Mahatma Education Society's

Pillai College of Engineering

(Autonomous)

Affiliated to University of Mumbai

Dr. K. M. Vasudevan Pillai's Campus, Sector 16, New Panvel – 410 206.

Department of Automobile Engineering

Syllabus

of

B.Tech. in Automobile Engineering

for

The Admission Batch of AY 2023-24

First Year - Effective from Academic Year **2023-24**

Second Year - Effective from Academic Year **2024-25**

Third Year - Effective from Academic Year **2025-26**

Fourth Year - Effective from Academic Year **2026-27**

as per

Choice Based Credit and Grading System

Mahatma Education Society's

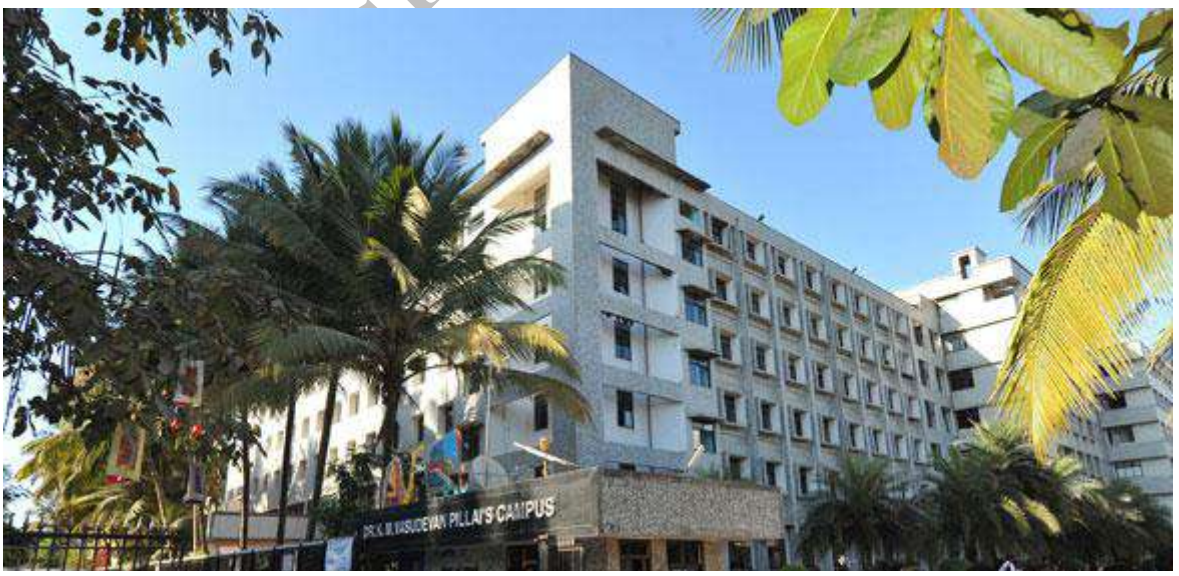
Pillai College of Engineering

Vision

Pillai College of Engineering (PCE) will admit, educate and train a diverse population of students who are academically prepared to benefit from the Institute's infrastructure and faculty experience, to become responsible professionals or entrepreneurs in a technical arena. It will further attract, develop and retain, dedicated, excellent teachers, scholars and professionals from diverse backgrounds whose work gives them knowledge beyond the classroom and who are committed to making a significant difference in the lives of their students and the community.

Mission

To develop professional engineers with respect for the environment and make them responsible citizens in technological development both from an Indian and global perspective. This objective is fulfilled through quality education, practical training and interaction with industries and social organizations.



Dr. K. M. Vasudevan Pillai's Campus, Sector - 16, New Panvel – 410 206

Department of Automobile Engineering

Vision

To develop an established institution of Automobile Engineering which will become a centre of quality standardization, research and academics through innovation, high quality teaching, projects and world class technology.

Mission

To provide quality education and knowledge that is well-grounded in the fundamental principles of engineering, which fosters innovation, and prepares students for leadership positions and successful careers in industry, academia or entrepreneurial ventures.

Program Educational Objectives (PEOs):

I. Students should develop sound fundamental knowledge in mathematics, science and automobile engineering.

II. Students would acquire an ability to function productively as an individual as well as in a team and are well versed in using modern technology and equipment to solve real world problems.

III. Students would be provided with opportunities to develop an instinct for innovation and skills as researchers through industry collaboration, practical training, laboratory experience, projects and the various courses offered to them.

IV. Students would inculcate a professional and ethical attitude, good leadership qualities and commitment to social responsibilities in their thought process.

V. Students will be encouraged to understand the importance of lifelong learning, working on contemporary global issues and to become a successful entrepreneur.

Program Outcomes:

Engineering Graduates will be able to:

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

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

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

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

5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities.

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

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

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

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

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

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

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

Program Specific Outcomes (PSOs):

1. Student should be able to generate and develop ideas that can result in self-employment (eg. Start–ups) and create more jobs.
2. Students should be updated with the latest trends in automobile engineering, beyond curriculum by way of doing internships and research projects.

The Autonomous status of the institute has given an opportunity to design and frame the curriculum in such a way that it incorporates all the needs and requirements of recent developments in all fields within the scope of the technical education. This curriculum will help graduates to attain excellence in their respective field. The curriculum has a blend of basic and advanced courses along with provision of imparting practical knowledge to students through minor and major projects. The syllabus has been approved and passed by the Board of Studies.

Outcome based education is implemented in the academics and every necessary step is undertaken to attain the requirements. Every course has its objectives and outcomes defined in the syllabus which are met through continuous assessment and end semester examinations. Evaluation is done on the basis of Choice Based Credit and Grading System (CBCGS). Optional courses are offered at department and institute level. Selection of electives from the same specialization makes the student eligible to attain a B. Tech. degree with respective specialization.

Every learner/student will be assessed for each course through (i) an Internal/Continuous assessment during the semester in the form of either Practical Performance, Presentation, Demonstration or written examination and (ii) End Semester Examination (ESE), in the form of either theory or viva voce or practical, as prescribed by the respective Board Studies and mentioned in the assessment scheme of the course content/syllabus. This system involves the Continuous Evaluation of students' progress Semester wise. The number of credits assigned with a course is based on the number of contact hours of instruction per week for the course. The credit allocation is available in the syllabus scheme of each semester.

The performance of a learner in a semester is indicated by a number called Semester Grade Performance Index (SGPI). The SGPI is the weighted average of the grade points obtained in all the courses by the learner during the semester. For example, if a learner passes five courses (Theory/labs./Projects/ Seminar etc.) in a semester with credits C1, C2, C3, C4 and C5 and learners grade points in these courses are G1, G2, G3, G4 and G5 respectively, then learners SGPI is equal to:

$$SGPI = \frac{C_1G_1 + C_2G_2 + C_3G_3 + C_4G_4 + C_5G_5}{C_1 + C_2 + C_3 + C_4 + C_5}$$

The learner's up to date assessment of the overall performance from the time s/he entered for the programme is obtained by calculating a number called the Cumulative Grade Performance Index (CGPI), in a manner similar to the calculation of SGPI. The CGPI therefore considers all the courses mentioned in the scheme of instructions and examinations, towards the

minimum requirement of the degree learners have enrolled for. The CGPI at the end of this semester is calculated as,

$$CGPI = \frac{C_1G_1 + C_2G_2 + C_3G_3 + \ldots + C_i * G_i + \ldots + C_nG_n}{C_1 + C_2 + C_3 + \cdots + C_i + \ldots + C_n}$$

The Department of Automobile Engineering offers a B. Tech. programme in Automobile Engineering. This is an eight-semester course. The complete course is a 169 credit course which comprises basic sciences and mathematics, core courses, projects, internship, MOOC course and elective courses. The elective courses are distributed over 7 specializations. The specializations are:

1. Electric Vehicles
2. Additive Manufacturing
3. Motor Sports Engineering
4. Autonomous Vehicles
5. Transportation
6. Supply Chain Management and Logistics
7. Automotive Designing

The students also have a choice of opting for Institute level specializations. These are

1. Business and Entrepreneurship
2. Bioengineering
3. Engineering Design
4. Art and Humanities
5. Applied Science
6. Life Skills, Repair, Maintenance and Safety

As minimum requirements for the credits to be earned for the B.Tech in Automobile Engineering program, a student will have to complete a minimum of three specializations of which two are to be chosen from the Department list and one has to be from the Institute level specialization list. In order to complete each specialization, a minimum of three courses under that specialization has to be completed.

- ***At least One MOOC course is highly recommended to be completed with certification in the four years of study.***

The credit requirement for the B.Tech. In Automobile Engineering course is tabulated in Table 1.

Table 1. Credit Requirement for B.Tech in Automobile Engineering

Category	Credits
Humanities and Social Sciences including Management courses	18
Basic Science courses	18
Engineering Science courses including workshop, drawing, basics of electrical/mechanical/computer etc	12
Professional core courses	52
Professional Elective courses relevant to chosen specialization/branch	17
Open subjects – Electives from other technical and /or emerging subjects	34
Project work, seminar and internship in industry or elsewhere	15
Mandatory Courses - Environmental Sciences, Induction training, Indian Constitution, Essence of Indian Traditional Knowledge	2
Human Values	2
Total Credits	**170**

Program Structure for
Bachelor of Technology in Automobile Engineering
W.E.F. A.Y.2023-24
Semester I

Course Code	Course Name	Category	Teaching Scheme (Contact Hours)		Credits Assigned		
			Theory	Pract.	Theory	Pract.	Total
FY101	Engineering Mathematics I	BSC	3	2	3	1	4
FY102	Engineering Physics I	BSC	2	1	2	0.5	2.5
FY103	Engineering Chemistry I	BSC	2	1	2	0.5	2.5
FY105	Basic Electrical Engineering	ESC	3	-	3	-	3
FY106	Engineering Mechanics	ESC	3	2	3	1	4
FY109	Basic Electrical Engineering Lab	Skill	-	2	-	1	1
FY112	Engineering Workshop-I	Skill	-	2	-	2	1
FY113	Indian Knowledge Systems	HSSM	-	2+2#	-	2	2
FY114	Co-curricular course-I	Liberal Learning	-	4	-	2	2
Total			13	18	13	10	**22**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		1	2	Avg.					
FY101	Engineering Mathematics I	40	40	40	60	2	25	-	125
FY102	Engineering Physics I	30	30	30	45	2	25	-	100
FY103	Engineering Chemistry I	30	30	30	45	2	25	-	100
FY105	Basic Electrical Engineering	40	40	40	60	2	-	-	100
FY106	Engineering Mechanics	40	40	40	60	2	25	25	150
FY109	Basic Electrical Engineering Lab	-	-	-	-	-	25	25	50
FY112	Engineering Workshop-I	-	-	-	-	-	50	-	50
FY113	Indian Knowledge Systems	-	-	-	-	-	50	-	50
FY114	Co-curricular course-I	-	-	-	-	-	50	-	50
Total									**775**

