UNIVERSITY OF MUMBAI

Bachelor of Engineering

in

Automobile Engineering

Third Year with Effect from AY 2021-22

(REV- 2019 'C' Scheme) from Academic Year 2019 – 20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	**Third Year B.E. in Automobile Engineering**
2	Eligibility for Admission	**After Passing Second Year Engineering as per the Ordinance 0.6243**
3	Passing Marks	**40%**
4	Ordinances / Regulations (if any)	**Ordinance 0.6243**
5	No. of Years / Semesters	**8 semesters**
6	Level	~~P.G.~~ / **U.G.**/ ~~Diploma / Certificate~~ (Strike out which is not applicable)
7	Pattern	~~Yearly~~ / **Semester** (Strike out which is not applicable)
8	Status	~~New~~ / **Revised** (Strike out which is not applicable)
9	To be implemented from Academic Year	**2021-2022**

Date

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering) of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 171, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

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University of Mumbai	University of Mumbai

Incorporation and implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of 'C ' scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme 'A' and 'B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD's/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

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University of Mumbai   University of Mumbai

Preface

Engineering education in India, in general, is being revamped so as to impart the theoretical knowledge along with industrial exposure. It is our attempt, when we are introducing a new curriculum; to bridge the industry-academia gap. To enable this, we have introduced components such as skill-based laboratories and project-based learning. We trust that this will allow the learner to apply knowledge gained in previous and current semesters to solve problems for gaining better understanding. What once were pure mechanical systems have now been transformed into multidisciplinary systems of mechatronics, electronics and computer science. Interdisciplinary knowledge is gaining importance as we are moving towards automated world as technology advances. Keeping this in mind the curriculum has been designed in a way so that learner shall be acquainted with many Interdisciplinary subjects.

Automobile Engineering is one of the fastest growing sectors, with lots of inventions and innovations happening. The graduating Automobile Engineers can contribute in the areas such as engines, transmission, safety and stability, energy and alternate energy etc. The challenges for our budding engineers would be manifold, when electric vehicles are already gaining popularity and driverless cars becoming a reality.

Engineers develop new technological solutions. During the engineering design process, the responsibilities of the engineer may include defining problems, conducting and narrowing research, analyzing criteria, finding and analyzing solutions, and making decisions. The Program Educational Objectives proposed for the undergraduate program in Automobile Engineering are listed below;

1. To prepare the stake holder to exhibit leadership qualities with demonstrable attributes in lifelong learning to contribute to the societal needs.
2. To make ready the stake holder to pursue higher education for professional development
3. To help the stake holder to acquire the analytical and technical skills, knowledge, analytical ability attitude and behavior through the program
4. To prepare the stakeholders with a sound foundation in the mathematical, scientific and engineering fundamentals
5. To motivate the learner in the art of self-learning and to use modern tools for solving real life problems and also inculcate a professional and ethical attitude and good leadership qualities
6. To Prepare the stake holder to able to Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

We trust this revised version of syllabus come up to the expectations of all stakeholders. We wish to place on record our sincere thanks and appreciations to the various contributors from the academia and industry for their most learned inputs in framing this syllabus.

Board of Studies in Mechanical Engineering

Dr. Vivek K. Sunnapwar : Chairman
Dr. S. M. Khot : Member
Dr. V. M. Phalle : Member
Dr. Siddappa Bhusnoor : Member
Dr. S.S. Pawar : Member
Dr. Sanjay U. Bokade : Member
Dr. Dhanraj Tambuskar : Member

Semester V

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract.	Theory	Pract.	Total
AEC501	Mechanical Measurements & Controls [#]	3	--	3	--	3
AEC502	Internal Combustion Engines	3	--	3	--	3
AEC503	Machine Design	3	--	3	--	3
AEC504	Finite Element Analysis [#]	3	--	3	--	3
AEDLO501X	Department Level Optional Course – 1 [#]	3	--	3	--	3
AEL501	Measurement and Engine Testing Lab	--	2	--	1	1
AEL502	Machine Design	--	2	--	1	1
AEL503	Finite Element Analysis [#]	--	2	--	1	1
AESBL501	Professional Communication and Ethics - II [#]	--	2*+2	--	2	2
AEPBL501	Mini Project – 2 A	--	4[$]	--	2	2
Total		**15**	**14**	**15**	**07**	**22**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Prac/oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
		Test1	Test2	Avg					
AEC501	Mechanical Measurements & Controls [#]	20	20	20	80	3	--	--	100
AEC502	Internal Combustion Engines	20	20	20	80	3	--	--	100
AEC503	Machine Design	20	20	20	80	3	--	--	100
AEC504	Finite Element Analysis [#]	20	20	20	80	3	--	--	100
AEDLO501X	Department Level Optional Course – 1 [#]	20	20	20	80	3	--	--	100
AEL501	Measurement and Engine Testing Lab	--	--	--	--	--	25	25	50

Course Code	Course Name								
AEL502	Machine Design	--	--	--	--	--	25	--	50
AEL503	Finite Element Analysis#	--	--	--	--	--	25	25	50
AESBL501	Professional Communication and Ethics - II #	--	--	--	--	--	25	25	50
AEPBL501	Mini Project – 2 A	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**125**	**100**	**725**

Department Level Optional Course – 1

Course Code	Department Level Optional Course – 1
AEDLO5011	Optimization Techniques#
AEDLO5012	Statistical Techniques#
AEDLO5013	Computational Methods#

* Theory class to be conducted for full class
\$ indicates work load of Learner (Not Faculty), for Mini Project
 # indicates common with Mechanical Engineering

Note: Students are required to undergo Internship (Garage Training) of minimum 4 weeks in vacation of Semester V.

Course Code	Course Name	Credits
AEC501	**Mechanical Measurements and Controls**	**03**

Objectives:

1. To study the principles of precision measuring instruments & their significance.
2. To familiarize with the handling & use of precision measuring instruments/ equipment's.
3. To impart knowledge of architecture of the measurement system.
4. To deliver working principle of mechanical measurement system.
5. To study concept of mathematical modelling of the control system.
6. To acquaint with control system under different time domain.

Outcomes: Learner will be able to…

1. Handle, operate and apply the precision measuring instruments / equipment's.
2. Analyze simple machined components for dimensional stability & functionality.
3. Classify various types of static characteristics and types of errors occurring in the system.
4. Classify and select proper measuring instrument for displacement, pressure, flow and temperature measurements.
5. Design mathematical model of system/process for standard input responses and analyse error and differentiate various types of control systems and time domain specifications
6. Analyse the problems associated with stability.

