of SSIEnterprises, Government policy and development of the Small Scale sector in India, Growth and Performance of Small Scale Industries in India, Sickness in SSI sector, Problems for Small Scale Industries, Impact of Globalization on SSI, Impact of WTO/GATT on SSIs, Ancillary Industry		

and Tiny Industry (Definition only).

Institutional Support for Business Enterprises: Introduction, Policies & Schemes of Central–Level Institutions, State-Level Institutions.

Laboratory Sessions/ Experimental learning

Case study on the growth of small scale industries.

Application: Small Scale Industries Web Link and Video Lectures

https://www.slideshare.net/syedmubarak15/institutional-support-for-business-enterprises

Module-5	L1., L2	8Hours

Project Management: Meaning of Project, Project Objectives & Characteristics, Project Identification- Meaning & Importance; Project Life Cycle, Project Scheduling, Capital Budgeting, Generating an Investment Project Proposal, Project Report-Need and Significance of Report, Contents, Formulation, Project Analysis-Market, Technical, Financial, Economic, Ecological, Project Evaluation and Selection, Project Financing, Project Implementation Phase, Human & Administrative aspects of Project Management, Prerequisites for Successful Project Implementation. New Control Techniques- PERT and CPM, Steps involved in developing the network, Uses and Limitations of PERT and CPM.

Laboratory Sessions/ Experimental learning

Investigation on the market in correspondence to project. Application

Preparations of project report. Web Link and Video Lectures

ttps://www.projectmanager.com/project-scheduling

https://kissflow.com/project/basics-of-project-scheduling/

Course outcomes:

CO1	UnderstandtheconceptofManagement
CO2	Understandthestaffingprocess
CO3	ExplainthesocialresponsibilitiesofbusinesstowardsDifferentGroups
CO4	ExplaintheRoleofSmallScale Industries
CO5	InterprettheProjectObjectives

Reference Books:

1	StephenP.Robbins&MaryCoulter,Management‖,PrenticeHall(India)Pvt.Ltd.,10th Edition, 2009
2	JAFStoner,FreemanR.EandDanielRGilbert,Management‖,PearsonEducation, Edition,

	2004.
3	StephenA. Robbins&DavidA. Decenzo & Mary Coulter, Fundamentals ofManagement, PearsonEducation,7thEdition,2011.
4	RobertKreitner&MamataMohapatra,Management‖,Biztantra,2008.

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

xliv. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

xlv. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

xlvi. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping

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

High-3, Medium-2, Low-1

Course Title	AIRCRAFT SYSTEMS & INSTRUMENTATION	Semester	V
Course Code	MVJ19AE52	CIE	50
Total No. of Contact Hours	50 L : T : P :: 3 : 2: 0	SEE	50
No. of Contact Hours/week	5	Total	100
Credits	4	Exam. Duration	3 Hrs.

Course objective is to:

1. Gain knowledge of the aircraft control systems.
2. Understand the applications of hydraulics and pneumatics in aircraft systems.
3. Acquire knowledge regarding aircraft engine systems.
4. Comprehend the aircraft auxiliary systems
5. Acquire the knowledge of aircraft instruments.

Module 1	L1,L2,L3	10 Hrs.

Airplane Control Systems: Conventional Systems, fully powered flight controls, Power actuated systems, Modern control systems, Digital fly by wire systems, Auto pilot system active control Technology.

LaboratorySessions/ Experimental learning:

How it works, flight controls PID controls.

Applications:

Pilot training, UAV design and piloting, RC aircraft design and piloting.

Video link / Additional online information (related to module if any):

1. https://nptel.ac.in/courses/101/104/101104066
2. https://onlinecourses.nptel.ac.in/noc21_ae05/preview
3. https://digitalcommons.calpoly.edu/cgi/viewcontent.cgi?article=1067&context=aerosp

Module 2	L1,L2,L3,	10 Hrs.

Aircraft Systems: Hydraulic systems, Study of typical workable system, components, Pneumatic systems, Advantages, Working principles, Typical Air pressure system, Brake system, Typical Pneumatic power system, Components, Landing Gear systems, Classification.

Laboratory Sessions/ Experimental learning:

Calculation on force required for hydraulic system and pneumatic system in aircraft applications.

Applications:

Hydraulic lifts, pneumatic door openings and closing, landing gears, breaks.

Video link / Additional online information (related to module if any):

1. https://nptel.ac.in/courses/112/105/112105047/
2. https://nptel.ac.in/courses/112/103/112103249/
3. https://sciencing.com/make-simple-hydraulic-system-7380816.html

Module 3	L1,L2,L3	10 Hrs.

Engine Systems: Fuel systems for Piston and jet engines, Components of multi engines. lubricating systems for piston and jet engines - Starting and Ignition systems - Typical examples for piston and jet engines.

Laboratory Sessions/ Experimental learning:

Engine Fuel and Fuel Metering Systems (Lab session IIT Kanpur, Virtual lab)

https://www.youtube.com/watch?v=xEssM_sYtd8

Applications:

Range and Endurance calculation, actions to take in case of engine failures.

Video link / Additional online information (related to module if any):

1. https://nptel.ac.in/courses/101/101/101101002/
2. https://spocathon.page/video/lecture-06-lubrication-system

Module 4	L1,L2,L3	10 Hrs.

Auxiliary System: Basic Air cycle systems, Vapour Cycle systems, Evaporative vapour cycle systems, Evaporative air cycle systems, Fire protection systems, Deicing and anti-icing systems.

Laboratory Sessions/ Experimental learning:

Response time and operations of firefighting systems in case of engine failure.

Applications:

Firefighting, precautions, how to fight different classes of fire.

Video link / Additional online information (related to module if any):

1. https://nptel.ac.in/content/storage2/courses/101106035/001_Chapter%201_L1_(01-10-2013)
2. https://nptel.ac.in/courses/103/107/103107156/
3. https://www.draeger.com/en_seeur/ Products/Aircraft-fire-training-systems.

Module 5	L1,L2	10 Hrs.

Aircraft Instruments: Flight Instruments and Navigation Instruments, Gyroscope, Accelerometers, Air speed Indicators, TAS, EAS, Mach Meters, Altimeters, Principles and operation, Study of various types of engine instruments, Tachometers, Temperature gauges, Pressure gauges, Operation and Principles.