Program Structure for
Bachelor of Technology in Automobile Engineering
W.E.F. A.Y.2023-24
Semester II

Course Code	Course Name	Category	Teaching Scheme (Contact Hours)		Credits Assigned		
			Theory	Pract.	Theory	Pract.	Total
FY115	Engineering Mathematics II	BSC	3	2	3	1	4
FY116	Engineering Physics II	BSC	2	1	2	0.5	2.5
FY117	Engineering Chemistry II	BSC	2	1	2	0.5	2.5
FY120	Engineering Drawing	ESC	2	4	2	2	4
FY119	Python Programming	ESC	3	-	3	-	3
FY121	Professional Communication and Ethics-I	HSSM	1	2	1	1	2
FY122	Python Programming Lab	Skill	-	2	-	1	1
FY124	Engineering Workshop-II	Skill	-	2	-	1	1
FY125	Co-curricular Course-II	Liberal learning	-	4	-	4	2
Total			**14**	**16**	**14**	**10**	**22**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract./ Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs.)			
		1	2	Avg.					
FY115	Engineering Mathematics II	40	40	40	60	2	25	-	125
FY116	Engineering Physics II	30	30	30	45	2	25	-	100
FY117	Engineering Chemistry II	30	30	30	45	2	25	-	100
FY120	Engineering Drawing	40	40	40	60	3	25	25	150
FY119	Python Programming	40	40	40	60	2	-		100
FY121	Professional Communication and Ethics-I	20	20	20	30	1	25	-	75
FY122	Python Programming Lab	-	-	-	-	-	25	25	50
FY124	Engineering Workshop-II	-	-	-	-	-	50	-	50
FY125	Co-curricular Course-II	-	-	-	-	-	50	-	50
Total									**800**

Program Structure for Second-Year
Bachelor of Technology in Automobile Engineering
W.E.F. A.Y. 2024-25
Semester III

Course Code	Course Name	Category	Teaching Scheme (Contact Hours)		Credits Assigned		
			Theory	Pract.	Theory	Pract.	Total
AE201	Production Technology	PCC	3	-	3	-	3
AE202	Engineering Mathematics III*	MD M	2	-	2	-	2
AE203	Strength of Materials*	MD M	3	2	3	1	4
AE204	Thermodynamics*	PCC	3	-	3	-	3
AE205	Engineering Metallurgy and Automotive Materials	PCC	3	2	3	1	4
AE206	Computer Aided Drafting	VSEC	-	2	-	1	1
AE207	CNC and Additive Manufacturing Lab	VSEC	-	2	-	1	1
AE 208	Human Values and Social Ethics	HSSM	2	-	2	-	2
AE291	Minor Project I	CEP	1	2	1	1	2
Total			**17**	**10**	**17**	**5**	**22**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs.)			
		1	2	Avg.					
AE 201	Production Technology	40	40	40	60	2	-	-	100
AE 202	Engineering Mathematics III*	30	30	30	45	2	-	-	75
AE 203	Strength of Materials*	40	40	40	60	2	25	25	150
AE 204	Thermodynamics*	40	40	40	60	2	-	-	100
AE 205	Engineering Metallurgy and Automotive Materials	40	40	40	60	2	25	-	125
AE 206	Computer Aided Drafting	-	-	-	-	-	25	50	75
AE 207	CNC and Additive Manufacturing Lab	-	-	-	-	-	25	25	50
AE 208	Human Values and Social Ethics	-	-	-	-	-	50	-	50
AE291	Minor Project I	25(Mid Sem assessment)					25	25	75
Total									**800**

*** - Common with B.Tech in Mechanical Engineering**

Program Structure for
Bachelor of Technology in Automobile Engineering
W.E.F. A.Y. 2024-25
Semester IV

Course Code	Course Name	Category	Teaching Scheme (Contact Hours)		Credits Assigned		
			Theory	Pract.	Theory	Pract	Total
AE 209	Automotive Engines & Combustion	PCC	3	2	3	1	4
AE 210	Theory of Machines & Mechanisms*	PCC	3	2	3	1	4
AE 211	Fluid Mechanics & Machinery*	PCC	3	2	3	1	4
AE 212	Elements of Machine Design	PCC	3	2	3	1	4
AE 213	Engineering Mathematics-IV	MD M	2	-	2	-	2
AE 214	Data Science	AEP	-	4	-	2	2
AE 292	Minor Project II	CEP	1	2	1	1	2
Total			**15**	**14**	**15**	**7**	**22**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs.)			
		1	2	Avg.					
AE 209	Automotive Engines & Combustion	40	40	40	60	2	25	25	150
AE 210	Theory of Machines & Mechanisms*	40	40	40	60	2	25	25	150
AE 211	Fluid Mechanics & Machinery*	40	40	40	60	2	25	25	150
AE 212	Elements of Machine Design	40	40	40	60	2	25	25	150
AE 213	Engineering Mathematics-IV	30	30	30	45	2	-	-	75
AE 214	Data Science	-	-	-	-	-	25	50	75
AE 292	Minor Project II	25 (Mid Sem assessment)					25	25	75
Total									825

*** - Common with B.Tech in Mechanical Engineering**

Course Code	Course Name	Credits
AE201	**Production Technology**	3

Course Objectives:

1. To familiarize with the various production processes used on shop floors
2. To study appropriate production processes for a specific application.
3. To introduce to the learner various machine tools used for manufacturing
4. To familiarize with principle and working of non-traditional manufacturing
5. To introduce to them the Intelligent manufacturing in the context of Industry 4.0

Course Outcomes:

1. Demonstrate an understanding of casting process
2. Illustrate principles of forming processes.
3. Demonstrate applications of various types of welding processes.
4. Differentiate chip forming processes such as turning, milling, drilling, etc.
5. Illustrate the concept of producing polymer components and ceramic components.
6. Illustrate principles and working of non-traditional manufacturing
7. Understand the manufacturing technologies enabling Industry 4.0

Module	Details	Hours
1	**Introduction to Production Processes and Metal Casting** Classification of Production Processes and introduction to metal casting Pattern-making materials, Types of patterns and allowances. Sand moulding and Machine moulding Gating system: Types of risers, types of gates, solidification Special casting processes: CO2 and shell moulding, Investment casting, Die casting, Vacuum casting, Inspection & casting defects and remedies	6
2	**Joining Processes** Classification of various joining processes; Applicability, advantages and limitations of Adhesive bonding, Mechanical Fastening. Welding and allied processes. Principles and equipment used in Gas welding, Arc welding, Resistance welding, Thermitt welding. Soldering. Brazing. . Welding Joints, Welding Positions, Welding defects and their remedies.	6
3	**Forming Processes** Basic concepts and classification of forming processes. Principal equipment used and application of Forging, Rolling, Extrusion, Wire drawing. Classification of Sheet metal operations, types of Presses used in sheet metal operations, types of dies. Powder metallurgy, steps involved, applications.	7
4	**Conventional Machining** General principles of working. Types and commonly performed operations in Lathe, Shaper, Planer, Milling machine, Drilling machine, Grinding machine, Gear cutting.	8

	Geometry and nomenclature of single point cutting tool, Speed, feed, depth of cut, Taylor's tool life equation, Concept of chip formation and types of chips. Introduction to Jigs and Fixtures and types.	
5	**Maintenance of Lathe and Milling Machines** Importance of maintenance in industrial settings, key components of the machines, and common issues. Tools and equipment needed for maintenance, detailed procedures for cleaning, lubrication, alignment, and calibration, as well as troubleshooting common mechanical problems. Practical hands-on sessions to apply the learning in real-world scenarios, case studies and problem-solving exercises. Safety protocols and best practices.	**8**
6	**Unconventional Machining:** Need for unconventional machining processes. Principles and application of Abrasive jet machining, Ultrasonic machining, Electro discharge machining, Electromechanical machining, Chemical machining, Laser beam machining, Electron beam machining, Plasma arc machining.	**5**

Assessment:

Internal Assessment:

Consisting of Two Compulsory 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).

Duration of each test shall be one hour and thirty minutes and would be for 40 marks.

End Semester Examination:

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

1. Question paper will comprise of four 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 three questions need to be solved.

Duration of test will be two hours and would be for 60 marks

Books/References:

1. Welding technology by O P Khanna
2. Foundry technology by O P Khanna
3. Elements of workshop technology. Vol. 1 & II by S K Hajra Choudhury
4. Manufacturing Science by Ghosh and Malik
5. Rapid Manufacturing –An Industrial revolution for the digital age by N.Hopkinson, R.J.M.Hauge, P M, Dickens, Wiley
6. Rapid Manufacturing by Pham D T and Dimov, Springer Verlag
7. Production Technology by WAJ Chapman Vol I, II, III
8. Production Technology by P C Sharma.
9. Production Technology by Raghuvanshi.
10. Industry 4.0: The Industrial Internet of Things by Alasdair Gilchrist, 2016, Apress.
11. Cyber-Physical Systems: From Theory to Practice by Danda B. Rawat, Joel Rodrigues, Ivan Stojmenovic, 2015, C.R.C. Press.
12. Optimization of Manufacturing Systems using Internet of Things by Yingfeng Zhang, Fei Tao, 2017, Academic Press (AP), Elsevier.

Back to Scheme

Course Code	Course Name	Credits
AE202	**Engineering Mathematics III***	2

Course Objectives:

1. To learn the Laplace Transform of various functions, and its applications.
2. To Learn Inverse Laplace Transform of various functions, and its applications.
3. To learn the concept of Fourier Series and enhance problem-solving skills.
4. To learn complex form of Fourier series and Fourier Transform and enhance problem-solving skills.
5. To Learn the regression analysis and interpolation methods.
6. To Learn matrices eigen values and eigen vectors .

Course Outcomes

1. Able to solve examples of Laplace transform & apply the concept of Laplace transform and its application to solve the real integrals.
2. Able to solve examples of inverse Laplace transform of various functions & apply the concept of inverse Laplace transform in application to solve differential equations & engineering problems.
3. Able to find Fourier series & Apply the knowledge of Fourier series in engineering problems.
4. Able to solve examples of complex forms of Fourier series and Fourier Transform & Apply the knowledge of complex forms of Fourier series and Fourier Transform in problem solving.
5. Able to solve examples of regression, correlation, rank correlation, interpolation and fitting of curves & Apply the concept of regression, correlation, rank correlation, interpolation and fitting of curves in engineering problems.
6. Able to solve examples of eigen values and eigen vectors of matrices & apply concept of eigen values and eigen vectors of matrices in diagonalization of matrix & engineering problems.