Module	Details	Hrs.
1	**1.1** Introduction to Metrology, Need for inspection, Fundamental principles and definition, Standards of measurement, Errors in measurements, International standardization. **1.2** Limits, fits and tolerances of interchangeable manufacture, Elements of interchangeable system, Hole based and shaft based systems, Tolerance grades, Types of fits, General requirements of Go & No go gauging, Taylor's principle, Design of Go & No go gauges.	**06**
2	**2.1** Principles of interference, Concept of flatness, Flatness testing, Optical flats, Optical Interferometer and Laser interferometer. **2.2** Surface texture measurement: importance of surface conditions, roughness and waviness, surface roughness standards specifying surface roughness parameters - Ra, Ry, Rz, RMS value etc., Surface roughness measuring instruments. **2.3** Screw Thread measurement: Two wire and three wire methods, Floating carriage micrometer. **2.4** Gear measurement: Gear tooth comparator, Master gears, Measurement using rollers and Parkinson's Tester.	**08**
3	**3.1** Significance of Mechanical Measurements, Classification of measuring instruments, generalized measurement system, types of inputs: Desired, interfering and modifying inputs. **3.2** Static characteristics: Static calibration, Linearity, Static Sensitivity, Accuracy, Static error, Precision, Reproducibility, Threshold, Resolution, Hysteresis, Drift, Span & Range etc.	**06**

4	**4.1** Displacement Measurement: Transducers for displacement, displacement measurement, potentiometer, LVDT, Capacitance Types, Digital Transducers (optical encoder), Nozzle Flapper Transducer	**08**
	4.2 Strain Measurement: Theory of Strain Gauges, gauge factor, temperature Compensation, Bridge circuit, orientation of strain gauges for force and torque, Strain gauge based load cells and torque sensors	
	4.3 Pressure Measurement: Elastic pressure transducers viz. Bourdon tubes, diaphragm, bellows and piezoelectric pressure sensors, High Pressure Measurements, Bridge man gauge. Vacuum measurement: Vacuum gauges viz. McLeod gauge, Ionization and Thermal Conductivity gauges	
	4.4 Flow Measurement: Bernoulli flowmeters, Ultrasonic Flowmeter, Magnetic flow meter, rotameter	
	4.5 Temperature Measurement: Electrical methods of temperature measurement Resistance thermometers, Thermistors and thermocouples, Pyrometers	
5	**5.1** Introduction to control systems, Classification of control system. Open loop and closed loop systems.	**06**
	5.2 Mathematical modelling of control systems, concept of transfer function, Block diagram algebra	
	5.3 Transient and steady state analysis of first and second order system. Time Domain specifications. Step response of second order system. Steady-state error, error coefficients, steady state analysis of different type of systems using step, ramp and parabolic inputs	
6	**6.1** Stability analysis: Introduction to concepts of stability, The Routh criteria for stability	**06**
	6.2 Experimental determination of frequency response, Stability analysis using Root locus, Bode plot	

Assessment:

Internal Assessment for 20 marks:

Consisting**Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

Text/Reference Books:

1. Engineering. Metrology, I.C. GUPTA, Dhanpat Rai Publications.
2. Engineering. Metrology, R. K. Jain, Khanna Publisher.
3. Measurement Systems: Applications and Design, by EO Doebelin,5th Edition, McGraw Hill
4. Mechanical Engineering Measurements, A. K. Sawhney, Dhanpat Rai & Sons, New Delhi
5. Instrumentation & Mechanical Measurements, A. K. Thayal
6. Control System Engineering by Nagrath I.J. and Gopal M, Wiley EasternLtd.
7. Modem Control engineering: by K. Ogata, Prentice Hall
8. Control systems by Dhanesh Manik, Cengage Learning
9. Engineering Metrology and Measurements by N V Raghavendra and L Krishnamurthy, Oxford University Press.
10. Instrumentation and Control System, W. Bolton, Elsevier
11. Experimental Methods for Engineers by J P Holman, McGraw Hills Int. Edition
12. Engineering Experimentation by EO Doebelin, McGraw Hills Int. Edition
13. Mechanical Measurements by S P Venkateshan, John Wiley & Sons

NPTEL Courses

https://nptel.ac.in/courses/112/103/112103261/ - Principles of Mechanical Measurement, IIT Guwahati

https://nptel.ac.in/courses/112/107/112107242/ - Mechanical Measurement System, IIT Roorkee

https://nptel.ac.in/courses/112/106/112106138/ - Mechanical Measurements and Metrology, IIT Madras

Course Code	Course Name	Credits
AEC502	**Internal Combustion Engines**	**03**

Objectives:

1. To provide fundamental idea on Spark Ignition & Compression Ignition Engines.
2. To familiarise with the complexity in combustion processes.
3. To give clear concept of power generation and engine performance.
4. To gather clear knowledge on effects of emission and its control.
5. To acquaint with recent trends in Engine Technology.

Outcomes: Learner will be able to…

1. Explain the actual engine operation.
2. Analyse the combustion process in IC engines.
3. Illustrate different power boosting methods in IC Engines
4. Analyse operating parameters & performance of IC Engines.
5. Illustrate emission norms and emission control techniques.
6. Comprehend the recent trends in fuels and engines

Module	Details	Hrs
1	**Introduction** Classification of I.C. Engines, Parts of I.C. Engine and their materials, Atkinson Cycle and Miller Cycle, Fuel Air and Actual working cycles analysis, Valve Timing Diagram, LHR & VCR Engines, Homogeneous charge compression Ignition, Rotary Engine-Six stroke engine concept (No Numerical from this module)	04
2	**Spark Ignition Engines** **Fuel Supply System:** Automotive engine air-fuel mixture requirements, principle of carburetion & working (only introduction – No Numerical) Fuel Injection: Single-point and Multipoint injection, Gasoline Direct Injection **Ignition System:** Schematic details and working of different types of Ignition systems in SI Engines **Combustion:** Combustion phenomenon in SI Engines, Ignition delay, Flame propagation, Pressure-Crank angle diagram, Detonation and Knocking, Factors affecting combustion and detonation, Introduction to combustion chamber design, Types of combustion chambers	08