Laboratory Sessions/ Experimental learning:

Gyroscope working and applications, Avionics lab instruments working.

Applications:

Understanding readings of the flight instruments, prediction of failure or trouble before actual encounter and taking necessary precautions.

Video link / Additional online information (related to module if any):

1. https://nptel.ac.in/courses/101/108/101108056/
2. https://onlinecourses.nptel.ac.in/noc20_ae01/preview
3. https://www.wingbug.com/wingbug-for-experimental-aircraft/

Course outcomes:

Upon completion of the course, students will be able to:

CO302.1	Distinguish the conventional and modern control systems.
CO302.2	Analyse the aircraft systems.
CO302.3	Analyse the working of Aircraft engine systems.
CO303.4	Describe aircraft Auxiliary systems
CO303.5	Applydifferent aircraft instruments.

Reference Books:

1.	Ian MoirandAllan Seabridge,Aircraft Systems: Mechanical, Electrical and Avionics-Subsystem Integration, Wiley India Pvt Ltd, 3rd edition, 2012.
2.	Lalit Gupta and OP. Sharma,Aircraft Systems (Fundamentals of Flight Vol. IV), Himalayan Books, 2006.
3.	William A Neese,Aircraft Hydraulic Systems, Himalayan Books, 2007
4.	SR. Majumdar,Pneumatic Systems, Tata McGraw Hill Publishing Co, 1st Edition, 2001

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

- Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.
- Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.
- One question must be set from each unit. The duration of examination is 3 hours.

CO, PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	0	0	0	0	0	0	0	0	1	1	0
CO2	3	2	1	0	0	0	0	0	0	0	0	1	1	0
CO3	3	2	1	0	0	1	1	0	0	0	0	1	1	0
CO4	3	2	1	0	0	1	1	0	0	0	0	1	1	0
CO5	3	2	1	0	0	0	0	0	0	0	0	1	1	0

Course Title	FINITE ELEMENT METHODS	Semester	V
Course Code	MVJ19AE53	CIE	50
Total No. of Contact Hours	50 L : T : P :: 3 : 2: 0	SEE	50
No. of Contact Hours/week	5	Total	100
Credits	4	Exam. Duration	3 Hrs.

The course objective is to:

1. Understand the importance of discretization of domain using different finite elements.
2. Acquire the knowledge of different loading and boundary conditions.
3. Understand the governing methods of finite element analysis.
4. Comprehend the higher order discretization.
5. Gain the knowledge offield problems.

Module 1	L1, L2, L3	10 Hrs.

Introduction: Basic Concepts, Background Review: Introduction,Stresses and Equilibrium, Plane stress, Plane strain, Boundary Conditions, Strain-Displacement Relations, simple elements for the FEM, Potential Energy and Equilibrium, The Rayleigh-Ritz Method, Galerkin's Method, Saint Venant's Principle, Von Mises Stress,

Finite Element Modeling, node, element, Coordinates and Shape Functions, Element Stiffness Matrix and assembly, Properties of K, Use of local and natural coordinates, compatibility, and convergence requirements of shape functions.

Laboratory Sessions/ Experimental learning:2D plane stress analysis using ANSYS

Applications:

1. Solving practical technical problems using scientific and mathematical tools,
2. Calculating the global stiffness matrix in the finite element method

Video link / Additional online information

4. https://nptel.ac.in/courses/112/104/112104193/
5. https://nptel.ac.in/courses/112/104/112104116/
6. https://ocw.mit.edu/courses/mechanical-engineering/2-092-finite-element-analysis-of-solids-and-fluids-i-fall-2009/study-materials/

Module 2	L1, L2, L3,	10 Hrs.

Analysis of bars, truss, frames, and beams:

Construction of shape functions for bar element and beam element, Plane trusses, Three-Dimensional trusses, Three-dimensional Frames

Construction of shape functions for bar element and beam element, Bar elements, uniform bar elements, uniform section, mechanical and thermal loading, varying section, truss analysis, Frame element, Beam element, problems for various loadings and boundary

Laboratory Sessions/ Experimental learning:To determine maximum deflection and bending stress for given cantilever beam using ANSYS

Applications:

1. 2D and 3 D elements to apply boundary conditions,
2. The direct stiffness method to compute degrees of freedom at the element nodes.
3. To determine the value of state variable at any point of element based on values of state variable.

Video link / Additional online information

1. https://nptel.ac.in/courses/112/104/112104193/
2. https://nptel.ac.in/courses/112/104/112104116/
3. https://ocw.mit.edu/courses/mechanical-engineering/2-092-finite-element-analysis-of-solids-and-fluids-i-fall-2009/study-materials/

Module 3	L1, L2, L3	10 Hrs.

Analysis of Two- and Three-dimensional Elements: Shape functions of Triangular, Rectangular and Quadrilateral elements, different types of higher order elements, constant and linear strain triangular elements, stiffness matrix Four-Noded Tetrahedral Element (TET 4), Eight-Noded Hexahedral Element (HEXA 8), Tetrahedral elements, Hexahedral elements: Serendipity family, Hexahedral elements: Lagrange family. Numerical

Laboratory Sessions/ Experimental learning:Analysis of CST Element by using ANSYS

Applications:

To approximate the *shape* of the object and to compute the displacement of points inside the boundary of the object

Video link / Additional online information:

3. https://nptel.ac.in/courses/112/104/112104193/
4. https://nptel.ac.in/courses/112/104/112104116/
5. https://ocw.mit.edu/courses/mechanical-engineering/2-092-finite-element-analysis-of-solids-and-fluids-i-fall-2009/study-materials/

Module 4	L1, L2, L3	10 Hrs.

Theory of Isoparametric Elements and Axisymmetric: Isoparametric, sub parametric and super-parametric elements, characteristics of Isoparametric quadrilateral elements, structure of

computer program for FEM analysis, description of different modules, pre and post processing, Axisymmetric formulation finite element modeling of triangular and quadrilateral element. Numerical

Laboratory Sessions/ Experimental learning:Analysis of Long Cylinder (Axiymmetric Problem) using Quadrilateral Elements in ANSYS

Applications:

1. To create shape functions that would ensure the compatibility of the displacement between neighbouringelements while maintaining the requirements for shape functions
2. Higher-order approximation of the unknown function over a bounding surface described by non-planar elements.