Module	Details	Hours
1	**Laplace Transform** 1.1 Definition, Laplace Transforms of Standard Functions. 1.2 Linearity properties of Laplace Transform, First Shifting theorem, 1.3 Change of scale Property, Effect of multiplication by t, 1.4 Effect of Division by t.	4
2	**Inverse Laplace Transform** 2.1 Use of standard formulae of Inverse Laplace Transform , 2.2 Partial fractions method, 2.3 First shift property, 2.4 Convolution theorem (without proof) .	4
3	**Fourier Series** 3.1 Orthogonal and orthonormal set of functions. 3.2 Fourier series of periodic function with period 2π , 3.3 Fourier series of even and odd functions with period 2π, 3.4 Half range Sine and Cosine Series with period π. 3.5 Half range Sine and Cosine Series with period L, where $L \neq \pi$ (Definition only).	4

4	**Fourier Integral and Fourier Transform** 4.1 Complex form of Fourier Series with period 2π , 4.2 Fourier Integrals (Definition only). 4.3 Fourier transform of constant and exponential function. 4.4 Fourier cosine and sine transform of constant and exponential function.	4
5	**Interpolation, Regression , Correlation & Fitting of Curves** 5.1 Interpolation: - Lagrange's Linear and Quadratic 5.2 Linear Regression, Lines of regression 5.3 Karl Pearson's Coefficient of correlation (r) , Spearman's Rank correlation coefficient (R) (Repeated & non repeated ranks problems). 5.4 Fitting of Curves : Fitting of straight line and Second degree curve by Method of least squares.	5
6	**Matrices** **Prerequisite:** Inverse of a matrix, addition, multiplication and transpose of a matrix ,Elementary row and column transformation, System of homogeneous and non –homogeneous equations, their consistency and solutions 6.1 Eigenvalues and Eigenvectors of Matrices. 6.2 Properties of Eigenvalues (Without proof). 6.3 Cayley Hamilton theorem(Without Proof): Verification of Cayley Hamilton theorem (CHT) , 6.4 Application of CHT to find inverse of a matrix .	5

Assessment:

Internal Assessment Test:

Assessment consists of class tests of 30 marks each. The IA1 is to be conducted when approx. 40% syllabus is completed and IA2 marks shall be an average of six assignments', advised to be conducted during tutorials, marks , one assignment on each of the six modules separately for 30 marks .

End Semester Theory Examination:

1. Question paper will comprise of total 4 questions, each carrying 15 marks.
2. Total 03 questions need to be solved.
3. Question No: 01 will be compulsory and based on the entire syllabus wherein
   5 sub-questions of 3 marks each will be asked.
4. Remaining questions will be randomly selected from all the modules.
5. Weightage of each module will be proportional to number of respective lectures mentioned in the syllabus.

References:

1. Higher Engineering Mathematics, Dr.B.S.Grewal, Khanna Publication
2. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley EasternLimited, 9thEd.
3. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication,
4. Probability, Statistics and Random Processes, T. Veerarajan, McGraw-Hill education
5. Advanced Engineering Mathematics H.K. Das, S. Chand, Publications
6. Matrices, Shanti Narayan, S. Chand publication.
7. Introductory Methods of Numerical Analysis, S. S. Sastry, Prentice-Hall of India Private Limited.

Back to Scheme

Course Code	Course Name	Credits
AE203	**Strength of Materials***	3+1

Prerequisites:
1.Fundamentals of engineering mechanics
2.Concept of centroid, Analysis of forces and moments
3.Algebra and trigonometry, Elementary Calculus

Course Objectives:

1. To understand the mechanical behavior of the body by determining the stresses, strains and deformations produced by the loads up to the elastic limit.
2. To understand the fundamental concepts related to shear force and bending moments, torsional moments, strain energy.
3. To understand the fundamental concepts related to deflection of beams, columns, and thin cylindrical and spherical shells.

Course Outcomes:
Upon successful completion of this course, learner will be able to:

1. Apply principles of statics to analyze the reactions & internal forces in bodies subjected to static loads.
2. Evaluate the different types of stresses and strains developed in the members subjected to axial, bending, shear & torsional loads.
3. Compute slope and deflection at various cross-sections along a beam's length.
4. Determine and compare the maximum stress and deformation in structures under gradual, sudden and impact loads.
5. Determine the stability and load carrying capacity of columns with various end conditions under compressive loads.
6. Conduct various tests on standard testing machines to determine the failure limits of materials under various loadings, and comprehend the behavior and properties of engineering materials.

Theory Syllabus:

Module	Details	Hours
1	**Simple stresses and strains:** Stress, strain, Stress-strain diagram for ductile and brittle materials, factor of safety. Hooke's law, Poisson's ratio, Modulus of Elasticity, Modulus of Rigidity, Bulk Modulus. Interrelation between elastic constants. Thermal stresses and strains. Principal stresses and Principal planes, Mohr's circle. Moment of Inertia and Polar moment of Inertia.	06
2	**Shear Force and Bending Moment in Beams:** Definition of bending moment and shear force, Sign conventions, Relationship between load intensity, bending moment and shear force. Shear force and bending moment diagrams for statically determinate beam due to concentrated load, uniformly distributed load, uniformly varying load and couple, Point of Contraflexure. Beams with Internal Hinges/Moment Release (limited to two per beam).	07
3	**Stresses in Beams:**	07

	Flexural stresses – Theory of simple bending, Assumptions, derivation of equation of bending, neutral axis, determination of bending stresses, section modulus. **Shear stresses –** Derivation of formula, shear stress distribution across various beam sections like rectangular, circular, I, T sections **Direct and Bending stresses-** Introduction, eccentric loading, columns with eccentric loading, Limit of eccentricity,	
4	**Torsion of Shafts:** Introduction to Torsion, Torsion formula – stresses and deformations in circular and hollow shafts, Stepped shafts, Design of shafts according to theories of failure. **Strain Energy:** Strain energy due to axial load (gradual, sudden and impact), Strain energy due to bending and torsion.	06
5	**Deflection of Beams:** Double integration method and its limitations. Macaulay's method of singularity or half-range functions to calculate slope and deflection at a cross-section along the beam's length.	07
6	**Columns and Struts:** Concept of buckling of columns, derivation of Euler's formula for buckling load for columns with various end conditions, concept of equivalent length, limitations of Euler's formula, Rankine's formula, safe load on columns. **Thin Cylinders and Spheres:** Cylinders and Spheres due to internal pressure, Cylindrical shell with hemispherical ends.	07

Lab Syllabus:

Module	Details	Hours
1.	Tension Test on Mild Steel Bar and other ductile materials using UTM (Universal Testing Machine), for specimens having diameter between 6 - 12 mm. Use of graph plotting software like MS Excel or similar to plot the Load vs. Deformation plot and Stress vs. Strain plot.	2
2.	Compression Test on Concrete or Wooden Block using UTM.	2
3.	Flexure (Bending) Test on Simply Supported Beam (3 Point Bending) using UTM.	2
4.	Shear Test on rods of various materials using Shear Attachment on UTM.	2
5.	Hardness Tests using Hardness Testing Machine: (a). Rockwell Hardness Test (b). Brinell Hardness Test	2
6.	Impact Tests on Impact Testing Machine: (a). Izod Impact Test (b). Charpy Impact Test	2
7.	Torsion Test on Tor-steel rod using Torsion Testing Machine. Use of graph plotting software like MS Excel or similar to plot the Torque vs. Angular Deformation (Twist) plot.	2
8.	Tensile Test on thin cross-section (rectangular/circular) specimens	2

	using Tensile Testing Machine. Use of graph plotting software like MS Excel or similar to plot the Load vs. Deformation plot and Stress vs. Strain plot.	
9	Simulation Tests on the above experiments using Virtual Laboratory.	10

Theory Assessment:
Internal Assessment:
1.Consisting of One Compulsory Class Tests - 40 Marks
2.Continuous evaluation- Test/Assignments /Quiz/Case studies/Seminar presentation - 40 Marks

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

1. Question paper will comprise of four 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 three questions need to be solved.

Duration of test will be two hours and would be for 60 marks

Laboratory Assessment:
Term Work: 25 marks.
Term Work consists of an ample number of assignments and experiments as decided by the Instructor. Mini-project based on this subject may be undertaken for which the number of assignments may be suitably reduced. Students can also avail NPTEL Certification for this course, which shall be considered in place of the assignment work.
Viva-você / Practical: 25 marks.
Viva-você (on the entire syllabus) or Practical exam (on at least one experiment) shall be conducted at the end of the course. In case both viva-voce and practical exams are conducted, 15 marks shall be allotted to viva-voce and 10 marks to the practical exam.

Books/References:

1. S. S. Rattan, Strength of Materials, TMH Publications
2. R.K. Bansal, Strength of Materials, Laxmi Publications, India
3. Beer and Johnston - Strength of materials - CBS Publication
4. Ramamrutham - Strength of material - Dhanpat Rai Publication
5. W. A. Nash and M. C. Potter, Strength of Materials, Schaum's Outline Series, McGraw-Hill
6. Singer and Pytel - Strength of materials - Harper and Row Publication
7. Strength of Materials - Lab Manual, by Anand Jayakumar Arumugham, Notion Press.
8. Experiments in Strength of Materials and Cement Laboratory, by Earl B. Smith, Leopold Classic Library.
9. Laboratory Strength of Materials, by Murad, Hassan, Abdulrahman

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Course Code	Course Name	Credits
AE204	**Thermodynamics***	3+1

Course Objectives:

1. To explore ideas about energy into forms suitable for engineering analysis.
2. To introduce entropy and show its use for thermodynamic analysis.
3. To study power systems utilizing working fluids like vapor and gas.
4. To demonstrate the procedures for determining thermodynamic properties of pure substances from tables of property data.
5. To introduce the first law of thermodynamics, energy balances, and energy transfer mechanisms to or from a system.

Course Outcomes:

Upon successful completion of this course, the learner will be able to

1. Able to describe basic concepts of thermodynamics.
2. Able to apply first law of thermodynamics for closed and open systems and construct conservation of mass and energy equations.
3. Able to calculate thermal efficiency and coefficient of performance for heat engine, refrigerators and heat pumps.
4. Able to explain the available and unavailable energy.
5. Able to calculate the properties of the steam and analyse the vapour power cycle.
6. Able to analyse the gas power cycles.