3	**Compression Ignition Engines**	08
	Fuel Injection Systems: Air injection systems, Airless/solid injection systems, Common rail, individual pump, distributor and unit systems. Injection pumps, Fuel injector, Types of nozzles, Electronically controlled CRDI system	
	Combustion: Combustion phenomenon in C I engines, Stages of combustion, Delay period, Knocking, Pressure-Crank angle diagram, Factors affecting combustion and knocking, Types of combustion chambers	
4	**Engine lubrication:** Types of Lubricants, their properties, SAE rating of Lubricants, Types of Lubrication systems.	06
	Engine Cooling: Necessity of engine cooling, disadvantages of overcooling, Cooling systems and their comparison: Air cooling, Liquid cooling	
	Supercharging/Turbo-charging: Objectives, Limitations, Methods and Types, Different arrangements of Turbochargers. Latest Trends in power boosting methods.	
5	**Engine Testing and Performance:** Measurement of Brake Power, Indicated Power, Frictional Power, Fuel Consumption, Air flow, BMEP, Performance characteristics of SI and CI Engines, Effects of load and speed on Mechanical, Indicated Thermal, Brake Thermal and Volumetric Efficiencies, Heat Balance Sheet.	08
	Engine Exhaust Emission and its control: Constituents of exhaust emission and its harmful effects on environment and human health, Formation of NOx, HC, CO and particulate emissions, Methods of controlling emissions; Catalytic convertors, particulate traps, Exhaust Gas Recirculation, EURO and BHARAT norms.	
6	**I C Engine Fuels:** Gasoline - Alcohol - Hydrogen - Natural Gas and Liquefied Petroleum Gas - Biodiesel- Biogas - Producer Gas: Properties - Suitability - Engine Modifications - Merits and Demerits as fuels.	05
	Basics of Electronic Engine Controls: Electronic Control Module (ECM): Components, requirement & working. Sensors: Throttle Position, Crankshaft Position, Camshaft Position, Inlet Air Temperature, Coolant Temperature, Mass Air flow and Exhaust Gas Oxygen sensors (their construction and importance in ECM) Electronic Spark control, Air Management system, Idle speed control	

Text Books:

1. A Course in Internal Combustion Engine, Mathur and Sharma, Dhanpat Rai & Sons, New Delhi, 2001
2. Internal Combustion Engine, V Ganesan, McGraw-Hill, 1995
3. Internal Combustion Engines, Domkundwar & Domkundwar, Dhanpat Rai & Co., 2013

Reference Books:

1. Internal Combustion Engines Fundamentals, Heywood, McGraw Hill, 1988
2. High Speed Combustion Engines, Heldt, Oxford IBH Publishing Co., Calcutta, 1985
3. Internal Combustion Engines, V.L. Maleeve, McGraw-Hill Inc.,US; International 2 Revised ed edition, 1964
4. Fundamental of Internal Combustion Engines, Gill and Smith, 4/E,. Oxford & IBH Publishing Company Pvt. Limited, 2007
5. Fundamentals of Internal Combustion Engines, Gupta, Prentice-Hall of India Pvt.Ltd (June 1, 2006) 2nd ed,
6. Internal Combustion Engine, S.L. Beohar

Assessment:

Internal Assessment for 20 marks:

Consisting of **Two Compulsory Class Tests**

First test based on approximately 40% of content and second test based on remaining contents (approx.40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the syllabus.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the syllabus**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions to be solved.**

Links for online NPTEL/SWAYAM courses:

1. https://nptel.ac.in/courses/112/103/112103262/
2. https://nptel.ac.in/courses/112/104/112104033/
3. https://onlinecourses.nptel.ac.in/noc20_me42/preview
4. https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-me42/

Course Code	Course Name	Credits
AEC503	**Machine Design**	**03**

Objectives:

1. To study basic principles of machine design
2. To acquaint with the concepts of design based on strength & rigidity
3. To familiarize with the use of design data books & various codes of practice
4. To make conversant with preparation of working drawings based on designs

Outcomes: Learner will be able to…

1. Demonstrate understanding of various design considerations
2. Illustrate basic principles of machine design
3. Design machine elements for static as well as dynamic loading
4. Design machine elements based on strength/ rigidity concepts
5. Use design data books in designing various components
6. Acquire skill in preparing production drawings of various designs

Module	Details	Hrs
1	**Introduction** Mechanical Engineering Design, Design methods; Material properties and their uses in design; Different considerations in design: Design consideration of casting, forging, Manufacturing, Aesthetic & Ergonomics; Basic principle of Machine Design; Modes of failures; Theories of failures; Different Standards & Codes and Preferred Series and Numbers.	**05**
2	**Design against static loads** Cotter joint (Socket & Spigot type); Knuckle joint; Turnbuckle; Eccentrically loaded Bolted Joints (considering initial tightening); Eccentrically loaded Welded joints; Power Screw – screw presses, C-clamps along with the Frame.	**10**
3	**Design of Shaft** Including power transmission and power distribution shafts, under static & fatigue criteria and using ASME code. **Keys** Types of Keys and their selection based on shafting condition **Couplings** Classification of coupling; Design of Flange couplings and Bush pin type flexible couplings.	**10**
4	**Design of Gears** Design of Spur & Helical Gears: Selection of Material; Gear Blank Design; Number of Teeth; Face Width; Beam Strength of Gear Tooth; Permissible Bending Stress; Effective Load on Gear Tooth; Estimation of Module Based on Beam Strength and Wear Strength.	**06**

5	**Design against fluctuating loads** Fluctuating, reversed and repeated stresses; Fatigue failure: static and fatigue stress concentration factors; Endurance limit- estimation of endurance limit; Design for finite and infinite life: using Soderberg, Gerber and Goodman design criteria.	**06**	
6	**Design of Springs** Helical compression spring under Static and Variable loads; Design of Leaf springs	**05**	

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and the second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

The weightage of each module in end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

1. The question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover the maximum contents of the curriculum**
3. **The remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

Text Books:

1. Design of Machine Elements - V.B. Banadari, Tata McGraw Hill Publication
2. Design of Machine Elements - Sharma, Purohit. Prentice Hall India Publication
3. Machine Design by Pandya & Shah, Charotar Publishing

References:

1. Machine Design -An Integrated Approach - Robert L. Norton, Pearson Education
2. Mechanical Engineering Design by J.E.Shigley, McGraw Hill
3. Machine Design by Reshetov, Mir Publication
4. Machine Design by Black Adams, McGraw Hill
5. Fundamentals of Machine Elements by Hawrock, Jacobson McGraw Hill
6. Machine Design by R.C.Patel, Pandya, Sikh, Vol-I & II C. Jamnadas & Co
7. Design of Machine Elements by V.M.Faires
8. Design of Machine Elements by Spotts
9. Recommended Data Books – PSG and Mahadevan & Reddy

Links for online NPTEL/SWAYAM courses:

1. Design of Machine Elements | NPTEL Online Videos, Courses - IIT Video Lectures (nptelvideos.in)

Course Code	Course Name	Credits
AEC504	**Finite Element Analysis**	**03**

Prerequisite:

Knowledge of:

- Differential equations (Formulation and solution, Types-Ordinary, Partial, Order and degree of the DE and the boundary conditions)
- Matrix algebra (Matrix operations, gauss elimination method to get inverse the inverse of matrix)
- Basics of the core field (Governing laws, relationship between the various variables and constants –like in structural field stress-strain,Thermal field-temp, heat transfer rate etc

Objectives:

1. To understand the concepts of FEA and its applicability to different engineering field problems.
2. To understand the representation of the physical model into an equivalent FEA model and steps to solve it.
3. To acquaint with application of numerical techniques for solving problems.

Outcomes: Learner will be able to…

1. Solve differential equations using weighted residual methods.
2. Develop the finite element equations to model engineering problems governed by second order differential equations.
3. Apply the basic finite element formulation techniques to solve engineering problems by using one dimensional elements.
4. Apply the basic finite element formulation techniques to solve engineering problems by using two dimensional elements.
5. Apply the basic finite element formulation techniques to find natural frequency of single degree of vibration system.
6. Use commercial FEA software, to solve problems related to mechanical engineering.

Module	Details	Hrs
1	**Introduction:** 1.1 Introductory Concepts: Introduction to FEM, Historical Background, General FEM procedure, Applications of FEM in various fields Advantages and disadvantages of FEM 1.2 Mathematical Modelling of field problems in engineering, Governing Differential equations, primary/secondary variables, boundary conditions-types-essential/natural etc. 1.3Approximate solution of differential equations, Weighted residual techniques (Galerkin , Subdomain method).	**5**
2	**FEA Procedure:(Pre-processing, Processing, Post-processing)** 2.1 Discrete and Continuous Models, Weighted Residual Methods - Ritz Technique- Basic Concepts of the Finite Element Method. 2.2 Definitions of various terms used in FEM like element, order of the element, internal and external node/s, degree of freedom.	**8**

	2.3 Minimization of a functional, Principle of minimum total potential, Piecewise Rayleigh-Ritz method, Formulation of 'stiffness matrix', assembly concepts to develop system equation.	
3	**One Dimensional Problems:** 3.1 One dimensional second order equations - discretization-element types - linear and higher order elements -derivation of shape functions and stiffness matrices and force vectors. 3.2 Assembly of Matrices- solution of problems in one dimensional structural analysis, heat transfer and fluid flow (stepped and taper bars, fluid network, spring-Cart Systems) 3.3 Analysis of Plane trusses, Analysis of Beams	**10**
4	**Two Dimensional Finite Element Formulations:** 4.1 Introduction, three node triangular element, four node rectangular element 4.2 Natural coordinates and coordinates transformations: serendipity and Lagrange's methods for deriving shape functions for triangular element. 4.3 Convergence criterion, sources of errors	**5**
5	**Two Dimensional Vector Variable Problems:** 5.1 Equations of elasticity - Plane stress, plane strain and axi-symmetric problems 5.2 Jacobian matrix, stress analysis of CST.	**6**
6	**Finite Element Formulation of Dynamics and Numerical Techniques:** 6.1 Applications to free vibration problems of rod and beam, Lumped and consistent mass matrices. 6.2 Solutions techniques to Dynamic problems, longitudinal vibration frequencies and mode shapes, Fourth order beam equation, transverse deflections and natural frequencies of beams.	**5**

Assessment:

Internal Assessment for 20 marks:

Consisting**Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.
1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3Only **Four questions need to be solved**

Text/Reference Books:
1. Textbook of Finite Element Analysis by Seshu P, Prentice Hall of India
2. Finite Element Method by J N Reddy, TMH
3. 'Introduction to Finite Elements in Engineering, Chandrupatla and Belegundu, Pearson Education
4. Finite Element Methods by R Dhanraj and K Prabhakaran Nair, Oxford University Press
5. A first course in Finite Element Method by Logan D L, Thomson Asia PvtLtd

6. 'Concepts and Applications of Finite Element Analysis by Cook R D, Malkus D S, Plesha ME, John- Wiley Sons
7. The Finite Element Method in Engineering by S. S. Rao, Butter Worth Heinemann
8. Fundamental Finite Element Analysis and Application with Mathematica and MATLAB Computations by M. Asghar Bhatti, Wiley India Pvt. Ltd.

Links for online NPTEL/SWAYAM courses:

https://nptel.ac.in/courses/112/104/112104193/
https://nptel.ac.in/courses/105/106/105106051/
https://nptel.ac.in/courses/112/104/112104115/
https://nptel.ac.in/courses/112/103/112103295/
https://nptel.ac.in/courses/112/106/112106135/
https://nptel.ac.in/courses/112/106/112106130/
https://nptel.ac.in/courses/105/105/105105041/
https://nptel.ac.in/courses/112/104/112104116/

Course Code	Course Name	Credits
AEDLO5011	**Optimization Techniques**	**03**

Objectives:

1. To Understand the need and origin of the optimization methods.
2. To understand various linear, nonlinear and other optimization techniques.
3. To understand various multi criterion and multi-objective decision making methods.
4. To understand recent tools in optimization

Outcomes: Learner will be able to…

1. Identify the types of optimization problems and apply the calculus method to single variable problems.
2. Formulate the problem as Linear Programming problem and analyse the sensitivity of a decision variable.
3. Apply various linear and non-linear techniques for problem solving in various domain.
4. Apply multi-objective decision making methods for problem in manufacturing environment and other domain.
5. Apply multi criterion decision making methods for problem in manufacturing environment and other domain.
6. Apply Design of Experiments method for Optimization