Video link / Additional online information:

4. https://nptel.ac.in/courses/112/104/112104193/
5. https://nptel.ac.in/courses/112/104/112104116/
6. https://ocw.mit.edu/courses/mechanical-engineering/2-092-finite-element-analysis-of-solids-and-fluids-i-fall-2009/study-materials/

Module 5	**L1, L2, L3**	10 Hrs.

Field Problems: Heat transfer problems, Steady state fin problems, 1D heat conduction governing equation, Derivation of element matrices for two dimensional problems, Dynamic consideration-Formulation-Hamilton's principle, Element mass matrices. Numerical

Laboratory Sessions/ Experimental learning:Performing Heat Transfer Analysis Using ANSYS

Applications:

1. Problem involving heat flow
2. Structural dynamics

Video link / Additional online information:

4. https://nptel.ac.in/courses/112/104/112104193/
5. https://nptel.ac.in/courses/112/104/112104116/
6. https://ocw.mit.edu/courses/mechanical-engineering/2-092-finite-element-analysis-of-solids-and-fluids-i-fall-2009/study-materials/

Course outcomes:

Upon completion of the course, students will be able to:

CO303.1	Apply discretization technique for domain using different finite elements
CO303.2	Evaluate the effects of different loading and boundary conditions

CO303.3	Analyse the governing equations of finite element analysis
CO303.4	Formulating mathematical model using higher order element type
CO303.5	Analyseheat flow problem by considering dynamic consideration

Reference Books:	
1.	Chandru Patla T. R, PHI Finite Elements in engineering, 3rd edition, 2002
2.	Bhavi Katti, Finite element Analysis, New Age International, 3rd edition,2015
3.	Zienkiewicz. O.C, The Finite Element Method, Elsevier, 7th edition,2013
4.	C.S. Krishnamurthy, Finite Element analysis - Theory and Programming, Tata McGraw Hill Co. Ltd, New Delhi, 2nd edition,2011

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

- Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.
- Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.
- One question must be set from each unit. The duration of examination is 3 hours.

CO, PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	1	2	1	1	1	2	2	1	2	1	2
CO2	3	3	2	2	2	1	1	1	2	2	1	2	1	2
CO3	3	3	2	2	2	1	1	1	2	2	1	2	1	2
CO4	3	3	3	2	2	1	1	1	2	2	1	2	1	2
CO5	3	3	2	2	2	1	1	1	2	2	1	2	1	2

Course Title	THOERY OF VIBRATIONS	Semester	V
Course Code	MVJ19AE54/AS54	CIE	50
Total No. of Contact Hours	40 L : T : P :: 3: 1: 0	SEE	50
No. of Contact Hours/week	4	Total	100
Credits	3	Exam. Duration	3 Hrs.

Course objective is to:

1.Understand the basic concepts of vibrations

2.Gain the knowledge of the undamped free vibration and damped free vibrations

3. Learn the vibration measuring instrumentation

4. Acquire knowledge of two degrees of freedom systems

5. Understand numerical methods for Multi-Degree Freedom Systems

Module 1	L1,L2,L3	10 Hrs.

Types of vibrations, S.H.M, principle of super position applied to Simple Harmonic Motions.Beats, Fourier theorem and simple problems.

Laboratory Sessions/ Experimental learning:

Simple pendulum experiment to understand concept of wave motion

Applications: Various types of vibrations and its real time applications

Concept of wave and its characteristics.

Video link / Additional online information (related to module if any): (NPTEL,IIT ROORKEE)

https://www.youtube.com/watch?v=9r630K5HmJc&list=PLSGws_74K01_pG3R7rgtDtrDZBjcTgPdR

Module 2	L1,L2,L3	10 Hrs.

Undamped Free Vibrations: Single degree of freedom systems. Undamped free vibration, natural frequency of free vibration, Spring and Mass elements, effect of mass of spring, Compound Pendulum.

Damped Free Vibrations: Single degree of freedom systems, different types of damping, concept of critical damping and its importance, study of response of viscous damped systems for cases of under damping, criticaland over damping, Logarithmic decrement

Laboratory Sessions/ Experimental learning:

Identifying Damping ration experiment allows students to understand behavior of vicious damper. [Design lab]

Applications: Various types of dampers and its real time applications.

Video link / Additional online information (related to module if any) (NPTEL,IIT MADRAS) https://www.youtube.com/watch?v=tJNaPt5aPmg		
Module 3	L1,L2.L3	10 Hrs.
Forced Vibration: Single degree of freedom systems, steady state solution with viscous damping due toharmonic force. Solution by Complex algebra, reciprocating and rotating unbalance, vibration isolation,transmissibility ratio due to harmonic excitation and support motion. **Vibration Measuring Instruments & Whirling of Shafts**: Vibration of elastic bodies – Vibration of strings –Longitudinal, lateral and torsional Vibrations. **Laboratory Sessions/ Experimental learning**: Whirling of shaft experiment [Design Lab] **Applications**: Isolators and its Application. **Video link / Additional online information (related to module if any): (NPTEL,IIT KANPUR)** https://www.youtube.com/watch?v=XGQr1uEX-Dc		
Module 4	L1,L2,L3	10 Hrs.
Systems with Two Degrees of Freedom: Introduction, principle modes and Normal modes of vibration, coordinatecoupling, generalized and principal co-ordinates, Free vibration in terms of initial conditions. Gearedsystems. Forced Oscillations-Harmonic excitation. Applications: Vehicle suspension, Dynamic vibrationabsorber and Dynamics of reciprocating Engines. **Continuous Systems**: Introduction, vibration of string, longitudinal vibration of rods, Torsional vibration ofrods, Euler's equation for beams. **Laboratory Sessions/ Experimental learning**:Determination of two natural frequencies, or modes, for the system Applications: **Dynamic vibration absorber and its application in reciprocating engine.** **Video link / Additional online information (related to module if any): (NPTEL,IIT MADRAS)** https://www.youtube.com/watch?v=V_Lj4Pun_WM		
Module 5	L1,L2	10Hrs.
Numerical Methods for Multi-Degree Freedom Systems: Introduction, Influence coefficients, Maxwell reciprocal theorem, Dunkerley's equation. Orthogonalityofprincipal modes, Method of matrix iteration-Method of determination of all the natural frequencies usingsweeping matrix and Orthogonality principle. Holzer's method, Stodola method. **Non-Linear Vibration** : (Advance theory of vibration by ssrao) **Laboratory Sessions/ Experimental learning**: Plotting displacement curve using Analytical Approach.		