Module	Details	Hours
1	**1.1 Fundamentals** Applications of Thermodynamics, macroscopic and microscopic approach, Thermodynamic systems, properties of a system, state, path, process and cycle, point function & path function, thermodynamic equilibrium, temperature & zeroth law of thermodynamics, temperature scale, ideal gas equation of state. **1.2 Energy & Energy Transfer** Energy – a property of the system, Sources of energy, Forms of energy, internal energy, enthalpy, heat transfer, sign convention for heat transfer, Thermodynamic definition of work transfer, sign convention for work transfer, similarities & dissimilarities between heat and work transfer, Exact & inexact differentials.	7
2	**2.1 First Law of thermodynamics applied to closed system:** Statement, first law applied to the closed system undergoing a process and for a cyclic process (Joule's Experiment), PMM1. Concept of moving boundary work, Ideal gas processes, **2.2 First Law of thermodynamics applied to steady flow system:** Flow process and flow energy, steady flow process, derivation of steady flow energy equation (SFEE). Application of SFEE to the steady flow devices such as nozzle, turbine, compressor, pump, throttling process, boiler, heat exchanger, Limitations of the First Law of thermodynamics.	7
3	**3.1 Second Law of Thermodynamics:**	7

	Thermal reservoir, Concept of heat engine, Heat pump and Refrigerator, Statements of the second law of thermodynamics, equivalence between Kelvin-Planck and Clausius statement, PMM2, Reversible and irreversible Process, condition for a reversible process, Carnot cycle, Carnot theorem, **3.2 Entropy:** Clausius Inequality theorem, Entropy – a property of the system, Temperature-Entropy diagram, increase of entropy principle, entropy generation, Tds relations, entropy change for an ideal gas.	
4	**4.1 Availability:** Concept of high- and low-grade energy, available and unavailable energy, dead state, useful work, availability, irreversibility, availability of energy entering a system. **4.2 Thermodynamic Relations** Helmholtz and Gibbs functions, Maxwell equation (without derivation), Clausius-Clapeyron equation, Joule Thomson coefficient – porous plug experiment.	6
5	**5.1 Properties of Pure Substance:** Pure substance, phase change phenomenon of pure substance, saturation pressure and saturation temperature, terminology of pure substance, P-V-T surfaces, p-v, p-T, T-s & h-s (Mollier diagram) diagrams, Steam diagram, critical point and triple point, Quality of steam, Calculation of various properties of steam, advantages & applications of use of steam, **5.2 Vapour Power Cycle:** Carnot cycle, Limitations of Carnot vapour cycle, Rankine cycle, mean temperature of heat addition, Rankine cycle with superheat.	6
6	**6.1 Gas Power Cycle:** Nomenclature of a reciprocating engine, Mean effective pressure, Assumptions of air Standard Cycle, Otto cycle, Diesel Cycle and Dual cycle, Comparison of Otto and Diesel cycle for same compression ratio. Working principle of Brayton Cycle, Stirling Cycle, Ericsson Cycle, Lenoir cycle and Atkinson cycle. (No Numerical for Brayton, Stirling, Ericsson, Lenoir & Atkinson Cycle).	6

Assessment:

Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests of 40 Marks
2. Continuous evaluation: Class Test/ Assignments / Quiz/ Case studies/ Seminar presentation of 40 Marks

End Semester Examination: 60 Marks

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

Term Work Assessment (Based on Tutorial):

Term Work consists of assignments on the syllabus as decided by the course Instructor.
Term Work: 25 marks.

Submission of assignments: 20 Marks
Attendance: 5 Marks.

Books/References:

1. Fundamentals of engineering thermodynamics by Michael J. Moran &Howard N. Shapiro, John wiley and Sons, Fifth edition,
2. Applied thermodynamics by B K Ventanna, PHI publications.
3. Thermodynamics: An Engineering Approach by Yunus A. Cengel and Michael A. Boles, 9th edition, TMH
4. Basic Engineering Thermodynamics by Rayner Joel, 5thedition, Longman Publishers
5. Engineering Thermodynamics by P Chattopadhyay, 2ndedition, Oxford University Press India
6. Thermodynamics by P K Nag, 6thEdition,TMH
7. Thermodynamics by Onkar Singh, 4th Edition New AgeInternational
8. Thermodynamics by C P Arora,1st EditionTMH
9. Thermal Engineering By Ajoy Kumar, G. N. Sah, 2nd Edition, Narosa Publishing house
10. Engineering Thermodynamics Through Examples by Y V C Rao, Universities Press (India) PvtLtd
11. Fundamentals of Thermodynamics by Moran &Shapiro, Eighth Edition, Wiley
12. Fundamentals of Classical Thermodynamics by Van Wylen G.H. & Sonntag R.E., 9th Edition John Wiley & Sons
13. Thermodynamics by W.C. Reynolds, McGraw-Hill &Co
14. Thermodynamics by J P Holman, 4th Edition McGraw-Hill & Co.

E-Books / Web References

1. Engineering Thermodynamics, Achuthan, 2nd Edition, Phi Learning, 2009
2. Fundamentals of Engineering Thermodynamics, Rathakrishnan, 2nd Edition, Phi Learning, 2005
3. http://nptel.ac.in/courses/112104113/
4. http://nptel.ac.in/courses/112108148/
5. http://nptel.ac.in/courses/112105123/

MOOCS

1. https://www.coursera.org/course/introthermodynamics
2. https://www.iitbombayx.in/courses/IITBombayX/ME209xA15/2015_T1/about
3. https://legacy.saylor.org/me103/Intro/

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Course Code	Course Name	Credits
AE205	Engineering Metallurgy and Automotive Materials	3+1

Course Objectives:

1. To help students know about the different types of materials
2. To enable students to make a good selection of materials
3. To be able to understand the significance of structure property relationship
4. To understand the role of materials in automotive developments

Course Outcomes: On completion of this course, a learner will be able to

1. Identify the different classes of materials
2. Suggest ways to improve the strength of materials
3. Differentiate between steels and cast irons wrt composition and property development
4. Analyze the phase transformations and apply appropriate heat treatment
5. Suggest lightweight alternatives for automotive parts
6. Evaluate the reasons of failure in components and take corrective actions

Theory Syllabus:

Module	Details	Hours
1.	Stress-strain curve, Deformability and Strengthening Mechanisms-Hot and Cold working, Recrystallisation-its effects and factors affecting it.	6
2.	Concepts of solidification,difference in solidification of metals and alloys, Phases, Phase diagrams, Alloying - Fe-Fe3C diagram and cooling of steels and cast irons.	8
3.	Austenite transformation-equilibrium and non equilibrium,Hardenability and its importance, Hardenability tests, Alloy Steels-stainless steels, tool steels.	8
4.	Heat treatments: Thorough and Surface heat treatment, Isothermal treatments-Patenting, Austempering and martempering, Ausforming and Maraging.	6
5.	Developments in automotive materials with the aim of lightweighting-Shift to composite materials for bodies, interiors and engines.	6
6.	Failure by fracture-micromechanisms-fatigue and creep. Non destructive evaluation to prevent failures.	5

Lab Syllabus:

Experiment	Details	Hours
1	Metallographic sample preparation and etching	2
2	Comparison of hardness before and after Annealing, Normalizing and Hardening in medium carbon steel	2
3	Study of tempering characteristics of hardened steel	2
4	Determination of hardenability of steel using Jominy end Quench Test	2
5	Tension test on mild steel bar (stress-strain behaviour, determination of yield strength and modulus of elasticity)	2
6	Impact test on metal specimen (Izod/Charpy Impact test)	2
7	Hardness test on metals – (Brinell/ Rockwell Hardness	2

	Number	
8	Basics of Scanning electron Microscopy. https://emb-iitk.vlabs.ac.in/exp/sem-basics/	2
9	Basic operations of transmissions electron microscopy https://emb-iitk.vlabs.ac.in/exp/transmission-electron-microscope/	2
10	Sample preparation for TEM Analysis (bulk metal, powder sample,brittle)https://emb-iitk.vlabs.ac.in/exp/tem-analysis/	2
11	Electron diffraction of various materials https://emb-iitk.vlabs.ac.in/exp/electron-diffraction/	2
12	Feature size measurement porosity, grain and reinforcement https://emb-iitk.vlabs.ac.in/exp/feature-size-measurement/	2
13	Virtual Labs (virtual-labs.github.io)-Fatigue test	2

At Least 10 experiments from the above list to be performed.

Theory Assessment:

Internal Assessment:

Consisting of Two Compulsory 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). Duration of each test shall be one hour and thirty minutes and would be for 40 marks.

End Semester Examination:

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

1. Question paper will comprise of four 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 three questions need to be solved.

Duration of test will be two hours and would be for 60 marks.

Lab Assessment:

Term Work:

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

1. Experiment write ups : 20 Marks
2. Attendance : 05 marks

Books/References:

1. Materials Science and Engineering: An Introduction: William Callister Jr. and David G. Rethwisch, Wiley Publication
2. Introduction to Physical Metallurgy, Sidney H. Avner, Tata McGraw Hill
3. Introduction to Engineering Materials,BK Agrawal, TataMcGraw Hill
4. Materials Science and Engineering: A First Course,Raghavan V, Prentice Hall India
5. Automotive Materials, Brian Cantor

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Course Code	Course Name	Credits
AE206	**Computer Aided Drafting**	1

Course Objectives:

1. To enable students to create, modify, and optimize both 2D and 3D CAD models.
2. To enable students to apply GD&T principles, including limits, fits, and tolerances, to produce accurate engineering drawings.
3. To teach students how to build assemblies and create surface models
4. Provide knowledge of CAD data exchange formats and practical applications through case studies like reverse engineering.

Course Outcomes: Upon successful completion of this course, the learner will be able to

1. Create and optimize 2D and 3D CAD models.
2. Apply Geometric Dimensioning and Tolerancing (GD&T) for precise engineering drawings.
3. Assemble, edit, and check 3D modeled parts for constraints and interferences.
4. Create and manipulate surface models.
5. Draft detailed parts and assemblies.
6. Utilize various CAD data formats and perform reverse engineering.