Module	Details	Hrs
1	Basic Concepts: Statement of the Optimization Problem, Basic Definitions, Optimality Criteria for Unconstrained Optimization, Optimality Criteria for Constrained Optimization, Engineering Application of Optimization, Classification of Optimization Problems. Classical Optimization Techniques: Single variable optimization	**6**
2	Linear Programming Problem: Formulation, Simplex method, Big M Method, Two Phase, Primal to Dual, Dual Simplex method, Sensitivity Analysis and applications of LP Transportation and Assignment Models.	**8**
3	Integer Programming Model: Gomory's cutting plane method, Branch & Bound Technique. Non L.P. Model: Lagrangian method & Kuhn tucker Method, Newton's method. Discrete Event Simulation: Generation of Random Variable, Simulation Processes, Monte-Carlo Technique.	**8**

4	Multi Objective Decision making (MODM) Methods: Introduction to Multi objective optimization, Traditional Techniques such as, quadratic programming, geometric programming, Numerical on goal programming and dynamic programming. Introduction to Non-traditional optimization Techniques such as Genetic Algorithm, particle swarm, genetic algorithms, simulated annealing and Techniques based on Neural network & Fuzziness **(Only concepts)**	8
5	Multi Criterion Decision-making (MCDM) Methods: Introduction to multi criterion optimization Simple Additive Weighting (SAW) Method Weighted Product Method (WPM) Analytic Network Process (ANP) Analytic Hierarchy Process (AHP) Method TOPSIS Method PROMETHEE	6
6	Robust Design Methods: DOE and Taguchi techniques Full Factorial Design: The basics of "full factorials", ANOVA, Factorial effects and plots, and Model evaluation Fractional Factorial Design: The one-half fraction and one-quarter of the 2^k design, The general 2^{k-p} fractional factorial design Application of related software (Minitab, Design Expert or MATLAB)	8

Assessment:

Internal Assessment for 20 marks:
Consisting **Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

Text/Reference Books:

1. S.S. Rao, "Engineering Optimization - Theory and Practice", John Wiley and Sons Inc.
2. Ranjan Ganguli, "Engineering Optimization - A Modern Approach" Universities Press
3. Pablo Pedregal, "Introduction to Optimization", Springer
4. L.C. Jhamb, "Quantitative Techniques Vol. 1 and 2", Everest Pub. House
5. Pierre D.A., "Optimization, Theory with Application", John Wiley & sons.

6. R V Rao, "Decision Making in the Manufacturing Environment Using Graph Theory and Fuzzy Multiple Attribute Decision Making" (Springer Publication).
7. Ritter, H., Martinetz, T., &Schulten, K., Addison,"Neural Computation and Self-Organizing Maps"-Wesley Publishing Company
8. Douglas C.Montgomery,"Design and analysis of experiments"(John Wiley & Sons Inc.)
9. Saravanan R,"Manufacturing Optimization through Intelligent Techniques", Taylor & Francis (CRC Press)-2006.

Links for online NPTEL/SWAYAM courses:

https://nptel.ac.in/courses/112/101/112101298/ - Optimization from Fundamentals, IIT Bombay

Course Code	Course Name	Credits
AEDLO5012	**Statistical Techniques**	**03**

Objectives:

1. To acquaint the learners with the basic concepts of Statistical Techniques.
2. To develop understanding of sampling theory.
3. To study methods for curve fitting and regression.
4. To learn statistical decision theory.

Outcomes: Upon successful completion of this course, Learner will be able to…

1. Apply the concepts of statistical distributions in engineering applications
2. Use sampling theory for a given data set
3. Fit curve for a given data set
4. Demonstrate the understanding of correlation and regression analysis
5. Perform analysis of variance from the available experimental data.
6. Demonstrate the understanding of Statistical Decision making and Hypothesis testing

Module	Content	No. of Hours
1	**Statistical Distributions:** Random Variable and Probability Distribution. Binomial, Poisson, Normal, Exponential, Hypergeometric, Uniform distributions	05
2	**Sampling Theory:** Meaning and Objectives of Sampling. Types of Sampling, Methods of drawing random samples. Sampling Distributions, Standard Error and Probable Error	08
3	**Curve Fitting and Methods of Least Squares:** Relationship between Variables, Curve Fitting, Equations of Approximating Curves, The Method of Least Squares, The Least Squares Line, Non-linear Relationships, The Least Squares Parabola,	08
4.	**Correlation and Regression:** Types of Correlation. Linear Correlation, Measures of Correlation, Standard Error of Estimate, Karl Pearson's and Rank Correlation coefficient. Simple linear regression: Least Squares Method.	08
5	**Analysis of Variance (ANOVA):** The Purpose of Analysis of Variance, One-Way Classification, Total Variation, Variation Within Treatments and Variation Between Treatments. The F Test for the Null Hypothesis of Equal Means, Two-Way Classification, Analysis of Variance for Two-Factor Experiments	05

6	**Statistical Decision Theory:** Statistical Decisions, Statistical Hypotheses, Tests of Hypotheses and Significance, or Decision Rules, Type I and Type II Errors, Level of Significance, Tests Involving Normal Distributions, Two-tailed and One-tailed Tests, Special Tests. Confidence Interval, Z test and Chi Square Test for Goodness of fit.	**05**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks.**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum.**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

Text/Reference Books:

1. Douglas C. Montgomery, "Design and Analysis of Experiments", John Wiley and Sons Inc
2. Murray R. Spiegel, "Probability and Statistics", Schaum's Outline Series, McGraw-Hill Book Company
3. Kothari, C.R.,1985, "Research Methodology-Methods and Techniques", Wiley Publications
4. N. G. Das, "Statistical Methods", Vol – I & II, Tata McGraw Hill.

NPTEL

https://nptel.ac.in/courses/112104211 – Statistical Methods for Scientists and Engineers, IIT Kharagpur

https://onlinecourses.nptel.ac.in/noc21_ma74/preview – Probability and Statistics, IIT Kharagpur

https://onlinecourses.nptel.ac.in/noc20_ma19/preview – Statistical Inference, IIT Delhi

Course Code	Course Name	Credits
AEDLO5013	**Computational Methods**	**03**

Objectives:

1. Introduction to analytical and numerical techniques.
2. Application of mathematical modelling to mechanical systems.
3. Learn the significance of statistical techniques and data interpolation.