Applications: Understanding non linear behavior of waves or vibration. **Video link / Additional online information (related to module if any): (NPTEL,IIT MADRAS)** https://www.youtube.com/watch?v=V_Lj4Pun_WM

Course outcomes: Upon completion of the course, students will be able to:	
CO304.1	Apply the principle of super position to Simple Harmonic Motions.
CO304.2	Analyse undamped free and damped free vibration
CO304.3	Perform measurements of vibrations
CO304.4	Evaluate the equations of twodegrees of freedom systems.
CO304.5	Evaluate themulti degree of freedom system.

Reference Books:	
1.	W.T. Thomson and MarieDillon Dahleh, Theory of Vibration with Applications, Pearson Education, 2008
2.	V.P. Singh, Mechanical Vibrations, DhanpatRai& Company Pvt. Ltd, 2016
3.	S.S. Rao, Mechanical Vibrations, Pearson Education Inc, 2003
4.	S. Graham Kelly, Mechanical Vibrations, Tata McGraw Hill, 2007

CIE Assessment:
CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests - Quizzes/mini tests (4 marks) - Mini Project / Case Studies (8 Marks) - Activities/Experimentations related to courses (8 Marks)
SEE Assessment:
- Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

- Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.
- One question must be set from each unit. The duration of examination is 3 hours.

CO,PO Mapping														
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	3	1	1	1	1	1	1	0	2	3	1	1
CO2	3	3	1	3	1	1	0	1	1	0	1	3	1	1
CO3	3	3	2	3	2	1	0	0	1	0	1	3	1	1
CO4	3	3	2	3	3	2	0	0	1	0	01	3	1	1
CO5	2	2	2	2	1	1	0	1	1	0	0	3	1	1

High,3, Medium,2, Low,1

Course Title	EXPERIMENTAL AERODYNAMICS	Semester	V
Course Code	MVJ19AE551	CIE	50
Total No. of Contact Hours	40 L : T : P :: 3: 1: 0	SEE	50
No. of Contact Hours/week	4	Total	100
Credits	3	Exam. Duration	3 Hrs.

Course objective is to:

1. Comprehend the basic concepts of Aerodynamic Measurements
2. Acquire the knowledge of various subsonic and transonic wind tunnels
3. Acquire the knowledge of supersonic and hypersonic wind tunnels
4. Understand the basics of various measurement techniques
5. Acquire the knowledge of role of wind tunnel in Aerodynamic Design

Module 1	L1,L2,L3	08 Hrs.

Introduction Aerodynamics, Review of Wind Tunnels:Background, Principle, Open and Close Circuit Wind Reynolds Number Effect and Laminar to Turbulent Transition, Dynamics Similarity and Dimensionless Parameters, Constraints of Testing: Blockage and correction, Model Installation and Different Kinds of Support, Free stream Vortical and Acoustic Perturbations, Design and Fabrication of Wind Tunnel Models. Deformation of Models, Deformation of Models, Limitations and Constraints of Numerical Methods and Wind Tunnel Test

Industrial Aerodynamics Testing: Combining Tests and Numerical Simulation. Flight Test Beds, Catapulted Flight Test, Aeroballistics Flight Test, Simulated Altitude Test Cells, Impact of Altitude, an Altitude Test Cell Work, Benefits of Simulated Altitude Tests in Addition to Ground

Laboratory Sessions/ Experimental learning: Estimation of forces on various models

Applications:Applicable in standard Airplane Design

Video link / Additional online information (related to module if any):

https://nptel.ac.in/courses/101/106/101106040/

https://nptel.ac.in/courses/101/104/101104066/

Module 2	L1,L2,L3	08 Hrs.

Subsonic Wind Tunnels: Various Cross Sections, Low Reynolds Number, Multiple Test Section, Low Turbulence Research, Pressurized, Large Research Wind Tunnels. Special Purpose Wind Tunnels: Vertical, Climatic, Icing, Anechoic Chambers and Aero acoustic Wind Tunnel, Dual Purpose Aerodynamic and Acoustic Wind Tunnel, Wind Tunnels for Ground Vehicles, Water Tunnels.

Transonic Wind Tunnels : Definition of the Transonic Regime, Blockage Reduction and Flow Un-Chocking : Perforated or Slotted Walls , Adaptive Walls , Reflection of Disturbances, Double Throat Diffuser, Typical Transonic Wind Tunnels **Laboratory Sessions/** Experimental learning: Estimation **of blockage and corrections on various models** **Applications**:Applicable in standard Airplane Design to validate the CFD results **Video link / Additional online information (related to module if any)**: https://nptel.ac.in/courses/101/106/101106040/ https://nptel.ac.in/courses/101/104/101104066/		
Module 3	**L1,L2,L3**	08 Hrs..
High speed wind tunnels: Types of high speed tunnels Supersonic wind tunnels: Test section flow parameters, Components of supersonic wind tunnels, Power required for the operation of supersonic wind tunnels. Closed circuit supersonic wind tunnel. Actual flow in the supersonic wind tunnel Starting, Model Sizing and operational problems of the supersonic the wind tunnel. **The shock tube**: Shock tube equations, Reflected shocks, Viscous effects and the shock tube boundary layer, Observation time in shock tube, Measurement of shock speed , Hypersonic facilities: Hypersonic wind tunnels, Plasma arc tunnels, Ballistic ranges, Low density wind tunnels **Laboratory Sessions/ Experimental learning**: Estimation of power required for various wind tunnels **Applications**: Applicable in standard High speed Airplane Design **Video link / Additional online information (related to module if any)**: https://nptel.ac.in/courses/101/106/101106040/ https://nptel.ac.in/courses/101/105/101105024/		
Module 4	**L1,L2,L3**	08 Hrs.
Flow Visualization Techniques, Intrusive and Non-intrusive: Mechanical, Electrical and Electronic measuring Devices and their error estimates: Pressure, Temperature, Velocity, Density, Forces and Moment, Flow properties on a surface. Special Devices: Laser Spectroscopy and Electron Beam Excitation **Laboratory Sessions/ Experimental learning**: Estimation of errors for various measurement techniques **Applications**:Applicable in standard High speed Airplane Design **Video link / Additional online information (related to module if any)**: https://nptel.ac.in/courses/101/106/101106040/ https://nptel.ac.in/courses/112/103/112103290/		
Module 5	**L1,L2,L3**	08 Hrs.