Module	Details	Hours
1	**CAD Introduction,GD & T** **Overview**: Introduction to CAD, including the creation of CAD models, types and uses of models from different perspectives, parametric and non-parametric modeling. **GD & T**: Understanding Geometric Dimensioning and Tolerancing (GD&T), along with limits, fits, and tolerance.	2
2.	**Part Modelling** **2D Modeling**: Creating geometric models of engineering components using sketching commands (line, arc, circle, etc.), modification commands (trim, move, rotate, etc.), and viewing tools (pan, zoom, rotate). **Solid Modeling**: Developing 3D geometric models of engineering components using commands like extrude, revolve, sweep, blend, and loft.	8
3.	**Assembly** **Assembly Process:** Assembling 3D modeled parts, editing parts within the assembly, applying constraints, creating exploded views, and performing interference checks.Utilizing 3D components from the software library (e.g., nut, bolt, screw).	4

4.	**Surface Modeling** **Surface Creation**: Using commands such as extrude, sweep, and trim to create and manipulate surfaces **Feature Manipulation**: Employing operations like copy, edit, pattern, suppress, and history operations.	4
5.	**Drafting** **Drafting Process**: Drafting parts and assemblies, creating layouts, standard and sectional views, detailing, and plotting. **Advanced Drafting**: Using ballooning, dimensioning, GD&T symbols, and printing drawing files.	6
6.	**Data Exchange and Case Study** **Data Exchange Formats**: Understanding and comparing CAD data exchange formats like IGES, PDES, PARASOLID, DXF, and STL. **Case Study**: Conducting a reverse engineering case study to generate a model.	2

Assessment:

Term work:

1. Printouts/Plots: 10 marks

2. Reverse Engineering: Continuous Evaluation for Case study:10Marks

3.Attendance : 05 marks

Using the above knowledge and skills acquired through six modules students should complete minimum six assignments/experiments from the given sets of assignments (two from each set) using standard CAD modeler like PTC Creo/CATIA/ Solid work/UG /any other suitable software.

Set 1: Beginner Level: 3D modeling of basic Engineering components likes Nuts, Bolts, Keys, cotter, Screws, Springs etc.

Set 2: Intermediate Level: 3D modeling of basic Machine components like Clapper block, Single tool post, Lathe and Milling tail stock, Shaper tool head slide, jigs and fixtures Cotter, Knuckle joint, Couplings: simple, muff, flanged Protected flange coupling, Oldham's coupling, Universal coupling, element of engine system and Miscellaneous parts.

Set 3: Advance Level:

1. Generation of any Assembly model (minimum five child parts) along with Production drawing for any of the system by creating 3D modeling with assembly constraints, Interference check, Exploded view, GD&T, Bill of material.

2. Reverse Engineering of a physical model: disassembling of any physical model having not less than five parts, measure the required dimensions of each component, sketch the minimum views required for each component, convert these sketches into 3-D model and create an assembly drawing with actual dimensions.

End Semester Practical/Oral examination:

To be conducted by pair of Internal and External Examiners

1. Practical examination duration is two hours, based on Advance level of the Term work. Oral examination should also be conducted to check the knowledge of CAD Modelling Tools.

2. The distribution of marks shall be as follows: Practical Exam : 30 marks Oral Exam : 20 marks

3. Evaluation of practical examinations to be done based on the printout of students' work.

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

Books/References:

1. Machine Drawing by N.D. Bhatt.

2. A textbook of Machine Drawing by Laxminarayan and M.L.Mathur, Jain brothers Delhi.

3. Machine Drawing by Kamat and Rao.

4. Machine Drawing by M.B.Shah.

5. A text book of Machine Drawing by R.B.Gupta, Satyaprakashan, Tech. Publication.

6. Machine Drawing by K.I. Narayana, P. Kannaiah, K.Venkata Reddy.

7. Machine Drawing by Sidheshwar and Kannaiah.

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Course Code	Course Name	Credits
AE207	**CNC and Additive Manufacturing Lab**	1

Course Objectives:

1. To understand the use of measuring instruments in engineering practice.
2. To understand Conventional machine handling.
3. To lean tool path generation process in CAM
4. To observe and learn industrial CNC machines.
5. To use and learn all stages of any additive manufacturing process..
6. To understand various advanced fabrication processes in industry

Course Outcomes: Upon successful completion of this course, learner will be able to

1. Use and apply knowledge of measurement instrument handling.
2. Operate conventional machines for Various applications.
3. Implement tool path generation used in CAM.
4. Develop programs for CNC using simulations.
5. Learn and operate all stages of 3D Printing Process for additive manufacturing.
6. Learn various advanced fabrication processes in industry

Module	Details	Hours
1	Measurement using Vernier caliper and micrometer screw gauge.	2
2	Thread manufacturing using Conventional Machining - Lathe	4
3	Gear manufacturing using Conventional Machining - Milling Machine	4
4	Creation of 3D model from 2D images using any image processing software and printing it. (3D Slicer open source)	2
5	Tool-path generation by translation of part geometry from computer aided design (CAD) to computer aided manufacturing (CAM) systems. - Solidworks CAD to CAM]	2
6	Part programming simulation and part fabrication on CNC Turning trainer (Involving processes like Step turning, facing, Taper turning, threading, etc.)- Problem 1	2
7	Part programming simulation and part fabrication on CNC Turning trainer (Involving processes like Step turning, facing, Taper turning, threading, etc.) - Problem 2	2
8	Part programming simulation and part fabrication on CNC Milling trainer (Involving processes like contouring, drilling, facing, pocketing etc.) - Problem 1	2
9	Part programming simulation and part fabrication on CNC Milling trainer (Involving processes like contouring, drilling, facing, pocketing etc.) - Problem 2	2
10	Development of physical 3D mechanical structure using FDM - Basic of FDM, Importance of orientation and supports	2
11	Development of physical 3D mechanical structure using FDM - Advanced level - Assembly printing / embedding materials in 3D FDM Printing	2
12	Case Study: Report on a visit conducted to any Commercial CNC Machining Centre explaining the Design features, preprocessing in CAM software and its capabilities.	2

Note : 1. Minimum eight distinct practicals have to be performed during the semester.

2. Industrial visit is compulsory and cannot be a part of minimum required practicals.

Assessment:
Termwork:
Distribution of marks:

Practical Performance : 20 marks (Continuous Evaluation)
Attendance : 05 marks

Practical/Oral examination
To be conducted by pair of Internal and External Examiner
The distribution of marks for practical examination shall be as follows:

a. Oral Exam : 10 marks
b. Practical Exam : 15 marks

Books/References:

1. CAD/CAM Principles and Applications, P. N. Rao, Tata McGraw Hill Publications
2. CNC Technology and Programming, Krar, S., and Gill, A., McGraw Hill Publishers.
3. CNC Programming for Machining, Kaushik Kumar, Chikesh Ranjan, J. Paulo Davim, Springer Publication.
4. Medical Modelling The Application of Advanced Design and Rapid Prototyping Techniques in Medicine, Richard Bibb, DoMinorc Eggbeer and Abby Paterson, Woodhead Publishing Series in Biomaterials: Number 91, Elsevier Ltd.
5. Biomaterials, artificial organs and tissue engineering, Edited by Larry L. Hench and Julian R. Jones, Woodhead Publishing and Maney Publishing, CRC Press 2005
6. Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, I. Gibson l D. W. Rosen l B. Stucker, Springer Publication.
7. Rapid Prototyping and Manufacturing, P. F. Jacobs, Society of Manufacturing Engineers

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Course Code	Course Name	Credits
AE208	**Human Values and Social Ethics**	2

Prerequisite: Should have respect for justice and be able to reflect on one's personal beliefs and values

Course Objectives:

1. To enable learners understand the core values that shape the ethical behaviour of a professional.
2. To develop an awareness of the different ethical dilemmas at the workplace and society.
3. To inculcate the ethical code of conduct in writing technical articles and technology development.
4. To internalize ethical principles and code of conduct of a good human being at home, society and at work place.

Course Outcomes: After successful completion of the course students will be able to

1. Learners will be able to recognize the relation between ethics and values pertinent for an engineering professional.
2. Learners will be able to exercise the responsibility for establishing fair and just processes for participation and group decision making
3. Learners will be able to demonstrate an awareness of self-held beliefs and values and how they are altered in interactions with others.
4. Learners will be able to acquire the writing skills necessary to analyse data from research and attribute the source with proper citation.
5. Learners will be competent to incorporate values and ethical principles in social and professional situations.

Module	Details	Hours
1	**Ethics and Values** Meaning & Concept of Ethics Difference between Ethics and Values Ethical code of conduct	03
2	**Professional Ethics** Professional Ethics vs Personal ethics Components of professional ethics Professional values and its importance	05
3	**Ethics and Society** Relevance of values and ethics in social work Ethical dilemmas Values and ethical principles of social work • Service • Dignity and worth of a person • Importance of Human relationships • Integrity • Competence • Social Justice	04
4	**Ethics in Technical writing** Documenting sources	07

	Presentation of Information Ethics & Plagiarism	
5	**Ethics and Technology Development** Risk management and Individual rights Moral issues in development and application of technology Privacy/confidentiality of information Managing Technology to ensure fair practices	07

Assessment:
Termwork : 50 marks (Continuous evaluation)

Reference Books:

1. Martin Cohen, *101 Ethical Dilemmas* Routledge, 2nd edition, 2007.
2. M. Govindarajan, S. Natarajan & V.S. Senthilkumar, *Professional Ethics and Human Values,* Prentice Hall India Learning Private Limited, 2013.
3. Mike W. Martin, *Ethics in Engineering*, McGraw Hill Education; Fourth edition, 2017.

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Course Code	Course Name	Credits
AE 291	**Minor Project I**	2

Course Objectives:

1. To acquaint yourself 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 yourself with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Course Outcomes: 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 a 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 Minor 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 surveys and identify needs, which shall be converted into a problem statement for minor-project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Student groups shall submit an implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of the minor project.
- A log book has to be prepared by each group, wherein the group can record weekly work progress, and the guide/supervisor can verify and record notes/comments.
- Faculty supervisors may give inputs to students during minor project activity; however, focus shall be on self-learning.
- Students in a group shall understand the problem effectively, propose multiple solutions and select the best possible solution in consultation with the guide/supervisor.
- Students shall convert the best solution into a working model using various components of their domain areas and demonstrate.
- The solution has to be validated with proper justification and the report has to be compiled in the standard format.
- With the focus on self-learning and innovation, addressing societal problems and entrepreneurship quality development within the students through the Minor Projects, it is preferable that a single project of appropriate level and quality be carried out in two semesters by all the groups of the students. i.e. Minor Project 1 in semester III and IV. Similarly, Minor Project 2 in semesters V and VI may be considered. In other words, based on the individual students' or group's capability, with the mentor's recommendations, if the proposed Minor 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 Minor Project, in even semester with suitable improvements/modifications.

- Alternatively, student groups can work completely on a new project idea in the even semester, bearing no resemblance with the topic of odd semester. This policy can be adopted on a case to case basis.