Outcomes: Learner will be able to…

1. Understand and develop mathematical models of physical systems.
2. Identify an appropriate mathematical formulation to linear algebraic equations.
3. Build an appropriate mathematical formulation to non-linear algebraic equations.
4. Evaluate and interpret the data regression, curve fitting and statistics.
5. Apply the numerical techniques and numerical schemes.
6. Formulate the concept of numerical methods in realistic applications.

Module	Details	Hrs
1	**Introduction to Computational Methods** Motivation and applications of Computational Methods. Computation and Error Analysis:Accuracy and precision; Truncation andround-off errors (Numericals); Binary Number System; Error propagation.	6
2	**Linear Systems and Equations** Matrix representation: Cramer's rule; Gauss Elimination. Matrix Inversion; LUDecomposition; Iterative Methods;Relaxation Methods; Eigen Values and Eigen Vectors.	6
3	**Non Linear Algebraic Equations:** Bracketing methods: Bisection, Regula-Falsi. Crouts Method: LU Decomposition. Open methods: Secant, Fixed pointiteration, Newton-Raphson; MultivariateNewton's method.	6
4	**Regression and Curve Fitting** Interpolation function; Cubic Splines; Multi regression analysis, polynomial regression. **Statistical methods:** Statistical representation of data, modeling and analysis of data, test of hypotheses. **Fuzzy Logic:** Introduction to fuzzy logic, Fuzzy Logic Systems Architecture, Case study of Mechanical system.	8
5	**Integration and Integral Equations** Newton Cotes Quadrature **ODEs: Initial Value Problems** Euler's methods; Predictor-corrector method (Adam's Moulton, Milne's	7

		Method)	
		ODEs: Boundary Value Problems	
		Finite difference Method; Finite Element Method, Finite Volume Method	
6		**Application of Numerical Methods**	6
		Predict vibration response of components to intricate profile generated by different machine tools, Design next generation Formula One cars to working at the cutting edge of robotics, Predict behaviour of flows to estimation of heat transfer in complex scenarios; Crank Nicolson method – Solution of 1-D Wave equation.	

Assessment:

Internal Assessment for 20 marks:
Consisting**Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

Question paper will comprise of total **six questions**, **each carrying 20 marks**
Question 1 will be **compulsory** and should **cover maximum contents of the curriculum**
Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
Only **Four questions need to be solved.**

Text/Reference Books:

1. S. P. Venkateshan& Prasanna Swaminathan, "Computational Methods in Engineering", Ane Books Pvt. Ltd., 1st Edition, (2014) ISBN: 978-0-12-416702-5.
2. Steven C. Chapra& Raymond P.Canale, "Numerical Methods for Engineers", Mc-Graw Hill Education, 8TH Edition, (2020), ISBN: 1260571386
3. Joe D Hoffman, "Numerical Methods for Engineers and Scientists", Second Edition, Marcel Dekker (2001) ISBN: 0-8247-0443-6.
4. M.K. Jain, S.R. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, 7th Edition, New Age International Publishers, 2019.
5. S.S. Sastry, Introductory Methods of Numerical Analysis, PHI, Fifth Edition, 2012.
6. Rajesh Kumar Gupta, Numerical Methods – Fundamentals and Applications, Cambridge University Press, First Edition, 2019.
7. Gupta and Santosh K., "Numerical Methods for Engineers", 4th Edition, New Age International Publishers, 2019, ISBN: 9789387788794
8. FerzigerJ.and M. Peric, "Computational Methods for Fluid Dynamics" 3rd Edition, Springer, (2001) ISBN: 9783540420743.
9. Versteeg H., and W. Malalasekra,"An Introduction to Computational Fluid Dynamics: The Finite Volume Method" 2nd Edition, PHI(2007) ISBN: 9780131274983.

Links for online NPTEL/SWAYAM courses:

https://nptel.ac.in/courses/127/106/127106019/ - Numerical Methods for Engineers, IIT Madras
https://nptel.ac.in/courses/111/107/111107105/ - Numerical Methods, IIT Roorkee
https://nptel.ac.in/courses/111/106/111106101/ - Numerical Analysis, IIT Madras

- Numerical Methods: Finite Difference Approach, IIT Roorkee

Course Code	Course Name	Credits
AEL501	**Measurement and Engine Testing Lab**	**01**

Objectives:

1. To acquaint with the various methods for measurement of engine performance.
2. To analyse engine emissions.
3. To familiarise with latest developments in engine Technology

Outcomes: Learner will be able to…

1. Overhaul and Assemble engine components.
2. Perform load test/speed test on engine setup.
3. Calculate performance of multi cylinder engine.
4. Analyse engine performance and draw heat balance sheet.
5. Perform exhaust gas analysis.
6. Get acquainted with Calibration of sensors.

Term work:

Term work shall consist of minimum 8 exercises, from the list as per following details:

a) 2 must be actual experiments from Part A. From Part A exercise 1 is compulsory.
b) 4 must be actual experiments from Part B
c) 2 must be actual experiments from Part C

PART A: Dismantle and assemble the following:

1. 2-Stroke/4-Stroke Engines
2. Carburettor
3. Ignition system
4. Fuel injection system

PART B: Actual Test experiments:

1. Morse Test on Multi-cylinder S.I. engine
2. Speed Test on Spark Ignition or/and Compression Ignition engine
3. Load Test on Diesel engine.
4. Heat Balance Sheet on S.I. or C.I. engine.
5. Determination of Air fuel ratio and volumetric efficiency of the engine
6. Exhaust Gas/Smoke analysis of S.I./ C.I. engines

PART C: Measurement Experiments:

1. Calibration of Tachometers.
2. Study of Pressure, Torque, Temperature, Flow Measurement Sensors in IC engine.
3. System Identification of any one of the sensors.

PART D: Topics for Case study of various models:

   I.   Variable Valve Timing
  II.   Twin and Triple Turbo charging
 III.   Variable Compression Ratio Engine
  IV.   Electronic MPFI with various modes
   V.   Single overhead camshaft and double overhead camshaft
  VI.   Engine Downsizing
 VII.   Eco-boost Engine
VIII.   Turbocharging for S.I. Engine

Term Work:

The distribution of marks for term work shall be as follows:
   1. Laboratory work (8 Exercises):   **15 marks**
   2. Case study: **05 marks**
   3. Attendance: **05 marks**

Practical and Oral Examination:

   A. Pair of Internal and External Examiner should conduct practical/Oral exam.

   B. Distribution of marks for practical and oral examination shall be as follows:

           i. Practical performance   15 marks
          ii. Oral   10 marks

   C. Evaluation of practical examination to be done based on the experiment performed and the output of the experiment during practical examination.