Computer-Aided Wind Tunnel Test and Analysis: Experimental Versus Numerical Analysis, CFD for the Preparation of Wind Tunnel Tests, Correction and Monitoring of Wind Tunnel Results by CFD, Towards the Hybrid Wind Tunnel , Reconstruction of Data. Prospects and Challenges for Aerodynamics: Role of the Wind Tunnel in Design and Optimisation, Flow Control, Developments in Aeroacoustic Measurements, Search for Novel Aircraft Architectures, Supersonic and Hypersonic Flights, Prospects for the Aerodynamic Design.

Laboratory Sessions/ Experimental learning: Estimation of errors in Experiments Vs CFD

Applications:Applicable in standard Airplane Design

Video link / Additional online information (related to module if any):

https://nptel.ac.in/courses/101/106/101106040/

https://nptel.ac.in/courses/101/104/101104066/

Course outcomes:

Upon completion of the course, students will be able to:

CO305.1.1	Analyze various Aerodynamic Measurements
CO30.5.1.2	Develop design experiments on subsonic and transonic wind tunnels
CO305.1.3	Design experiments on supersonic and hypersonic wind tunnels.
CO305.1.4	Illustrate the limitations of various measurement techniques
CO305.1.5	Apply the knowledge of wind tunnel in Aerodynamic Design

Reference Books:

1.	Low Speed wind Tunnel Testing - Rae, W.H. and Pope,Alan
2.	Wind Tunnel Techniques - Pankrust, R.C and Holder, D.W.
3.	High Speed Wind Tunnel Testing - Pope,Alan & Goin
4.	Shock Tubes in high temperature chemical physics - Gaydon,A.G. and Hurle, J.R

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:
- Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus. - Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions. - One question must be set from each unit. The duration of examination is 3 hours.

CO – PO MAPPING														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2
CO1	3	3	3	3	0	0	0	0	0	0	1	1	3	3
CO2	3	3	3	3	0	0	0	0	0	0	1	1	3	3
CO3	3	3	3	3	0	0	0	0	0	0	1	1	3	3
CO4	3	3	3	3	0	0	0	0	0	0	1	1	3	3
CO5	3	3	3	3	0	0	0	0	0	0	1	1	3	3

High,3, Medium,2, Low,1

Course Title	COMPOSITE STRUCTURES	Semester	V
Course Code	MVJ19AS552/AE552	CIE	50
Total No. of Contact Hours	40 L : T : P :: 3: 1: 0	SEE	50
No. of Contact Hours/week	4	Total	100
Credits	3	Exam. Duration	3 Hrs.

The course objective is to:

1. Understand the properties and advantages of composite materials compared to conventional materials.
2. Comprehend the properties of polymer matrix composites with fibre reinforcements and to learn the fabrication methods used in composites
3. Gain knowledge about the Micro and macro mechanical properties of composite lamina and laminates
4. Understand the failure theories for predicting the failure of a composite lamina
5. Learn the NDT and DT methods of Composites with Composite applications

Module 1	L1,L2,L3	08 Hrs.

Introduction to Composite Materials

Definition, classification of composite materials, classification of reinforcement - particulate, short fibers, whiskers, long fibers composites. matrix materials – metals, ceramics, polymers (including thermoplastics and thermosets), Carbon-Carbon Composites

Metal Matrix Composites:

MMC with particulate and short fiber reinforcement, liquid and solid state processing of MMC – stir casting, squeeze casting. Properties of MMCs, Applications of Al, Mg, Ti based MMC

Laboratory Sessions/ Experimental learning:

Determination of various composite materials by different types of fibers with application

Applications: Aircraft structural Parts, Automobile Sector and Many Engineering fields

Video link / Additional online information (related to module if any):

7. https://youtu.be/0kB0G6WKhKE?list=PLSGws_74K01-bdEEUElQ9-obrujIKGEhg – IIT Kanpur

Module 2	L1,L2,L3,	08 Hrs.

Processing of Polymer Matrix Composites: Thermoset Polymers, Hand layup Process, Vacuum Bagging Process, Post Curing Process, Filament winding,**Resin Transfer Moulding**, Pultrusion, Pulforming, Autoclave Process

Processing of Polymer Matrix Composites: Thermoplastic Polymers, Extrusion process, Injection Moulding Process, Thermo-forming process.

Post Processing of Composites – Adhesive bonding, drilling, cutting processes.

Laboratory Sessions/ Experimental learning:

Preparation of Composite laminates by Hand layup method

Applications: Thermosets and Thermoplastics are used in Aircraft Construction, corrosive environment, Common applications include fans, grating, tanks, ducts, hoods, pumps and cabinets.

Video link / Additional online information (related to module if any):

https://youtu.be/tP8JCX87DzI - IIT Roorkee

Module 3	L1,L2,L3	08 Hrs.

Micro-Mechanical Behavior of a Lamina

Determination of elastic constants-Rule of mixtures, transformation of coordinates, micro-mechanics based analysis and experimental determination of material constants. **Ultimate Strengths of a Unidirectional Lamina**

Macro-Mechanical Behavior of a Lamina:

Hooke's law for different types of materials, Number of elastic constants, Two - dimensional relationship of compliance and stiffness matrix. Global and local axis for angle lamina, Stress-Strain relations for lamina of arbitrary orientation, Numerical problems.

Laboratory Sessions/ Experimental learning:

Determination of Young's Modulus of a Composite beam

Applications:Basics of macro level elastic properties, Scales of analysis of composites. Unidirectional and Woven fibers

Video link / Additional online information (related to module if any):

https://youtu.be/loyeZN5UQT8 - IIT Madras

Module 4	L1,L2,L3	08 Hrs.

Failure Theory

Different Strengths of Composite Lamina,Failure of Composite, Tsai-Hill, Tsai-Wu, Max Stress and Max Strain theories

Classical plate theory- Stress and strain variation in a laminate- Resultant forces and moments- A B & D matrices- Strength analysis of a laminate.

Laboratory Sessions/ Experimental learning:

Evaluate the mechanical properties of a lamina and a laminate

Applications: Prediction of failure of composite, load analysis methodology.