Guidelines for Assessment of Minor Project –Continuous assessment and Term Work:

- The review/ progress monitoring committee shall be constituted by heads of departments of each institute. The progress of the minor project to be evaluated on a continuous basis, Minimum two reviews in each semester- 25 marks.
- 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:
  - Quality of project report and presentation- 25 marks

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 the first semester the entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on the presentation given by the student group.
  - If the problem is based on development of a mechanism or a simple device for attaining a desired objective, the first presentation shall be reviewed based on generation of multiple feasible solutions to the given problem and identification of the best possible solution based on various parameters which may include one of more of the following viz., the total weight, volume, power consumption, mechanical advantage, efficiency, cost (including labour) per piece once manufactured, and so on. This may include creation of unique free-hand sketches by each and every member of the group to contribute to the solution of the given problem. The best possible solution has to be finalized during one or more brainstorming sessions by the members of the student group. In case the problem is of a programming/coding type, then the first presentation may be dedicated to the understanding of the theory behind the problem related to a particular domain subject, including the drafting of an algorithm and/or flowchart, and may also include the introductory part of the programming.
  - Second review shall be based on the computerization (3D CAD model of parts and assembly), and possibly the animation, depicting the working characteristics of the proposed solution to the given problem, allocating material properties to each part, identifying mass properties of the assembled parts, and so on. Checking interference is one of the important criteria that can be used when assembling the parts. For software based projects, this may include the presentation based on the extension of the programming work so as to cover the major portion of the remaining part of the topic.
- In the second semester expected work shall be procurement of components/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester. For those selecting software based projects, this may include completing the other half of the programming related work, identifying the errors, optimizing the software code, customization, creating a graphical user interface of input and output (GUI), displaying output data in the form of graphs/tables/figures/diagrams, creation of the code in executable (.exe) format or in the form of a mobile App, etc.
  - First review shall be conducted based on the readiness of the working prototype, or

programming of the remaining code for software based projects.
  - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester. This may also include the testing and validation of tests with the literature/available data/theory. For software based projects, the presentation includes the remaining work other than the programming, as described above.
- Apart from the hardware type (development of device) and software (program/coding) type of projects, the topics may also include computer based work, viz., generation of virtual laboratory (for one or more experiments) for any subject/domain of choice, or CAD modeling, analysis, optimization, and/or product design, without any relevance to developing any physical product.

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 finalization of problem and proposed solution
  - Second shall be for implementation and testing of solutions.

Assessment criteria of Minor Project:

1. Quality of survey/need identification
2. Clarity of problem definition based on need
3. Innovativeness/uniqueness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness/uniqueness
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 as member or leader
13. Clarity in written and oral communication

- In a **one year project**, the first semester evaluation may be based on the first six criteria as highlighted above and the remaining criteria may be used for second semester evaluation of performance of students in the minor project.
- In the case of a **half year project,** all criteria in general may be considered for evaluation of performance of students in the minor project.

Guidelines for Assessment of Minor Project - Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the Department.
- Minor project shall be assessed through a presentation and demonstration of working model or the execution of programme code 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 the Head of Institution.
- Students shall be motivated to publish a paper based on the work in conferences or student competitions.

Back to Scheme

Course Code	Course Name	Credits
AE209	**Automotive Engines & Combustion**	3+1

Course Objectives:

1. To provide fundamental ideas on Spark Ignition & Compression Ignition Engines.
2. To familiarize with the complexity in combustion processes.
3. To give a 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.

Course Outcomes: After completion of this course, learners 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.

Theory Syllabus:

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)	4
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	8
3	**Compression Ignition Engines** **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	8
4	**Engine lubrication:** Types of Lubricants, their properties, SAE rating of Lubricants, Types of Lubrication systems.	6

	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. **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.	8
6	**I C Engine Fuels:** Hydrogen - E diesel(Introduction to Flex Fuel Technology): Properties - Suitability - Engine Modifications - Merits and Demerits as fuels. **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	5

Lab Syllabus:

PART A: Dismantle and assemble the following:

1. 2-Stroke/4-Stroke Engines
2. Carburetor
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:

1. Variable Valve Timing
2. Twin and Triple Turbo charging
3. Variable Compression Ratio Engine
4. Electronic MPFI with various modes
5. Single overhead camshaft and double overhead camshaft
6. Engine Downsizing
7. Eco-boost Engine

8. Turbocharging for S.I. Engine

Theory Assessment:

Internal Assessment:

Consisting of Two Compulsory 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). Duration of each test shall be one hour and thirty minutes and would be for 40 marks.

End Semester Examination:

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

1. Question paper will comprise of four 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 three questions need to be solved.

Duration of test will be two hours and would be for 60 marks

Lab Assessment:

Term work:

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

1. 2 must be actual experiments from Part A. From Part A exercise 1 is compulsory.
2. 4 must be actual experiments from Part B
3. 2 must be actual experiments from Part C
4. Case studies based on topics mentioned in Part D for various car models

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

1. Experiment write ups : 15 Marks
2. Attendance : 05 marks
3. Case study : 05 Marks

Practical and Oral Examination:

1. Pair of Internal and External Examiner should conduct practical/Oral exam.
2. Distribution of marks for practical and oral examination shall be as follows:
   Practical Exam : 15 marks
   Oral Exam : 10 marks
3. Evaluation of practical examination to be done based on the experiment performed and the output of the experiment during practical examination.
4. Student's work along with evaluation report to be preserved till the next exam.

Text Books:

1. Internal Combustion Engine - Mathur and Sharma
2. Internal Combustion Engine - V Ganesan
3. Internal Combustion Engines - Domkundwar

Reference Books:

1. Internal Combustion Engines Fundamentals, John B. Heywood
2. Internal Combustion Engine, P.M Heldt.
3. Internal Combustion Engines, V.L. Maleeve
4. Internal Combustion Engine, Gills and Smith
5. Internal Combustion Engines, Gupta H N, 2nd ed,
6. Internal Combustion Engine, S.L. Beohar

Back to Scheme

Course Code	Course Name	Credits
AE210	**Theory of Machines & Mechanisms**	3+1

Prerequisites:

1. Engineering Mathematics
2. Engineering Mechanics
3. Engineering Physics

Course Objectives:

1. Understand the fundamentals of kinematics and mechanisms.
2. Analyze mechanisms involving lower pairs.
3. Apply graphical methods for velocity and acceleration analysis in plane mechanisms up to six links.
4. Study the kinematics of cams and followers, flexible connector mechanisms, gears and gear trains, and their applications in machines.
5. Develop problem-solving skills in designing and analyzing mechanisms for various engineering applications.

Course Outcomes:

Upon successful completion of this course, learner will be able to:

1. Calculate the mobility or degree of freedom of plane mechanisms.
2. Identify plane mechanisms and their inversions, and the mechanisms with lower pairs.
3. Compute velocity and acceleration of various links of plane mechanisms by different graphical methods.
4. Analyze velocity ratios and dynamics in belt and rope drives, and determine chain drive kinematics.
5. Analyze the various follower motions and draw the corresponding cam profiles.
6. Understand gear tooth terminology, and analyze the motion of gear trains.

Theory Syllabus:

Module	Details	Hours
1	**Fundamentals of Kinematics and Mechanisms** Concepts of Kinematics and Dynamics, Mechanisms and Machines, Planar and Spatial Mechanisms, Kinematic Pairs, Kinematic Chains, Kinematic Diagrams, Kinematic Inversion. Four bar chain and Slider Crank Mechanisms and their Inversions, Degrees of Freedom, Mobility and range of movement - Kutzbach and Grubler's criterion, Number Synthesis, Grashof's criterion.	06
2	**Mechanisms with Lower Pairs:** Straight line mechanisms - Exact and Straight, Steering gear mechanisms: Condition for correct steering, Davis steering gear mechanism, Ackermann steering gear mechanism. Hooke's joint-Single and Double.	06
3	**Velocity and Acceleration Analysis:** **Instantaneous center of rotation (ICR) method:** Definition of ICR, Types of ICRs, Methods of locating ICRs, Kennedy's Theorem. Velocity analysis of mechanisms (up to 6 links only).	08

	Relative velocity method: Relative velocity of a point on a link, Angular velocity of a link, Sliding velocity, Velocity polygons for simple mechanisms. **Relative acceleration method:** Relative acceleration of a point on a link, Angular acceleration of a link, Acceleration polygons for simple planar mechanisms (up to 6 links only). Coriolis component of acceleration.	
4	**Flexible Power Transmission Systems:** **Belts:** Introduction, Types and all other fundamentals of belting, Dynamic analysis—belt tensions, condition of maximum power transmission. **Chains:** Types of chains, chordal action, variation in velocity ratio, length of chain. **Ropes:** Introduction, Advantages and disadvantages, Types, Velocity ratio and slip, power transmission.	06
5	**Kinematics of Cams:** Types of cams and followers, Cam and follower terminology, displacement, velocity and acceleration diagrams of follower motions viz Uniform velocity, Simple harmonic motion, Uniform acceleration and retardation motion and cycloidal motion.	06
6	**Gears and Gear Trains:** **Gears:** Terminology, Law of Gearing, Characteristics of involute and cycloidal action, Interference and undercutting, centre distance variation, minimum number of teeth, contact ratio, spur, helical, spiral bevel and worm gears, problems. **Gear Trains:** Synthesis of Simple, compound & reverted gear trains, Analysis of epicyclic gear trains.	07

Laboratory Syllabus:

Module	Details	Hours
1	3 to 5 problems on velocity analysis using the ICR method.	04
2	3 to 5 problems on velocity and acceleration analysis using relative velocity and acceleration methods.	04
3	3 to 5 problems on velocity and acceleration analysis using relative velocity and acceleration methods involving Coriolis component.	04
4	Plotting of displacement–time, velocity-time and acceleration-time, jerk-time, and layout of cam profiles - 3 to 5 problems	06
5	Project based learning on design and fabrication of any one mechanism for a group of maximum 4 students.	08

Theory Assessment:
Internal Assessment:
Consisting of Two Compulsory 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). Duration of each test shall be one hour and thirty minutes and would be for 40 marks.

End Semester Examination:

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

1. Question paper will comprise of four 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 three questions need to be solved.

Duration of test will be two hours and would be for 60 marks.

Laboratory Assessment:

Term Work: 25 marks

Students have to submit signed and completed assignments based on the modules listed in the table, as a part of the term work. They can also avail NPTEL Certification for this course, for which the assignment work may be suitably reduced, at the discretion of the instructor.

Viva-você: 25 marks

Viva-você exam shall be conducted at the end of the course.

Books/References:

1. S. S. Rattan, “Theory of Machines”, Tata McGraw Hill
2. R L Norton, Kinematics and Dynamics of Machinery, McGraw-Hill Education
3. Ashok G. Ambekar, “Mechanism and Machine Theory”, Prentice Hall, India
4. Theory of Machines, Singh Sadhu, Pearson Education.
5. Shigley J. E., and Uicker J.J., “Theory of Machines and Mechanism”, McGraw Hill Inc.
6. Wilson C.E., Sandler J. P. Kinematics and Dynamics of Machinery”, Pearson Education.