   D. Student's work along with evaluation report to be preserved till the next exam.

Course Code	Name of the Course	Credit
AEL502	**Machine Design**	**01**

Objectives:
1. To study basic principles of machine design
2. To familiarize with the use of design data books & various codes of practice
3. To identify potential failures associated with a machine component by using DFMEA.

Outcomes: Learner will be able to…
1. Design Knuckle Joint and cotter joint
2. Design shaft under various conditions.
3. Design rigid and flexible flange couplings.
4. Design helical compression spring and leaf spring.
5. Use design data books in designing various components.
6. Report uncertainties associated with potential failure modes inherited from the component design.

Term Work: (Comprises part A, B & C)
A) Term work - Shall consist of (minimum 3) design exercises from the list which may include computer-aided drawing on **A3 size sheets**.
1) Knuckle Joint/cotter joint
2) Rigid/ Flexible flange couplings
3) Leaf springs
4) C-clamps along with the Frame

B) Assignment: Design exercises in the form of design calculations with sketches and/ or drawings on the following machine elements.
1) Bolted and welded joints
2) Combined stresses problem using the theories of failure.
3) Shaft design with/ without the use of ASME Code.
4) Design against fluctuating loads (For finite and infinite life)
5) Design of Gears

C) Case Study: A case study should be given to either individual or a group of two students to report uncertainties associated with potential failure modes inherited from a component design using the DFMEA approach.

The distribution of marks for term work shall be as follows:
- Part A: 10 marks.
- Part B: 05 marks.
- Part C: 05 marks
- Attendance: 05 Marks.

Course Code	Course Name	Credits
AEL503	**Finite Element Analysis**	**01**

Objectives:
1. To familiarise FEA concept for practical implementation
2. To acquaint with FEA application software

Outcomes: Learner will be able to…
1. Select appropriate element for given problem
2. Select suitable meshing and perform convergence test
3. Select appropriate solver for given problem
4. Interpret the result
5. Apply basic aspects of FEA to solve engineering problems
6. Validate FEA solution

Term Work: (Comprises a and b)

    a. List of Experiments: Students should use the commercial software or open source application programs, to verify the results obtained by manual calculations. The input data and output results of the problem solved using the computer programs (Minimum 6) should be included in the Journal.

    The proposed list is given below:
1. Any two problems using bar element
2. Any two problems using truss element
3. Any two problems using CST element
4. Any two problem using axisymmetric element
5. Any one problem of free vibration analysis using bar element
6. Any one problem on steady state heat conduction
7. Any one problem for analysis of Beams.

While performing the analysis the students should understand the concepts of selection of element type, meshing and convergence of solution.(using approach of refining mesh and or order of the element)

    b. Course Project: (Any one task out of the following proposed list)

A group of not more than four students, shall do

1) Finite Element Analysis of any mechanical engineering element /system, which involves element selection, assigning properties, meshing, assigning loads, and boundary conditions, analysis and result interpretation.
2) Develop the program to verify the results obtained by manual calculations for simple 1D/2D problems using Python, MATLAB programming platform etc.
3) Simulate a problem and validate the results with experimental results (the test rigs from Strength of material /Heat transfer/Dynamics of machine/fluid lab etc may be used for obtaining the experimental results)

The distribution of marks for term work shall be as follows:

    Part a:10 marks.
    Part b:10 marks.
    Attendance: 05 Marks.

End Semester Practical/Oral examination
1. Pair of Internal and External Examiner should conduct practical/viva based on contents
2. Duration of practical examination is 2 hour
3. Distribution of marks for practical/viva examination shall be as follows:
   a. Practical performance ……**15** marks
   b. Oral………………...   **10** marks

Evaluation of practical examination to be done based on the experiment performed andthe output of the experiments during practical examination.

Students work along with evaluation report to be preserved till the next examination.

Text/Reference Books:
1. Programming the Finite Element Method, I M Smith,D V Griffiths and Margetts WILEY Publications.
2. The Finite Element Method: Theory, Implementation, and Applications, Larson, Mats G., Bengzon, Fredrik,Springer
3. Introduction to Finite Element Analysis and Design by N. H. Kim, B. V. Sankar, and A. V. Kumar by Wiley publication
4. Finite Element analysis using ANSYS by PaletiSrinivas,Krishna Chaitanya, Rajesh Kumar Detti, PHI Publication.
5. Finite Element Analysis Theory and Application With ANSYS by Saeed Moaveni, Pearson Publication.
6. Introduction to Finite Element Analysis Using MATLAB and Abaqus By Amar Khennane, CRC Press publication

Course Code	Course Name	Credits
AESBL501	**Professional Communication and Ethics - II**	**02**

Objectives:

Learners should be able to:
1. Discern and develop an effective style of writing important technical/business documents.
2. Investigate possible resources and plan a successful job campaign.
3. Understand the dynamics of professional communication in the form of group discussions, meetings, etc. required for career enhancement.
4. Develop creative and impactful presentation skills.
5. Analyse personal traits, interests, values, aptitudes and skills.
6. Understand the importance of integrity and develop a personal code of ethics.

Outcomes: Learners will be able to…
1. Plan and prepare effective business/ technical documents which will in turn provide solid foundation for their future managerial roles.
2. Strategize their personal and professional skills to build a professional image and meet the demands of the industry.
3. Emerge successful in group discussions, meetings and result-oriented agreeable solutions in group communication situations.
4. Deliver persuasive and professional presentations.
5. Develop creative thinking and interpersonal skills required for effective professional communication.
6. Apply codes of ethical conduct, personal integrity and norms of organizationalbehaviour.