Video link / Additional online information (related to module if any):

https://youtu.be/6CLEWA2WNqM - IIT Madras		
Module 5	**L1,L2**	08 Hrs.
Inspection & Quality Control: Destructive & Non-Destructive Testing, Tensile, Compression, Flexural, Shear, Hardness; ultrasonic testing – A-B-C scan **Applications of Composites Materials** Automobile, Aircrafts, missiles, Space hardware, Electrical and electronics, marine, recreational and Sports equipment, future potential of composites. **Laboratory Sessions/ Experimental learning:** Determination of Defects in a composite by NDT Methods **Applications: NDT- DT Methods, Composites in Aerospace sector** **Video link / Additional online information (related to module if any):** https://youtu.be/ZMJ7O4vs-Q8 - IIT Kanpur		

Course outcomes: Upon completion of the course, students will be able to:	
CO305.2.1	Compare the properties and select material for the given application.
CO305.2.2	Analyse the properties of polymer matrix composites and Fabrication of Composite materials
CO305.2.3	Apply constitutive equations of *composite* materials and understand mechanical behaviour at *micro and macro* levels.
CO305.2.4	Design and failure *analysis* for manufacturing *composite* materials and Determine stresses and strains relation in composites materials.
CO305.2.5	Carry out various inspectionsin accordance with the established procedures and differentiate various defect types and select the appropriate **NDT** methods for better evaluation

Reference Books:	
1.	K.K Chawla, Composite Materials- Science and Engineering, IV edition, Springer International Publishing, 2019: ISBN: 978-3-030-28983-6
2.	Autar Kaw, Mechanics of Composites, II edition, Taylor & Francis Group CRC Press. 2006, ISBN:978-0-8493-1343-1
3.	R M Jones,Mechanics of Composite Materials, 2nd Edition, Taylor & Francis, 2015; ISBN:978-1560327127
4.	Ajay Kapadia, Non-Destructive Testing of Composite Materials, National Composites Network, Best Practices Guide, TWI Publications, 2006.

CIE Assessment:
CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests - Quizzes/mini tests (4 marks) - Mini Project / Case Studies (8 Marks) - Activities/Experimentations related to courses (8 Marks)
SEE Assessment:
- Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus. - Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions. - One question must be set from each unit. The duration of examination is 3 hours.

CO,PO Mapping														
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	2	1	2	2	1	2	2	2	2	2	1	1
CO2	3	1	3	2	2	2	2	2	2	2	2	2	1	1
CO3	3	3	3	3	2	2	1	2	2	2	1	1	1	1
CO4	3	3	3	3	2	2	1	2	2	2	1	1	1	1
CO5	3	1	3	2	2	2	2	2	2	2	2	1	1	1

High,3, Medium,2, Low,1

Course Title	HEAT & MASS TRANSFER IN AERONAUTICAL APPLICATIONS	Semester	V
Course Code	MVJ19AE553	CIE	50
Total No. of Contact Hours	40 L : T : P :: 3: 1: 0	SEE	50
No. of Contact Hours/week	4	Total	100
Credits	3	Exam. Duration	3 Hrs.

The course objective is to:

1. Understand the different modes of heat transfer.
2. Understand the conduction mode of heat transfer
3. Understand the free convection and forced convection.
4. Acquire knowledge on the working of heat exchangers used in aero industry.
5. Acquire the knowledge of heat transfer problems in aircraft technology.

Module 1	L1,L2	08 Hrs.

Fundamentals:

- Different modes of heat transfer and mass and momentum transfer, elements of mass diffusion and boundary layer theory.
- Mass transfer definition and terms used in mass transfer analysis, Fick's First law of diffusion.Numerical problems

Laboratory Sessions/ Experimental learning: Heat and mass transfer lab

Applications: Gas turbine engines, Heat exchangers in Aero applications.

Video link / Additional online information (related to module if any):

8. https://nptel.ac.in/courses/112/101/112101097/

Module 2	L1,L2,L3	08 Hrs.

Conduction: Derivation of general three-dimensional conduction equation in Cartesian coordinate, special cases, discussion on 3-D conduction in cylindrical and spherical coordinate systems.

Effect of variation of thermal conductivity on heat transfer in solids - Heat transfer problems in infinite and semi-infinite solids - Extended surfaces.

One dimensional transient heat conduction: Systems with negligible internal resistance, Significance of Biot and Fourier Numbers, Chart solutions of transient conduction systems.

Laboratory Sessions/ Experimental learning: Heat conduction experiment in HMT lab

Applications: Gas turbine combustion chamber, turbine and afterburners etc **Video link / Additional online information (related to module if any)**: 4. https://nptel.ac.in/courses/112/105/112105271/		
Module 3	**L1,L2,L3**	08 Hrs.
Convection:Concepts of Continuity, Momentum and Energy Equations. Dimensional analysis-Buckingham's Pi Theorem - Application for developing non-dimensional correlation for convective heat transfer • **Free Convection**:Development of Hydrodynamic and thermal boundary layer along a vertical plate, Use of empirical relations for Vertical plates and pipes. • **Forced Convection**:External Flows, Concepts of hydrodynamic and thermal boundary layer and use of empirical correlations for Flat plates and Cylinders. Internal Flows, Concepts about Hydrodynamic and Thermal Entry Lengths, use of empirical correlations for Horizontal Pipe Flow and annulus flow. **Laboratory Sessions/ Experimental learning**:Free and Forced convection experiments in HMT lab **Applications**:Heat exchangers in Aero applications,Gas turbine combustion chamber, turbine and afterburners etc **Video link / Additional online information (related to module if any)**: 1. https://nptel.ac.in/courses/112/106/112106170/		
Module 4	**L1,L2,L3**	08 Hrs.
Radiation: • Introduction to physical mechanism - Radiation properties - Radiation shape factors Heat exchange between non-black bodies – Radiation shields **Heat Exchangers**: • Heat Exchangers used in Aeronautical Industry: Classification of heat exchangers; overall heat transfer coefficient, Heat exchanger components, Numerical problems. **Laboratory Sessions/ Experimental learning**:Radiation experiment in HMT lab **Applications**: Combustion chambers in Rockets and varies gas turbine engines. **Video link / Additional online information (related to module if any)**: 7. https://nptel.ac.in/courses/112/106/112106170/		
Module 5	**L1,L2,L3,**	08 Hrs.
Heat and Mass Transfer Problems in Aeronautical Engineering:		

Heat transfer problems in gas turbine combustion chambers - Rocket thrust chambers - Aerodynamic heating -Ablative heat transfer. Heat transfer problems in turbine and nozzle blades. Cooling of Turbines. Environmental control systems of aircraft.

Laboratory Sessions/ Experimental learning: Basics in Aircraft propulsion lab

Applications: Rocket thrust chambers - Aerodynamic heating -Ablative heat transfer turbine and nozzle blades.

Video link / Additional online information (related to module if any):

7. https://nptel.ac.in/courses/112/101/112101097/

Course outcomes:

Upon completion of the course, students will be able to:

CO305.3.1	Analyse the fundamentals of heat and mass transfer
CO305.3.2	Explain the concept of one dimensional steady and transient heat conduction through various systems
CO305.3.3	Evaluate the heat transfer by convection with the flow of fluids
CO305.3.4	Analyzing heat transfer in heat exchangers
CO305.3.5	Analysing heat transfer problems occurring in aircraft systems.

Reference Books:

1.	Ozisik, Heat transfer-A basic approach, Tata McGraw Hill 2002
2.	Holman Heat Transfer, J.P McGraw Hill Book Co., Inc., New York 8th edition,1996
3.	Sachdeva.Fundamentals of Engineering Heat and Mass Transfer, S.C Wiley Eastern Ltd., New Delhi 1981
4.	SuttonRocket Propulsion Elements, G.P John Wiley and Sons 5th Edn.1986

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

- Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.
- Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.
- One question must be set from each unit. The duration of examination is 3 hours.

CO,PO Mapping														
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	0	0	0	0	0	0	1	1	1	1
CO2	3	3	2	3	0	0	0	0	0	0	1	2	1	1
CO3	3	3	3	3	0	0	0	0	0	0	0	2	1	1
CO4	3	3	2	3	0	0	0	0	0	0	0	1	1	1
CO5	3	2	2	2	0	0	0	0	0	0	1	1	1	1

High,3, Medium,2, Low,1

Course Title	AERODYNAMICS LAB	Semester	V
Course Code	MVJ19AEL56	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	03	Total	100
Credits	02	Exam. Duration	3 Hours

Course objective is to:

- Be acquainted with basic principles of aerodynamics using wind tunnel.
- Acquire the knowledge on flow visualization techniques.
- Understand the procedures used for calculating the lift and drag.

Sl No	Experiment Name	RBT Level	Hours
1	Calibration of a subsonic wind tunnel: test section static pressure and total head distributions.	L1,L2,L3	03
2	Smoke flow visualization studies on a two-dimensional circular cylinder at low speeds.	L1,L2,L3	03
3	Smokeflowvisualizationstudiesonatwodimensionalairfoilatdifferentanglesofincidenceatlowspeeds	L1,L2,L3	03
4	Smoke flow visualization studies on a two dimensional wing with flaps and slats at different angles of incidence at low speeds	L1,L2,L3	03
5	Tuft flow visualization on a wing model at different angles of incidence at low speeds: identify zones of attached and separated flows.	L1,L2,L3	03
6	Surface pressure distributions on a two dimensional smooth circular cylinder at low speeds and calculation of pressure drag.	L1,L2,L3	03
7	Surface pressure distributions on a two-dimensional wing of symmetric airfoil and estimation of Center of pressure and Aerodynamic center	L1,L2,L3	03
8	Surface pressure distributions on a two-dimensional wing of cambered airfoil at different angles of incidence, and estimation of Center of pressure and Aerodynamic center.	L1,L2,L3	03
9	Calculation of total drag of a two-dimensional circular cylinder at low speeds using pitot-static probe wake survey.	L1,L2,L3	03
10	Calculation of total drag of a two-dimensional wing of cambered airfoil at low speeds at incidence using pitot-static probe wake survey.	L1,L2,L3	03

11	Measurement of a typical boundary layer velocity profile on the tunnel wall (at low speeds) using a pitot probe and calculation of boundary layer displacement and momentum thickness.	L1,L2,L3	03
12	Calculation of aerodynamic forces and moments acting on a model aircraft at various Angle of Attack and speeds using wind tunnel balance With Yaw.	L1,L2,L3	03
13	Calculation of aerodynamic coefficients and forces acting on a model aircraft at various Angle of Attack and speeds using wind tunnel balance Without Yaw.	L1,L2,L3	03
14	Pressure measurements on aerofoil for a case of reverse flow.	L1,L2,L3	03

Course outcomes:	
CO1	Apply the flow visualization techniques
CO2	Estimate the pressure distribution over the bodies
CO3	Calculate the forces and moments on models.

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

High-3, Medium-2, Low-1

Course Title	ENERGY CONVERSION LAB	Semester	V
Course Code	MVJ19AEL57	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	03	Total	100
Credits	02	Exam. Duration	3 Hours

Course objective is to:

- Familiarize with the flash point, fire point and viscosity of lubricating oils.
- Study IC engine parts, opening and closing of valves to draw the valve-timing diagram.
- Gain knowledge of performance of IC engines.

Sl No	Experiment Name	RBT Level	Hours
1	Determination of Flash point and Fire point of lubricating oil using Abel Pensky Appratus	L1,L2,L3	03
2	Determination of Flash point and Fire point of lubricating oil using Pensky Martins Apparatus.	L1,L2,L3	03
3	Determination of Flash point and Fire point of lubricating oil using Cleave land Apparatus.	L1,L2,L3	03
4	Determination of Calorific value of fuels using bomb calorimeter	L1,L2,L3	03
5	Determination of Calorific value of fuels using Junker gas calorimeter	L1,L2,L3	03
6	Determination of Viscosity of lubricating oil using Red wood viscometer	L1,L2,L3	03
7	Determination of Viscosity of lubricating oil using Saybolt Viscometers.	L1,L2,L3	03
8	Determination of Viscosity of lubricating oil using Torsion viscometers	L1,L2,L3	03
9	Valve Timing diagram of 4-stroke IC Engine.	L1,L2,L3	03
10	Estimation of viscosity of fluid by using Planimeter.	L1,L2,L3	03
11	Performance Test on Four Stroke Petrol Engine and calculations of IP, BP, Thermal efficiencies, SFC, FP and to draw heat balance sheet.	L1,L2,L3	03
12	Performance Test on Four stroke Multi-cylinder Engine and calculations of IP, BP, Thermal efficiencies, SFC, FP and to draw heat	L1,L2,L3	03

	balance sheet.		
13	Performance testing and Morse test on four stroke cylinder petrol engine with hydraulic dynamometer	L1,L2,L3	03
14	Performance testing on four stroke single cylinder VCR engine with resistance loading	L1,L2,L3	03

Course outcomes:	
CO1	Determine the flash point, fire point and viscosity of lubricating oils.
CO2	Analyze closing of valves to draw the valve-timing diagram
CO3	Performance estimation of IC engines.

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

High-3, Medium-2, Low-1

Course Title	FLUID MECHANICS LAB	Semester	V
Course Code	MVJ19AEL58	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	03	Total	100
Credits	02	Exam. Duration	3 Hours

Course objective is to:

- Gain the knowledge of various flow meters and the concept of fluid mechanics.
- Understand functioning of hydraulic pumps
- Gain the knowledge of Compressors

Sl No	Experiment Name	RBT Level	Hours
1	Calibration of Venturimeter.	L1,L2,L3	03
2	Determination of Coefficient of discharge for a small orifice by a constant head method.	L1,L2,L3	03
3	Determination of coefficient of friction of flow in a pipe	L1,L2,L3	03
4	Calibration of contracted Rectangular Notch.	L1,L2,L3	03
5	Calibration of contracted V-Notch.	L1,L2,L3	03
6	Verification of Bernoulli's equation.	L1,L2,L3	03
7	Pipe friction apparatus with loss of head on pipe fittings.	L1,L2,L3	03
8	Determination of Coefficient of loss of head in a sudden contraction and friction factor.	L1,L2,L3	03
9	Estimate performance of hydraulic Pumps -Single stage centrifugal pumps	L1,L2,L3	03
10	Estimate performance of hydraulic Pumps –Multi- stage centrifugal pumps	L1,L2,L3	03
11	Performance hydraulic Pumps- Reciprocating pump	L1,L2,L3	03
12	Performance test on a two stage Reciprocating Air Compressor	L1,L2,L3	03
13	Determination of force developed by impact of Jets on Vannes.	L1,L2,L3	03
14	Estimate the performance of Air Blower	L1,L2,L3	03

Course outcomes:

CO1	Verify the Bernoulli's equation.
CO2	Analyze performance of hydraulic pumps

CO3	Analyze performance of Compressors

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

High-3, Medium-2, Low-1

Course Title	ENVIRONMENTAL STUDIES	Semester	V
Course Code	MVJ19ENV59	CIE	50
Total No. of Contact Hours	20 L: T: P 1 : 0 :0	SEE	50
No. of Contact Hours/week	1	Total	100
Credits	1	Exam. Duration	3 Hrs.

Course objective is to:

- Relate to interdisciplinary approach to complex environmental problems using basic tools of the natural and social sciences including geo-systems, biology, chemistry, economics, political science and international processes; Study drinking water quality standards and to illustrate qualitative analysis of water.
- Critically evaluate the science and policy ramifications of diverse energy portfolios on air and water quality, climate, weapons proliferation and societal stability..

Module 1	L1,L2,	04 Hrs.

Introduction to environmental studies, Multidisciplinary nature of environmental studies; Scope and importance; Concept of sustainability and sustainable development.

Ecosystems (Structure and Function): Forest, Desert, Rivers, Ocean

Biodiversity: Types, Hot spots; Threats and Conservation of biodiversity, Deforestation.

Video link:

https://nptel.ac.in/courses/127/106/127106004/

Module 2	L1,L2,L3,	10 Hrs.

Advances in Energy Systems (Merits, Demerits, Global Status and Applications): Hydrogen, Solar, OTEC, Tidal and Wind.

Natural Resource Management (Concept and case-study): Disaster Management, Sustainable Mining, Cloud Seeding, and Carbon Trading.

Video link:

https://nptel.ac.in/courses/121/106/121106014/

Module 3	L1,L2,L3	10 Hrs.

Environmental Pollution (Sources, Impacts, Corrective and Preventive measures, Relevant EnvironmentalActs, Case-studies):SurfaceandGroundWaterPollution;Noisepollution;SoilPollutionand Air Pollution.

Waste Management & Public Health Aspects: Bio-medical Waste; Solid waste; Hazardous waste;

E-waste. **Video link:** • https://nptel.ac.in/courses/122/106/122106030/ • https://nptel.ac.in/courses/105/103/105103205/		
Module 4	**L1,L2,L3**	10 Hrs.
. **Global Environmental Concerns (Concept, policies, and case-studies)**: Global Warming Climate Change; Acid Rain; Ozone Depletion; Fluoride problem In drinking water. **Video link:** • https://nptel.ac.in/courses/122/106/122106030/ • https://nptel.ac.in/courses/120108004/		
Module 5	**L1,L2**	10 Hrs.
Latest Developments in Environmental Pollution Mitigation Tools (Concept and Applications): G.I.S. & Remote Sensing, Environment Impact Assessment, Environmental Management Systems, ISO 14001. **Video link:** • https://nptel.ac.in/courses/105/102/105102015/ https://nptel.ac.in/courses/120/108/120108004/		

Course outcomes:	
Upon completion of the course, students will be able to:	
CO1	Describe the principles of ecology and environmental issues that apply to air, land, and water issues on a global scale.
CO2	Develop critical thinking and/or observation skills, and apply them to the analysis of a problem or question related to the environment.
CO3	Demonstrate ecology knowledge of a complex relationship between biotic and Abiotic components.
CO4	Apply their ecological knowledge to illustrate and graph a problem and describe the realities that managers face when dealing with complex issues.

Reference Books:	
1.	Principals of Environmental Science and Engineering, Raman Siva kumar, Cengage learning, Singapur, 2nd Edition, 2005
2.	Environmental Science – working with the Earth G.Tyler Miller Jr. Thomson Brooks /Cole, 11th Edition, 2006

3.	Textbook of Environmental and Ecology, Pratiba Singh, Anoop Singh & Piyush Malaviya , ACME Learning Pvt. Ltd. New Delhi, 1st Edition.

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

High,3, Medium,2, Low,1