Back to Scheme

Course Code	Course Name	Credits
AE 211	**Fluid Mechanics & Machinery***	3+1

Course Objectives:

1. To study fluid statics and fluid dynamics
2. To study application of mass, momentum and energy equations in fluid flow.
3. To learn various flow measurement techniques.
4. To study utilization of hydraulic energy

Course Outcomes: Upon successful completion of this course, the learner will be able to

1. Calculate the forces exerted by fluid at rest on submerged surfaces.
2. Apply Bernoulli equation to solve a variety of fluid flow problems.
3. Categorize the type of flow (whether laminar or turbulent) using Reynolds equation.
4. Estimate the loss of energy of the incompressible fluid associated with pipe flow.
5. Compare the impulse and reaction turbine.
6. Classify the pumps into centrifugal and positive displacement pumps.

Theory Syllabus:

Module	Details	Hours
1.	1.1 **Introduction:** Definition of Fluid, Properties of fluid (density, weight density, viscosity, specific gravity). No Numerical. 1.2 Newton's Law of viscosity, Classification of fluid. No Numerical on 1.2. 1.3 **Fluid Statics**: Hydrostatic pressure, Hydrostatic law, Forces on horizontal, vertical and inclined submerged plane.	6
2.	**Fluid Kinematics:** 2.1 Eulerian and Lagrangian approach, Velocity and acceleration in a Eulerian flow field. Classification of the fluid flow, streamlines, path lines and streak lines. 2.2 Definition and equations for stream function, velocity potential function, potential flow, vortex flow. No numerical on 2.2.	6
3.	**Fluid Dynamics:** Definition of control volume and control surface, Differential equations for conservation of mass, energy and momentum, Euler's equations in one and three dimensions. Derivation of Bernoulli's equation from principle of conservation of energy. Application of Bernoulli's equation in flow measurement device (pitot tube, venturimeter, orifice meter). Impulse momentum equation (Numerical on bent pipe only).	7
4.	**4.1 Laminar Viscous flow**: Introduction to Reynolds number, Derivation of relationship between shear stress and pressure gradient, Laminar flow between stationary parallel plates (only derivation), Laminar flow in circular pipe (Hagen-Poiseuille flow). **4.2 Flow through pipes**:	6

	Head loss in pipes due to friction (Darcy-Weisbach equation without proof), Loss of energy in pipe (major and minor losses), Hydraulic gradient and Energy gradient line, Pipes in series and parallel. **4.3 Hydrodynamic Boundary Layer Theory:** Concept of formation of boundary layer, boundary layer parameters. (No Numerical) **4.4 Flow around submerged objects:** Concept of drag and lift, Types of drag, Streamlined and bluff bodies. (No Numerical)	
5.	**Hydraulic Turbines:** General layout of hydro-electric power plant. Classification of hydraulic turbines, definition of various turbine parameters like head, Euler head, discharge, work done, input power, output power, efficiency, schematic representation of losses in turbine. 5.1 Pelton Turbine: Components, construction, working, workdone and efficiency, velocity triangle, Calculation of velocity of jet, speed ratio, jet ratio, number of jets, head, power and efficiency. 5.2 Francis Turbine: Components, construction and working, velocity diagram and numerical, Draft tube and its function.	7
6.	**Pumps** 6.1 Detailed classification of Pump, applications. 6.2 Reciprocating pumps: operating principle of reciprocating pump, Different types of head, discharge coefficient, slip. Calculation of work done and power input, concept of indicator diagram. 6.3 Centrifugal Pumps: Different types of head, Euler's equation and velocity triangles, pump losses and efficiency, Priming of pumps, Concept of NPSH (No Numerical) 6.4 Concept of multistage pump (No Numerical)	7

Laboratory Syllabus:

Any 8 of the following to be performed.

Sr. No.	Details	Hours
1	Calibration of Pressure gauge	2
2	Calibration of Venturimeter	2
3	Calibration of Orifice meter	2
4	Determination of Friction factor for pipes	2
5	Determination of Minor losses in pipe fittings	2
6	Verification of Bernoulli's equation	2
7	Trial on Pelton Wheel	2
8	Trial on Francis turbine	2
9	Trial on positive displacement pump (reciprocating/Gear pump/Vane pump/screw pump) (any one)	2
10	Trial on single stage Centrifugal pump	2

Theory Assessment:

Internal Assessment:

Consisting of Two Compulsory 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). Duration of each test shall be one hour and thirty minutes and would be for 40 marks.

End Semester Examination:

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

1. Question paper will comprise of four 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 three questions need to be solved.

Duration of test will be two hours and would be for 60 marks

Laboratory Assessment:

Internal Assessment

Term Work Marks: 25 Marks

Laboratory Work (Journal Completion) : 20 Marks
Attendance : 5 Marks

End Semester Practical/Oral Examination:

Pair of Internal and External Examiners should conduct practical/viva based on contents.
Distribution of marks for practical/viva examination shall be as follows:

Practical Examination : 15 Marks
Oral Examination : 10 Marks

Books/References:

1. Fluid Mechanics by Yunus A Cengel and John M Cimbala, Tata McGraw Hill Education, 3rd Edition, 2014.
2. Fluid Mechanics and Machinery by C S P Ojha, Chandramouli and R Berndtsson, Oxford University Press, 1st Edition, 2010.
3. Fox and McDonald's Introduction to Fluid Mechanics by Philip J. Pritchard and John W. Mitchell, Wiley Publishers, 9th Edition,2016.
4. A textbook of Fluid Mechanics & Hydraulic machines by R K Bansal, Laxmi Publication, 9th Edition, 2005
5. A textbook of Fluid Mechanics & Hydraulic machines by R K Rajput, S. Chand & company ltd Laxmi Publication, 4th Edition, 2010
6. Fluid Mechanics by Frank M. White, McGraw Hill Education, 7th Edition, 2011.
7. Fluid Mechanics by Victor Streeter, Benjamin Wylie and K W Bedford, McGraw Hill Education, 9thEdition, 2010.
8. Engineering Fluid Mechanics by K. L. Kumar, Eurasia Publishing House (P) Ltd, 1 st Edition and Reprint 2016.
9. Fluid Mechanics and Hydraulic Machinery, Modi and Seth, Standard Book House
10. Introduction to Fluid Mechanics by James A. Fay, MIT Press, Campbridge, 1st Edition, 1996.
11. Fluid Mechanics and Hydraulics by Suresh Ukarande, Ane Books Pvt.Ltd, Revised & Updated 1st Edition, 2016

Back to Scheme

Course Code	Course Name	Credits
AE212	**Elements of Machine Design**	3+1

Course 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

Course Outcomes: After completion of this course, 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	Hours
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. Introduction to Reliability and DFMEA	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.	08
3	**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
4	**Design of Shafts** power transmission and power distribution shafts, under static criteria and using ASME code. **Keys** Types of Keys and their selection based on shafting condition Design of splines **Couplings** Classification of coupling; Design of Flange couplings and Bush pin type flexible couplings.	10

5	**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
6	**Design of Springs** Helical compression spring under Static and Variable loads; Design of leaf Springs	05

Laboratory Syllabus:

Any 8 of the following to be performed

Sr. No.	Details	Hours
1	Design of Cotter joint	2
2	Design of Knuckle joint	2
3	Design of Turnbuckle	2
4	Design of power screw	2
5	Design of Flange Coupling	2
6	Design of Bush Pin type Flexible coupling	2
7	Design of single stage Gearbox (Spur Gear type)	2
8	Design of single stage Gearbox (Helical Gear type)	2
9	Design of Helical springs	2
10	Design of Leaf springs	2

Assessment:

Internal Assessment:

Consisting Two Compulsory 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). Duration of each test shall be one hour and thirty minutes and 40 marks.

End Semester Examination:

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

1. Question paper will comprise of four 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 three questions need to be solved.
5. Duration of test will be two hours and of 60 marks

Laboratory Assessment:
Internal Assessment
Term Work Marks: 25 Marks

Laboratory Work (Journal Completion)	: 20 Marks
Attendance	: 5 Marks

End Semester Practical/Oral Examination:
Pair of Internal and External Examiners should conduct practical/viva based on contents.
Distribution of marks for practical/viva examination shall be as follows:

Practical Examination	: 15 Marks
Oral Examination	: 10 Marks

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

Reference Books:

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

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Course Code	Course Name	Credits
AE213	**Engineering Mathematics IV***	2

Course Objectives:

The course is aimed.

1. To Learn the concepts of probability, random variables,

2. To Learn the concepts of probability distribution & expectation.

3. To Learn the various probability distributions.

4. To Learn the concepts of sampling theory.

5. To learn the partial differential equations and Analytical methods to solve it which are used in engineering problems.

6. To learn numerical methods to solve the partial differential equations which are used in engineering problems.

Course Outcomes:

On successful completion of course learner/student will be able to:

1. Able to solve examples of probability & random variables & apply the concepts of probability & random variables.

2. Able to solve examples of probability distribution and expectation for decision making & apply the concepts of probability distribution and expectation for decision making..

3. Able to solve examples of various probability distributions & apply various probability distributions in data science.

4. Able to solve examples of sampling theory & apply the concept of sampling theory in data science.

5. Able to solve examples of analytical methods to solve partial differential equations & apply the analytical methods to find the solution of Mathematical Models of real-life problems, engineering problems.

6. Able to solve examples of the numerical methods to solve partial differential equations & apply the numerical methods to find the solution of Mathematical Models of real-life problems, engineering problems.

Module	Details	Hours
1	**Probability Theory** **1.1** Introduction to probability, 1.2 Conditional probability, 1.3 Total Probability 1.4 Baye's Theorem.	4
2	**Probability Distribution - I** 2.1 Discrete and Continuous random variables, 2.2 Probability mass and density function, 2.3 Probability distribution for random variables, 2.4 Expectation, Variance, Co-variance .	4
3	**Probability Distribution – II** 3.1 Binomial distribution, 3.2 Poisson distribution, 3.3 Normal distribution .	4

4	**Sampling Theory-** 4.1 Sampling distribution, Test of Hypothesis, Level of Significance, Critical region, 4.2 One-tailed, and two-tailed test, Degree of freedom. 4.3 Students' t-distribution (Small sample)- Test the significance of single sample mean 4.4 Test the significance of sample means of two independent sample means (paired t-test) .	5
5	**Partial Differential Equations : Analytical methods** 5.1 Introduction of Partial Differential equations Classification 5.2 Method of separation of variables to solve the problem of Vibrations of string, 5.3 One dimensional heat and wave equations.	3
6	**Partial Differential Equations** : **Numerical methods** : 6.1 Numerical methods to solve PDE 6.2 Bender Schmidt scheme 6.3 Simplified Crank Nicholson scheme.	6

Assessment:

Internal Assessment Test:

Assessment consists of class tests of 30 marks each. The IA1 is to be conducted when approx. 40% syllabus is completed and IA2 marks shall be an average of six assignments', advised to be conducted during tutorials, marks , one assignment on each of the six modules separately for 30 marks .

End Semester Theory Examination:

1. Question paper will comprise of total 4 questions, each carrying 15 marks.
2. Total 03 questions need to be solved.
3. Question No: 01 will be compulsory and based on the entire syllabus wherein

   5 sub-questions of 3 marks each will be asked.
4. Remaining questions will be randomly selected from all the modules.
5. Weightage of each module will be proportional to number of respective lectures mentioned in the syllabus.

References:

1. Higher Engineering Mathematics, Dr.B.S.Grewal, Khanna Publication
2. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley EasternLimited, 9thEd.
3. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication,
4. Probability, Statistics and Random Processes, T. Veerarajan, McGraw-Hill education
5. Advanced Engineering Mathematics H.K. Das, S. Chand, Publications
6. Matrices, Shanti Narayan, S. Chand publication.
7. Introductory Methods of Numerical Analysis, S. S. Sastry, Prentice-Hall of India Private Limited.

Recommended NPTEL Courses :
Students can choose any two of the following SWAYAM-NPTEL courses advised as follows :
1. One of the recommended NPTEL courses from Sr. No. 1 to Sr. No. 5
2. One of the recommended NPTEL courses from Sr. No. 6 to Sr. No. 8

1) Introduction to probability and Statistics
By Prof. G. Srinivasan | IIT Madras
Link : https://onlinecourses.nptel.ac.in/noc25_mg35/preview

2) Probability and Statistics
By Prof. Somesh Kumar | IIT Kharagpur
Link : Link : https://onlinecourses.nptel.ac.in/noc25_ma49/preview

3) Biostatistics and Design of experiments
By Prof. Mukesh Doble | IIT Madras
Link : https://onlinecourses.nptel.ac.in/noc25_bt10/preview

4) Engineering Statistics
By Prof. Manjesh Kumar Hanawal | IIT Bombay
Link : https://onlinecourses.nptel.ac.in/noc25_ge10/preview

5) Essentials of Data Science With R Software-1: Probability and Statistical Inference
By Prof. Shalabh | IIT Kanpur
Link : https://onlinecourses.nptel.ac.in/noc25_ma20/preview

6) Partial Differential Equations (PDE) For Engineers: Solution By Separation Of Variables
By Prof. Sirshendu De | IIT Kharagpur
Link : https://onlinecourses.nptel.ac.in/noc25_ma46/preview

7) First Course on Partial Differential Equations - I
By Prof. P.S. Datti, Prof. A. K. Nandakumaran | IISc Bangalore
Link : https://onlinecourses.nptel.ac.in/noc25_ma22/preview

8) Ordinary and Partial Differential Equations and Applications
By Prof. P. N. Agarwal, Prof. D. N. Pandey | IIT Roorkee
Link : https://onlinecourses.nptel.ac.in/noc25_ma45/preview.

Course Code	Course Name	Credits
AE214	**Data Science**	2

Course Objectives:

1. To introduce students to the fundamental concepts of Data Science and its real-world applications.
2. To provide hands-on experience with R and R Studio for data analysis and visualization.
3. To familiarize students with essential statistical and probability concepts used in data analysis.
4. To teach data cleaning, transformation, and preprocessing techniques for effective data management.
5. To develop an understanding of basic machine learning models, including regression and clustering techniques.
6. To equip students with skills to evaluate and interpret data models for informed decision-making.

Course Outcomes: Upon successful completion of this course, the learner will be able to

1. Recognize the importance and applications of Data Science in various domains.
2. Utilize R programming to manipulate, analyze, and visualize data efficiently.
3. Apply statistical concepts and probability distributions in data analysis tasks.
4. Perform data cleaning, handling missing values, and implementing transformations to prepare data for analysis.
5. Develop and implement basic machine learning models such as Linear Regression, Logistic Regression, and K-Means Clustering.
6. Evaluate and interpret the performance of classification and clustering models using appropriate metrics.

Module	Details	Hours
1.	**Introduction to Data Science** What is Data Science, Importance of Data science, Data science project roles, Understanding the stages of a data science project, Application, Various programming tools to perform data analysis	02
2.	**Fundamentals of R** Installation of R & R Studio, Getting started with R Script, Basic & advanced data types in R, Variable operators in R, R functions and loops, Creating Data frames, Exploring data frames, Accessing columns in a Data frame, Reading a CSV text file, Removing rows and columns, Renaming rows and columns, sorting and merging data frames.	08
3.	**Data visualization** Need for data visualization, Components of data visualization, Visually checking distributions for a single variable, Visually checking relationships between two variables, Introduction to grammar of graphics, Using the ggplot2 package in R to create visualizations	06
4.	**Basics of Statistics & Probability** Mean, Median, Mode, Variance, Standard Deviations, Skewness, Standard probability distributions: Binomial, Normal etc., Central Limit Theorem, Hypothesis testing, Significance levels & P-Value, statistical tests : t-test, chi-square test, paired t-test, ANOVA	08

5.	**Data Managing** **Cleaning :** Needs & methods of data preparation, Handling missing values, Imputation Methods, Outlier treatment, Transformation, Modifying data with Base R, Data processing with dplyr package **Sampling for modeling and validation:** Test and training splits	06
6.	**Modelling :** Linear Regression, Logistic Regression, K-Means Clustering **Evaluating models :** Evaluating classification models, Evaluating clustering models	08

Assessment:
Lab Assessment:
Term Work: (25 Marks)
The distribution of marks for Term work shall be as follows:
Experiment write ups : 20 Marks
Attendance : 05 marks
Practical/Oral examination (50 Marks)
To be conducted by pair of Internal and External Examiner The distribution of marks for practical examination shall be as follows:
Practical Exam : 30 marks
Oral Exam : 20 marks

Books/References:

1. R for Data Science, Hadley Wickham, Garrett Grolemund, O'Reilly Media.
2. Hands-On Programming with R, Garrett Grolemund, O'Reilly Media.
3. Any digital resources and online guides for R or its packages.

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Course Code	Course Name	Credits
AE 292	**Minor Project II**	2

Course 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.

Course Outcomes: 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 a 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 Minor 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 surveys and identify needs, which shall be converted into a problem statement for minor-project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Student groups shall submit an implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of the minor project.
- A log book has to be prepared by each group, wherein the group can record weekly work progress, and the guide/supervisor can verify and record notes/comments.
- Faculty supervisors may give inputs to students during minor project activity; however, focus shall be on self-learning.
- Students in a group shall understand the problem effectively, propose multiple solutions and select the best possible solution in consultation with the guide/supervisor.
- Students shall convert the best solution into a working model using various components of their domain areas and demonstrate.
- The solution has to be validated with proper justification and the report has to be compiled in the standard format.
- With the focus on self-learning and innovation, addressing societal problems and entrepreneurship quality development within the students through the Minor Projects, it is preferable that a single project of appropriate level and quality be carried out in two semesters by all the groups of the students. i.e. Minor Project 1 in semester III and IV. Similarly, Minor Project 2 in semesters V and VI may be considered. In other words, based on the individual students' or group's capability, with the mentor's recommendations, if the proposed Minor 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 Minor Project, in even semester with suitable improvements/modifications.

- Alternatively, student groups can work completely on a new project idea in the even semester, bearing no resemblance with the topic of odd semester. This policy can be adopted on a case to case basis.

Guidelines for Assessment of Minor Project –Continuous assessment and Term Work:

- The review/ progress monitoring committee shall be constituted by heads of departments of each institute. The progress of the minor project to be evaluated on a continuous basis, Minimum two reviews in each semester- 25 marks.
- 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:
  Quality of project report and presentation- 25 marks

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 the first semester the entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on the presentation given by the student group.
  - If the problem is based on development of a mechanism or a simple device for attaining a desired objective, the first presentation shall be reviewed based on generation of multiple feasible solutions to the given problem and identification of the best possible solution based on various parameters which may include one of more of the following viz., the total weight, volume, power consumption, mechanical advantage, efficiency, cost (including labour) per piece once manufactured, and so on. This may include creation of unique free-hand sketches by each and every member of the group to contribute to the solution of the given problem. The best possible solution has to be finalized during one or more brainstorming sessions by the members of the student group. In case the problem is of a programming/coding type, then the first presentation may be dedicated to the understanding of the theory behind the problem related to a particular domain subject, including the drafting of an algorithm and/or flowchart, and may also include the introductory part of the programming.
  - Second review shall be based on the computerization (3D CAD model of parts and assembly), and possibly the animation, depicting the working characteristics of the proposed solution to the given problem, allocating material properties to each part, identifying mass properties of the assembled parts, and so on. Checking interference is one of the important criteria that can be used when assembling the parts. For software based projects, this may include the presentation based on the extension of the programming work so as to cover the major portion of the remaining part of the topic.
- In the second semester expected work shall be procurement of components/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester. For those selecting software based projects, this may include completing the other half of the programming related work, identifying the errors, optimizing the software code, customization, creating a graphical user interface of input and output (GUI), displaying output data in the form of graphs/tables/figures/diagrams, creation of the code in executable (.exe) format or in the form of a mobile App, etc.
  - First review shall be conducted based on the readiness of the working prototype, or

programming of the remaining code for software based projects.
  - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester. This may also include the testing and validation of tests with the literature/available data/theory. For software based projects, the presentation includes the remaining work other than the programming, as described above.
- Apart from the hardware type (development of device) and software (program/coding) type of projects, the topics may also include computer based work, viz., generation of virtual laboratory (for one or more experiments) for any subject/domain of choice, or CAD modeling, analysis, optimization, and/or product design, without any relevance to developing any physical product.

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 solutions.

Assessment criteria of Minor Project:

1. Quality of survey/need identification
2. Clarity of problem definition based on need
3. Innovativeness/uniqueness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness/uniqueness
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 as member or leader
13. Clarity in written and oral communication

- In a **one year project**, the first semester evaluation may be based on the first six criteria as highlighted above and the remaining criteria may be used for second semester evaluation of performance of students in the minor project.
- In the case of a half year project, all criteria in general may be considered for evaluation of performance of students in the minor project.

Guidelines for Assessment of Minor Project - Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the Department.
- Minor project shall be assessed through a presentation and demonstration of working model or the execution of programme code 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 the Head of Institution.
- Students shall be motivated to publish a paper based on the work in conferences or student competitions.

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