MODULE	DETAILS	HRS
MODULE 1 - ADVANCED TECHNICAL WRITING :PROJECT/PROBLEM BASED LEARNING (PBL)		
1.1. Purpose and Classification of Reports	**Classification on the basis of:** ● Subject Matter (Technology, Accounting, Finance, Marketing, etc.) ● Time Interval (Periodic, One-time, Special) ● Function (Informational, Analytical, etc.) ● Physical Factors (Memorandum, Letter, Short & Long)	**06**

1.2. Parts of a Long Formal Report	● Prefatory Parts (Front Matter) ● Report Proper (Main Body) ● Appended Parts (Back Matter)	
1.3. Language and Style of Reports	● Tense, Person & Voice of Reports ● Numbering Style of Chapters, Sections, Figures, Tables and Equations ● Referencing Styles in APA & MLA Format ● Proofreading through Plagiarism Checkers	
1.4. Definition, Purpose & Types of Proposals	● Solicited (in conformance with RFP) & Unsolicited Proposals ● Types (Short and Long proposals)	
1.5. Parts of a Proposal	● Elements ● Scope and Limitations ● Conclusion	
1.6. Technical Paper Writing	● Parts of a Technical Paper (Abstract, Introduction, Research Methods, Findings and Analysis, Discussion, Limitations, Future Scope and References) ● Language and Formatting ● Referencing in IEEE Format	
MODULE 2 - EMPLOYMENT SKILLS		
2.1. Cover Letter & Resume	● Parts and Content of a Cover Letter ● Difference between Bio-data, Resume & CV ● Essential Parts of a Resume ● Types of Resume (Chronological, Functional & Combination)	**06**
2.2 Statement of Purpose	● Importance of SOP ● Tips for Writing an Effective SOP	
2.3 Verbal Aptitude Test	● Modelled on CAT, GRE, GMAT exams	
2.4. Group Discussions	● Purpose of a GD ● Parameters of Evaluating a GD ● Types of GDs (Normal, Case-based & Role Plays) ● GD Etiquettes	

2.5. Personal Interviews	- Planning and Preparation - Types of Questions - Types of Interviews (Structured, Stress, Behavioural, Problem Solving & Case-based) - Modes of Interviews: Face-to-face (One-to one and Panel) Telephonic, Virtual	
MODULE 3 - BUSINESS MEETINGS		
3.1. Conducting Business Meetings	- Types of Meetings - Roles and Responsibilities of Chairperson, Secretary and Members - Meeting Etiquette	**02**
3.2. Documentation	- Notice - Agenda - Minutes	
MODULE 4 -TECHNICAL/ BUSINESS PRESENTATIONS		
4.1. Effective Presentation Strategies	- Defining Purpose - Analysing Audience, Location and Event - Gathering, Selecting &Arranging Material - Structuring a Presentation - Making Effective Slides - Types of Presentations Aids - Closing a Presentation - Platform Skills	**02**
4.2 Group Presentations	- Sharing Responsibility in a Team - Building the contents and visuals together - Transition Phases	
MODULE 5 - INTERPERSONAL SKILLS		
5.1. Interpersonal Skills	- Emotional Intelligence - Leadership & Motivation - Conflict Management & Negotiation - Time Management - Assertiveness - Decision Making	**08**
5.2 Start-up Skills	- Financial Literacy - Risk Assessment	

	● Data Analysis (e.g. Consumer Behaviour, Market Trends, etc.)	
MODULE 6 - CORPORATE ETHICS		
6.1. Intellectual Property Rights	● Copyrights ● Trademarks ● Patents ● Industrial Designs ● Geographical Indications ● Integrated Circuits ● Trade Secrets (Undisclosed Information)	02
6.2. Case Studies	● Cases related to Business/ Corporate Ethics	

List of Assignments for Termwork

(In the form of Short Notes, Questionnaire/ MCQ Test, Role Play, Case Study, Quiz, etc.)

1. Cover Letter and Resume
2. Short Proposal
3. Meeting Documentation
4. Writing a Technical Paper/ Analysing a Published Technical Paper
5. Writing a SOP
7. IPR
8. Interpersonal Skills
9. Aptitude test (Verbal Ability)

Note:
1. The Main Body of the project/book report should contain minimum 25 pages (excluding Front and Back matter).
2. The group size for the final report presentation should not be less than 5 students or exceed 7 students.
3. There will be an end–semester presentation based on the book report.

Guidelines for Internal Assessment

Term Work   25 Marks
Assignments   10 Marks
Attendance   05 Marks
Presentation slides   05 Marks
Book Report (hard copy)   05 Marks
Internal Oral   -   25 Marks
Oral Examination will be based on a GD & the Project/Book Report presentation.
Group Discussion   10 Marks
Project presentation (Individual Presentation)   10 Marks
Group Dynamics   05 Marks

SUGGESTED READING

1. Arms, V. M. (2005). Humanities for the engineering curriculum: With selected chapters from Olsen/Huckin: Technical writing and professional communication, second edition. Boston, MA: McGraw-Hill.
2. Bovée, C. L., &Thill, J. V. (2021). Business communication today. Upper Saddle River, NJ: Pearson.
3. Butterfield, J. (2017). Verbal communication: Soft skills for a digital workplace. Boston, MA: Cengage Learning.
4. Masters, L. A., Wallace, H. R., & Harwood, L. (2011).Personal development for life and work. Mason: South-Western Cengage Learning.
5. Robbins, S. P., Judge, T. A., & Campbell, T. T. (2017). Organizational Behaviour. Harlow, England: Pearson.
6. Meenakshi Raman, Sangeeta Sharma (2004) Technical Communication, Principles and Practice. Oxford University Press
7. Archana Ram (2018) Place Mentor, Tests of Aptitude For Placement Readiness. Oxford University Press
8. Sanjay Kumar &PushpLata (2018). Communication Skills a workbook, New Delhi: Oxford University Press.

Virtual Labs

https://ve-iitg.vlabs.ac.in/- Virtual English and Communication Virtual Lab, IIT Guwahati

http://vlabs.iitb.ac.in/vlabs-dev/labs/communication/- Professional Communication Virtual Lab, IIT Bombay

Course code	Course Name	Credits
AEPBL501	**Mini Project - 2A**	**02**

Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Outcome: Learner will be able to…

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the

students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.

- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
  - Marks awarded by guide/supervisor based on log book : 10
  - Marks awarded by review committee : 10
  - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
  - First shall be for finalisation of problem
  - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
  - First review is based on readiness of building working prototype to be conducted.
  - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
  - Identification of need/problem
  - Proposed final solution
  - Procurement of components/systems
  - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
  - First shall be for finalisation of problem and proposed solution
  - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project

Mini Project shall be assessed based on following criteria;
1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication