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 2021-22

First Year - Effective from Academic Year **2021-22**

Second Year - Effective from Academic Year **2022-23**

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

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

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 162 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	6
Basic Science courses	22
Engineering Science courses including workshop, drawing, basics of electrical/mechanical/computer etc	22
Professional core courses	66
Professional Elective courses relevant to chosen specialization/branch	18
Open subjects – Electives from other technical and /or emerging subjects	9
Project work, seminar and internship in industry or elsewhere	20
Mandatory Courses - Environmental Sciences, Induction training, Indian Constitution, Essence of Indian Traditional Knowledge	Non credit
Human Values	2
Total Credits	**162**

Program Structure for
Bachelor of Technology in Automobile Engineering
Semester I

Course Code	Course Name	Course Component	Teaching Scheme (Contact Hours)		Credits Assigned		
			Theory	Pract.	Theory	Pract.	Total
AE 101	Engineering Mathematics I	TLP	3	2	3	1	4
AE 102	Engineering Physics I	TL	2	1	2	0.5	2.5
AE 103	Engineering Chemistry I	TL	2	1	2	0.5	2.5
AE 104	Engineering Mechanics	TL	3	2	3	1	4
AE 105	Basic Electrical and Electronics Engineering	TL	3	2	3	1	4
AE 106	Engineering Workshop	L	-	3	-	1.5	1.5
Total			**13**	**11**	**13**	**5.5**	**18.5**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		1	2	Avg.					
AE 101	Engineering Mathematics I	40	40	40	60	2	25	-	125
AE 102	Engineering Physics I	30	30	30	45	2	25	-	100
AE 103	Engineering Chemistry I	30	30	30	45	2	25	-	100
AE 104	Engineering Mechanics	40	40	40	60	2	25	25	150
AE 105	Basic Electrical and Electronics Engineering	40	40	40	60	2	25	25	150
AE 106	Engineering Workshop	-	-	-	-	-	50	-	50
Total									**675**

T- Theory, L- Lab, P-Programming, C- Communication

Program Structure for
Bachelor of Technology in Automobile Engineering

Semester II

Course Code	Course Name	Course Component	Teaching Scheme (Contact Hours)		Credits Assigned		
			Theory	Pract.	Theory	Pract.	Total
AE 107	Engineering Mathematics II	TLP	3	2	3	1	4
AE 108	Engineering Physics II	TL	2	1	2	0.5	2.5
AE 109	Engineering Chemistry II	TL	2	1	2	0.5	2.5
AE 110	Engineering Drawing	TL	3	2	3	1	4
AE 111	Programming with Python	LP	0	4	0	2	2
AE 112	Professional Communication & Ethics I	TLC	1	2	1	1	2
AE 113	Machine Shop Practice	L	-	3	-	1.5	1.5
Total			**12**	**13**	**12**	**6.5**	**18.5**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract./ Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs.)			
		1	2	Avg.					
AE 107	Engineering Mathematics II	40	40	40	60	2	25	-	125
AE 108	Engineering Physics II	30	30	30	45	2	25	-	100
AE 109	Engineering Chemistry II	30	30	30	45	2	25	-	100
AE 110	Engineering Drawing	40	40	40	60	3	25	25	150
AE 111	Programming with Python	-	-	-	-	-	50	25	75
AE 112	Professional Communication and Ethics I	20	20	20	30	1	25	-	75
AE 113	Machine Shop Practice	-	-	-	-	-	50	-	50
Total									**675**

T- Theory, L- Lab, P-Programming, C- Communication

Program Structure for
Bachelor of Technology in Automobile Engineering
Semester III

Course Code	Course Name	Course Component	Teaching Scheme (Contact Hours)		Credits Assigned		
			Theory	Pract.	Theory	Pract.	Total
AE 201	Production Technology	T	3	-	3	-	3
AE 202	Engineering Mathematics III*	T	3	1	3	1	4
AE 203	Strength of Materials*	TL	3	2	3	1	4
AE 204	Thermodynamics*	T	3	-	3	-	3
AE 205	Engineering Metallurgy and Automotive Materials	TL	3	2	3	1	4
AE 206	Computer Aided Drafting	L	-	2	-	1	1
AE 207	CNC and Additive Manufacturing Lab	LP	-	2	-	1	1
AE 291	Minor Project I	LC	-	4	-	2	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 201	Production Technology	40	40	40	60	2	-	-	100
AE 202	Engineering Mathematics III*	40	40	40	60	2	25	-	125
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 291	Minor Project I	25 (Mid Sem assessment)					25	25	75
Total									**800**

T- Theory, L- Lab, P-Programming, C- Communication
*** - Common with B.Tech in Mechanical Engineering**

Program Structure for
Bachelor of Technology in Automobile Engineering
Semester IV

Course Code	Course Name	Course Component	Teaching Scheme (Contact Hours)		Credits Assigned		
			Theory	Pract.	Theory	Pract.	Total
AE 208	Automotive Engines & Combustion	TL	3	2	3	1	4
AE 209	Theory of Machines & Mechanisms*	TL	3	2	3	1	4
AE 210	Fluid Mechanics & Machinery*	TL	3	2	3	1	4
AE 211	Elements of Machine Design	T	3	-	3	-	3
AE 212	Human Values and Social Ethics*	T	2	-	2	-	2
AE 213	Data Science	LP	-	4	-	2	2
AE 292	Minor Project II	LC	-	4	-	2	2
Total			**14**	**14**	**14**	**7**	**21**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs.)			
		1	2	Avg.					
AE 208	Automotive Engines & Combustion	40	40	40	60	2	25	25	150
AE 209	Theory of Machines & Mechanisms*	40	40	40	60	2	25	25	150
AE 210	Fluid Mechanics & Machinery*	40	40	40	60	2	25	25	150
AE 211	Elements of Machine Design	40	40	40	60	2	-	-	100
AE 212	Human Values and Social Ethics*	-	-	-	-	-	50	-	50
AE 213	Data Science	-	-	-	-	-	50	25	75
AE 292	Minor Project II	25 (Mid Sem assessment)					25	25	75
Total									**750**

T- Theory, L- Lab, P-Programming, C- Communication

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

Program Structure for
Bachelor of Technology in Automobile Engineering
Semester V

Course Code	Course Name	Course Component	Teaching Scheme (Contact Hours)		Credits Assigned		
			Theory	Pract.	Theory	Pract.	Total
AE 301	Finite Element Analysis*	TL	3	2	3	1	4
AE 302	Heat Transfer*	TL	3	2	3	1	4
AE 303	Automotive Systems	TL	3	2	3	1	4
AE 304	Controls Engineering and Model based Systems	TLP	3	2	3	1	4
AE 3xx	Department Elective I	T	3	-	3	-	3
AE 391	Minor Project III	LC	-	4	-	2	2
Total			**15**	**12**	**15**	**6**	**21**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract./Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		1	2	Avg.					
AE 301	Finite Element Analysis*	40	40	40	60	2	25	25	150
AE 302	Heat Transfer*	40	40	40	60	2	25	25	150
AE 303	Automotive Systems	40	40	40	60	2	25	25	150
AE 304	Controls Engineering and Model based Systems	40	40	40	60	2	25	25	150
AE 3xx	Department Elective I	40	40	40	60	2	-	-	100
AE 391	Minor Project III	25 (Mid Sem assessment)					25	25	75
Total									**775**

T- Theory, L- Lab, P-Programming, C- Communication
*** - Common with B.Tech in Mechanical Engineering**

Group	Department Specialization	Course Code	DLOC I
1	Electric Vehicles	AE 305	Electrical Machines
2	Additive Manufacturing	AE 306	CAD for Additive Manufacturing
3	Motorsports Engineering	AE 307	Material Selection and Manufacturing

Program Structure for
Bachelor of Technology in Automobile Engineering
Semester VI

Course Code	Course Name	Course Component	Teaching Scheme (Contact Hours)		Credits Assigned		
			Theory	Pract.	Theory	Pract.	Total
AE 308	Automotive Body and Chassis Systems	TLP	3	2	3	1	4
AE 309	Automotive Vibrations	TL	3	2	3	1	4
AE 310	Professional Communication & Ethics II	TLC	1	2	1	1	2
AE 3xx	Department Elective II	T/TL	3	-	3	-	3
AE 3xx	Department Elective III	T/TL	3	-	3	-	3
IL 3xx	Institute Elective I	T	3	-	3	-	3
AE 392	Major Project I	LC	-	6	-	3	3
Total			**16**	**12**	**16**	**6**	**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 308	Automotive Body and Chassis Systems	40	40	40	60	2	25	25	150
AE 309	Automotive Vibrations	40	40	40	60	2	25	25	150
AE 310	Professional Communication & Ethics II	-	-	-	-	-	50	-	50
AE 3xx	Department Elective II	40	40	40	60	2	-	-	100
AE 3xx	Department Elective III	40	40	40	60	2	-	-	100
IL 3xx	Institute Elective I	40	40	40	60	2	-	-	100
AE 392	Major Project I						25	50	75
Total									**725**

T- Theory, L- Lab, P-Programming, C- Communication

For an elective which has a laboratory associated, the examination scheme will have additional 25 marks of termwork and that would be a continuous evaluation.

Semester VI

Group	Department Specialization	Course Code	DLOC II
1	Electric Vehicles	AE 311	Power Electronics (TL)
2	Additive Manufacturing	AE 312	Additive Manufacturing in Biomedical application (T)
3	Motor Sports Engineering	AE 313	Race Car Designing (TL)
		AE 314	Electronics in Race Cars (TL)

Group	Department Specialization	Course Code	DLOC III
4	Transportation	AE 315	Fundamentals of Transportation Engineering (T)
		AE 316	Motor Vehicles Acts & Loss Assessments (T)
5	Supply Chain Management & Logistics	AE 317	Supply Chain Management (T)
		AE 318	Production and Operations Management (T)
6	Automotive Designing	AE 319	Concept Sketching, Rendering and Modeling (TL)
7	Autonomous Vehicles	AE 320	Introduction to Self-Driving Cars (T)

Group	Institute Specialization	Course Code	ILOC I
1	Business and Entrepreneurship	IL 360	Entrepreneurship
		IL 361	IPR and Patenting
2	Bio Engineering	IL 362	Introduction to Bioengineering
3	Engineering Design	IL 363	Product Design
4	Art and Humanities	IL 364	Visual Art
		IL 365	Journalism, Media and Communication Studies
5	Applied Science	IL 366	Computational Physics
		IL 367	Polymers and Polymeric Materials
6	Life Skills, Repair, Maintenance and Safety	IL 368	Vehicle Safety
		IL 369	Maintenance of Electronics Equipment

Program Structure for
Bachelor of Technology in Automobile Engineering
Semester VII

Course Code	Course Name	Course Component	Teaching Scheme (Contact Hours)		Credits Assigned		
			Theory	Pract.	Theory	Pract.	Total
AE 401	Hybrid and Electric Vehicles	TL	3	2	3	1	4
AE 402	Vehicle Dynamics	TL	3	2	3	1	4
AE 4xx	Department Elective IV	T/TL	3	-	3	-	3
AE 4xx	Department Elective V	T/TL	3	-	3	-	3
IL 4xx	Institute Elective II	T	3	-	3	-	3
AE 491	Major Project II	LC	-	8	-	4	4
Total			**15**	**12**	**12**	**6**	**21**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs.)			
		1	2	Avg.					
AE 401	Hybrid and Electric Vehicles	40	40	40	60	2	25	25	150
AE 402	Vehicle Dynamics	40	40	40	60	2	25	25	150
AE 4xx	Department Elective IV	40	40	40	60	2	-	-	100
AE 4xx	Department Elective V	40	40	40	60	2	-	-	100
IL 47x	Institute Elective II	40	40	40	60	2	-	-	100
AE 491	Major Project II	-					50	50	100
Total									**700**

T- Theory, L- Lab, P-Programming, C- Communication

For an elective which has a laboratory associated, the examination scheme will have additional 25 marks of termwork and that would be a continuous evaluation.

Semester VII

Group	Department Specialization	Course Code	DLOC IV
1	Electric Vehicles	AE 403	Automotive Embedded Systems (T)
2	Additive Manufacturing	AE 404	Automotive Product Design and Development (T)
3	Motor Sports Engineering	AE 405	Race Car Dynamics (T)
		AE 406	Simulation of Racing Cars (TL)

Group	Department Specialization	Course Code	DLOC V
4	Transportation	AE 407	Spatial Mapping Techniques (T)
		AE 408	Mass Transport Systems (T)
5	Supply Chain Management & Logistics	AE 409	Procurement and Materials Management (T)
		AE 410	Logistics and Distribution management (T)
6	Automotive Designing	AE 411	Aesthetics and Ergonomics (T)
7	Autonomous Vehicles	AE 412	Image and Video Processing (TL)
		AE 413	Multi Object Tracking in Self-Driving Cars (T)

Group	Institute Specialization	Course Code	ILOC II
1	Business and Entrepreneurship	IL 470	E commerce and E business
		IL 471	Business Analytics
2	Bio Engineering	IL 472	Biomedical Instrumentation
3	Engineering Design	IL 473	Design for sustainability
4	Art and Humanities	IL 474	Political Science
5	Applied Science	IL 475	Research Methodology
6	Life Skills, Repair, Maintenance and Safety	IL 476	Maintenance of Mechanical Equipment
		IL 477	Cooking and Nutrition

Program Structure for
Bachelor of Technology in Automobile Engineering
Semester VIII

Course Code	Course Name	Course Component	Teaching Scheme (Contact Hours)		Credits Assigned		
			Theory	Pract.	Theory	Pract.	Total
AE 414	Personal Financial Management	T	2	-	2	-	2
AE 4xx	Department Elective VI	T/TL	3	-	3	-	3
IL 4xx	Institute Elective III	T	3	-	3	-	3
AE 492	Major Project III	LC	-	4	-	2	2
AE 493	Internship*	LC	-	-	-	8	8
Total			**8**	**4**	**8**	**10**	**18**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract./ Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs.)			
		1	2	Avg.					
AE 414	Personal Financial Management	20	20	20	40	2	-	-	60
AE 4xx	Department Elective VI	40	40	40	60	2	-	-	100
IL 48x	Institute Elective III	40	40	40	60	2	-	-	100
AE 492	Major Project III	-	-	-	-	-	25	-	25
AE 493	Internship	-	-	-	-	-	200	-	200
Total									**485**

T- Theory, L- Lab, P-Programming, C- Communication
*** - Six months internship to be undertaken by the student during the semester**

Semester VIII

Group	Department Specialization	Course Code	DLOC VI
4	Transportation	AE 415	Refrigeration and Air Conditioning (T)
5	Supply Chain Management & Logistics	AE 416	Quality Management (T)
6	Automotive Designing	AE 417	ARVR in Automobiles (TL)
		AE 418	Visual Communication & Digital Publishing (TL)
7	Autonomous Vehicles	AE 419	Decision making in Self Driving Cars (T)
		AE 420	Artificial Neural Networks (TL)

Group	Institute Specialization	Course Code	ILOC III
1	Business and Entrepreneurship	IL 480	Digital Business Management and Digital Marketing (T)
2	Bio Engineering	IL 481	Medical Image Processing (T)
3	Engineering Design	IL 482	Technologies for Rural Development (T)
4	Art and Humanities	IL 483	Economics (T)
5	Applied Science	IL 484	GIS and Remote Sensing (T)
6	Life Skills, Repair, Maintenance and Safety	IL 485	Physical Education (T)
		IL 486	Environmental Management (T)

Semester	I	II	III	IV	V	VI	VII	VIII	Total Credits
Credits	18.5	18.5	22	21	21	22	21	18	162
Grand Total of Credits									162

Department Specializations at a glance:

Minimum**Two** to be completed (Minimum**Three** subjects from each.)

Department Specializations						
1	**2**	**3**	**4**	**5**	**6**	**7**
Electric Vehicles	***Additive Manufacturing***	***MotorSports Engineering***	***Transportation***	***Supply Chain Management and Logistics***	***Automotive Designing***	***Autonomous Vehicles***
Electrical Machines (T)	CAD for Additive Manufacturing(T)	Material Selection and Manufacturing (T)	Fundamentals of Transportation Engineering(T)	Supply Chain Management (T)	Concept Sketching, Rendering and Modelling (TL)	Introduction to Self-Driving Cars (T)
Power Electronics (TL)	AM in Biomedical applications(T)	Race Car Designing(T)	Motor Vehicles Acts & Loss Assessments (T)	Production and Operations Management (T)	Aesthetics and Ergonomics (T)	Image and Video processing (TL)
Automotive Embedded Systems (T)	Automotive Product Design and Development (T)	Electronics in Race cars (TL)	Spatial Mapping Techniques (T)	Procurement and Materials Management (T)	ARVR in Automobiles (TL)	Multi Object Tracking in self-driving cars(T)
		Race Car Dynamics(T)	Mass Transport Systems (T)	Logistics and Distribution management (T)	Visual Communication & Digital Publishing (TL)	Decision making in Self Driving Cars (T)
		Simulation of Racing Cars (TL)	Refrigeration and Air Conditioning (T)	Quality Management (T)		Artificial Neural Networks (TL)

Institute Specializations at a glance:
Minimum**One** to be completed (Minimum**Two** subjects from each.)

Institute Specializations					
1	**2**	**3**	**4**	**5**	**6**
Business and Entrepreneurship	***Bio Engineering***	***Engineering Design***	***Art and Humanities***	***Applied Science***	***Life Skills, Repair, Maintenance and Safety***
Entrepreneurship	Introduction to Bioengineering	Product Design	Visual Art	Computational Physics	Vehicle Safety
IPR and Patenting	Biomedical Instrumentation	Design for sustainability	Journalism, Media and Communication studies	Polymers and Polymeric Materials	Maintenance of Electronics Equipment
e- Commerce and e-Business	Medical Image Processing	Technologies for Rural Development	Political Science	Research Methodology	Maintenance of Mechanical Equipment
Business analytics	----	---	Economics	GIS and Remote Sensing	Cooking and Nutrition

Course Code	Course Name	Credits
AE 101	**Engineering Mathematics I**	3+1

Course Objectives: The course is aimed

1. To develop the basic Mathematical skills of engineering students that are imperative for effective understanding of complex numbers and acquaint students with the hyperbolic, logarithmic functions in engineering subjects.
2. To understand the regression analysis and interpolation methods.
3. To understand differentiation and expansions of functions. which will serve as basic tools for specialized studies in many fields of engineering and technology.
4. To learn the partial differentiation techniques and its applications used in engineering problems.
5. To learn the applications of Matrices and eigenvalues and eigenvectors useful in engineering.
6. To provide hands on experience using SCILAB software to handle Mathematical modelling.

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

1. Apply the basic concept of complex numbers, Hyperbolic and logarithmic functions used to solve problems in engineering.
2. Apply the concept of regression and interpolation in engineering problems.
3. Apply the concept of expansion of functions and successive differentiation.
4. Use the basic concepts of partial differentiation in finding the Maxima and Minima required in engineering problems.
5. Use the concept of matrices in solving the system of equations and eigen values in many areas of research.
6. Apply the concept of numerical Methods for solving the engineering problems with the help of SCILAB software.

Theory Syllabus:

Module	Details	Hours
1	**Complex Numbers** **Pre-requisite:** Review of Complex Numbers- Algebra of Complex Number, Cartesian, polar and exponential form of complex number. De Moivre's Theorem. 1.1. Applications of De Moivre's Theorem. 1.2. Powers and Roots of complex number. 1.3 Introduction to Hyperbolic and Inverse Hyperbolic functions and simple examples. 1.4 Logarithmic functions, Separation of real and Imaginary parts of Logarithmic Functions	6

2	**Regression Analysis and Correlation** 2.1 Interpolation: - Lagrange's Linear and Quadratic 2.2 Linear Regression, Lines of regression 2.3 Fitting a Regression Line: Method of least squares. 2.4 Karl Pearson's Coefficient of correlation (r) and related concepts, Spearman's Rank correlation coefficient (R) (Repeated & non repeated ranks problems).	6
3	**Successive Differentiation, Expansion of Function** 3.1 Successive differentiation: nth derivative of standard functions 3.2 Taylor's Theorem (Statement only) and Taylor's series, Maclaurin's series (Statement only). Expansion of$e^{\wedge}(x)$, sin(x), cos(x), tan(x), sinh(x), cosh(x), tanh(x), log(1+x), $\sin^{-1}(x)$, $\cos^{-1}(x)$, $\tan^{-1}(x)$.	4
4	**Partial Differentiation and Applications of Partial Differentiation** 4.1 Partial Differentiation: Function of several variables, Partial derivatives of first and higher order. Differentiation of composite function. 4.2 Euler's Theorem on Homogeneous functions with two independent variables (without proof). Deductions from Euler's Theorem. 4.3 Maxima and Minima of a function of two independent variables, Lagrange's method of undetermined multipliers with one constraint. Jacobian of two independent variables.	9
5	**Matrices** **Pre-requisite:** Inverse of a matrix, addition, multiplication and transpose of a matrix, Elementary row and column transformation 5.1. Symmetric, Skew- Symmetric, Hermitian, Skew Hermitian, Unitary, Orthogonal Matrices and properties of Matrices (Without Proof). 5.2 Rank of a Matrix using Echelon forms, reduction to normal form and PAQ form. 5.3. System of homogeneous and non –homogeneous equations, their consistency and solutions. 5.4Eigen values and Eigen vectors of Matrices.	9
6	**Numerical Methods** 6.1 **Solution of system of linear algebraic equations:** (1) Gauss Elimination, (2) Gauss Jacobi Iteration Method (3) Gauss Seidel Iteration Method, 6.2 **Solutions of Transcendental equations:** (1) Bisection method (2) Secant Method (3) Newton Raphson	6

Theory Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 40 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and the second class test when an additional 35% syllabus is completed. Duration of each test shall be 90 minutes.

End Semester Theory Examination:

1. Question paper will comprise of total 05 questions, each carrying 20 marks.
2. Total 03 questions need to be solved.

3. Question No. 01 will be compulsory and based on the entire syllabus wherein 4 sub-questions of 5 marks each will be asked.

Lab Assessment:

Term Work:

General Instructions:

1. Batch wise practicals are to be conducted. The number of students per batch should be as per norms.
2. 2. Students must be encouraged to write SCILAB Programs in the laboratory. Each Student has to perform at least 4 SCILAB practicals and at least 6 assignments on the entire syllabus.
3. SCILAB practicals will be based on (i) Gauss Elimination(ii) Gauss Seidel Iteration method (iii) Gauss Jacobi Iteration Method (iv) Bisection method (v) Secant Method (vi) Newton Raphson (vii) Matrices (viii) Maxima and Minima. (At least four).

The distribution of Term Work marks will be as follows –

1. Attendance (Theory, Practicals) : 05 marks
2. Assignments on entire syllabus : 10 marks
3. SCILAB Practicals : 10 marks
4. Remaining questions will be randomly selected from all the modules.
5. Weightage of each module will be proportional to number of respective lecture mentioned in the syllabus.

Books/References:

1. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication
2. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Eastern Limited, 9thEd.
3. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication,
4. Matrices, Shanti Narayan, S. Chand publication.
5. Applied Numerical Methods with MATLAB for Engineers and Scientists by Steven Chapra, McGraw Hill.

Back to Scheme

Course Code	Course Name	Credits
AE102	**Engineering Physics I**	2+0.5

Course Objectives:

1. To impart knowledge of basic concepts in applied physics and founding principles of technology.
2. To provide the knowledge and methodology necessary for solving problems in the field of engineering.
3. To develop scientific temperament for scientific observations, recording, and inference drawing essential for technology studies.

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

1. Explain the functioning of lasers and their various applications.
2. Able to explain the working principle of optical fibres and their applications especially in the field of communication.
3. Explain the limits of Classical Physics and apply the fundamentals of quantum mechanics to study the one dimensional motion of microscopic particles.
4. Apply the knowledge of superconductivity to SQUID and Magnetic levitation.
5. Apply the reasons for Acoustic defects and use this in the proper design of a Hall/Auditorium and use the knowledge of Piezoelectric and Magnetostriction effect for production of ultrasonic waves and its application in various fields.
6. Apply the knowledge of coordinate systems and vector calculus to various situations. Also, the learner will be able to study further as the base is set in this topic.

Theory Syllabus:

Module	Details	Hours.
1.	Lasers:Laser spontaneous emission and stimulated emission; metastable state, population inversion, types of pumping, resonant cavity, Einstein's equations; Helium Neon laser; Nd:YAG laser; Semiconductor laser, Applications of laser- Holography (construction and reconstruction of holograms) and industrial applications (cutting, welding etc), Applications in the medical field; LIDAR (Light Detection and Ranging)	4
2.	Optical Fibres: Working Principle and structure, Numerical Aperture for step index fibre; critical angle; angle of acceptance; V number; number of modes of propagation; types of optical fibres; Applications: Fibre optic communication system; sensors (Pressure, temperature, smoke, water level), applications in the medical field.	4
3.	Quantum Mechanics: De Broglie hypothesis of matter waves; properties of matter waves; wave packet, phase velocity and group velocity; Wave function; Physical interpretation of wave function; Heisenberg uncertainty principle; nonexistence of electron in nucleus;Schrodinger's time dependent wave equation; time	6

	independent wave equation; Free electron, Particle trapped in one dimensional infinite potential well, Quantum Computing.	
4.	Superconductivity:Critical temperature, critical magnetic field, Meissner'seffect, Type I and Type II and high Tc superconductors; BCS Theory (concept of Cooper pair); Josephson effect Applications of superconductors- SQUID, MAGLEV	3
5.	Ultrasonics and Acoustics: Ultrasonic Wave generation; Magnetostriction Oscillator; Piezoelectric Oscillator; Applications of ultrasonic: Echo sounding; NDT; ultrasonic cleaning(cavitation); ultrasonicsensors; Industrial applications of ultrasonic (soldering, welding, cutting, drilling) Conditions of good acoustics; Reflection of sound (reverberation and echo); absorption of sound; absorption coefficient; Sabine's formula; Acoustic Design of a hall; Common Acoustical defects and acoustic materials	4
6.	Vector Calculus:Scalar and vector fields, Cartesian, polar, Cylindrical and Spherical Coordinate system, gradient, curl and divergence in Cartesian coordinate system, Central force, line integral, work energy theorem, surface integral, volume integral, divergence theorem, Continuity Equation, Stoke's theorem, Maxwell's Equations.	4

Suggested Experiments: (Any five)

1. Determination of number of lines on the grating surface using LASER Source.
2. Determination of Numerical Aperture of an optical fibre.
3. Determination of wavelength using Diffraction grating. (Laser source)
4. Study of Ultrasonic Distance Meter.
5. Determination of angular divergence of laser beam.
6. Determination of absorption coefficient of sound of given material.
7. To measure the thickness of fine wire and grating element of the given grating with help of Laser source

Theory Assessment

Internal Assessment Test

Assessment consists of two class tests of 30 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and the second class test when an additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Examination

In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

1. Question paper will comprise of 3 questions, each carrying 15 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total three questions need to be solved.

Lab Assessment:

Term work:

Term Work shall consist of Minimum five experiments.

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

- Laboratory work (Experiments and Journal) : 10 marks
- Project Groupwise or Topic Presentation : 10 marks
- Attendance (Theory and Practical) : 05 marks

The final certification and acceptance of TW ensures the satisfactory performance of laboratory work and Minimum passing in the TW.

Books/References:

1. A text book of Engineering Physics-Avadhanulu & Kshirsagar, S. Chand
2. A textbook of Optics - N. Subramanyam and Brijlal, S.Chand
3. Fundamentals of optics by Jenkins and White, McGrawHill
4. Modern Engineering Physics – Vasudeva, S.Chand
5. Concepts of Modern Physics- ArtherBeiser, Tata McGraw Hill
6. A TextBook of Engineering Physics, S. O. Pillai, New Age International Publishers.
7. Optics - Ajay Ghatak, Tata McGraw Hill8. Introduction to Electrodynamics- D. J. Griffiths, Pearson publication
8. Physics for Engineers, M.R. Srinivasan, New Age International Publishers.

Back to Scheme

Course Code	Course Name	Credits
AE103	**Engineering Chemistry I**	2+0.5

Course Objectives:

1. To impart a scientific approach and to familiarize the applications of chemistry in the field of engineering.
2. The student with the knowledge of the basic chemistry will understand and explain scientifically the various problems related to chemistry in the industry/engineering field.
3. To develop abilities and skills that are relevant to the study and practice of chemistry.

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

1. To understand and analyse the combustion mechanisms of various fuels and be able to characterize the fuels for practical purposes.
2. To determine the quality of the lubricants and be able to suggest lubricants for different industrial applications.
3. To become familiarized with corrosion types and the environmental factors affecting corrosion and to suggest the method of corrosion protection
4. To analyse the quality of water and will be able to suggest methods to improve water quality.
5. To apply phase rule to one and two component systems and understand the importance of phase diagrams in material science and engineering.
6. To acquire knowledge about the alloys and the determination of composition of the alloys.

Theory Syllabus:

Module	Details	Hours.
1	**Fuels and Combustion** **Pre-requisite:** What are fuels, Types of fuels, Characteristics of fuels. 1.1. Calorific value of a fuel - HCV and LCV, Theoretical determination of calorific value of fuel by Dulong's formula, Numerical problems 1.2 Solid fuels: Coal, Analysis of coal - Proximate and Ultimate analysis, Numerical problems Liquid fuels: Composition and refining, Knocking, Octane number, Cetane number, Biodiesel Gaseous Fuels: LPG and CNG 1.3. Combustion of fuels – Numerical problems for calculating the amount of air needed for the complete combustion of solid and gaseous fuels. 1.4 Limitations of fossil fuels. 1.5 Alternate and non-conventional energy sources- solar, wind, hydropower and biomass	6
2	**Lubricants** **Pre - requisites**: Definition of Lubricants and Lubrication, functions of lubricants 2.1 Mechanisms of lubrication – Thick film, Thin film and Extreme pressure	3

	2.2 Classification of lubricants - Solid (MoS_2, graphite), Semi solid (greases), Liquid (animal/vegetable oils, mineral oils, synthetic oils) 2.3 Properties of lubricants and their significance - Viscosity and Viscosity Index, Flash and Fire Points, Cloud and Pour Points, Acid Number, Saponification Number, Steam Emulsification Number and related numerical problems.	
3	**Corrosion and its Control** **Pre-requisite:** corrosion, corrosion product, electrochemical series, corrosive and non corrosive metals. 3.1 Mechanism of corrosion - Chemical and Electrochemical corrosion. 3.2 Types of corrosion: Galvanic corrosion, Differential aeration corrosion, Pitting corrosion, Intergranular corrosion, Waterline corrosion, Stress corrosion. 3.3 Factors Affecting Corrosion Rate: - (i) Nature of metal, (ii) Nature of environment. 3.4 Methods of mitigating corrosion: Material selection, Design, Cathodic protection, Anodic protection 3.5 Protective Coatings: Metallic coatings anodic coating (galvanizing) and cathodic coating (Tinning), Different Methods of Applying Metallic Coatings, Organic coatings	6
4	**Water and its Treatment** **Pre-requisite:**Knowledge of sources of water, Possible impurities in water, Characteristics imparted by impurities in water. 4.1 Hardness in water – types & its units, Determination of hardness by EDTA method, and numerical problems. 4.2. Effects of Hard water in boilers - Priming and Foaming, Scales and Sludges, Boiler corrosion, caustic embrittlement, 4.3 Softening of water- Ion exchange process. 4.4 Desalination of brackish water- Reverse Osmosis, Electrodialysis, Ultrafiltration	4
5	**Phase Rule** 5.1. Gibbs Phase Rule - Introduction, definition of terms with examples, One component system (Water system), 5.2. Reduced Phase rule, Two component system (Pb-Ag system) , Limitations of phase rule.	3
6	**Alloys** 6.1 Introduction to Alloys, 6.2 Plain Carbon Steel and Alloy Steels 6.3 Alloys of Cu, Al and Pb	2

List of Experiments

1. Determination of Hardness in water
2. Determination of Viscosity of oil by Redwood Viscometer
3. Determination of Flash point of a lubricant using Abel‘s apparatus
4. Determination of Acid Value and Saponification Value of an oil.
5. Determination of Chloride content of water by Mohr‘s Method
6. Determination of moisture content in coal sample.
7. Study of the effect of different environments (Acid, Base) on corrosion rate.
8. Determination of COD Value of water.
9. Removal of hardness using ion exchange column.
10. Determination of Fe in plain Carbon steel

Theory Assessment

Internal Assessment Test

Assessment consists of two class tests of 30 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and the second class test when an additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Examination

In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

1. Question paper will comprise of 3 questions, each carrying 15 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total three questions need to be solved.

Lab Assessment:

Term work:

Term Work shall consist of Minimum five experiments.

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

- Laboratory work (Experiments and Journal) : 10 marks
- Assignments and Viva on modules : 10 marks
- Attendance (Theory and Tutorial) : 05 marks

The final certification and acceptance of TW ensures the satisfactory performance of laboratory work and Minimum passing in the TW.

Books/References:

1. Engineering Chemistry – P.C.Jain and Monika Jain, Dhanpat Rai Publications
2. A Textbook of Engineering Chemistry, - Shashi Chawla (DhanpatRai publications)
3. A textbook of Engineering Chemistry - S.S. Dara, S. Chand Publishing House
4. Engineering Chemistry – Wiley India (ISBN-9788126519880)
5. Essentials of Physical Chemistry - Arun Bahl, B.S. Bahl and G.D. Tuli
6. Textbook on Experimental and calculations in Engineering Chemistry – S.S. Dara S. Chand Publishing House
7. Experiments in Engineering Chemistry – I.K International Publishing House

Back to Scheme

Course Code	Course Name	Credits
AE104	**Engineering Mechanics**	3+1

Course Objectives: The course is aimed

1. To develop the capacity to predict the effects of force and motion and to acquaint the concept of static and dynamic equilibrium.
2. Ability to visualize physical configurations in terms of actual systems and its constraints, and able to formulate the mathematical function of the system.
3. To study, analyze and formulate the motion of moving particles/bodies.

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

1. Illustrate the concept of force, moment and apply the same along with the concept of equilibrium in two- and three-dimensional systems with the help of FBD.
2. Determine the centroid and MI of plane lamina.
3. Apply equilibrium equations in statics.
4. Evaluate coefficient of friction between the different surfaces in contact.
5. Establish relation between velocity and acceleration of a particle and analyze the motion by plotting the relation.
6. Apply Newton's law in motion, and identify different kinds of particle motions

Theory Syllabus:

Module	Details	Hours.
1	**Coplanar Force System and Resultant:** 1.1 System of Coplanar Forces: Classification of force systems, Principle of transmissibility, composition and resolution of forces. 1.2 Resultant: Resultant of coplanar force system (Concurrent forces, parallel forces and non-concurrent non-parallel system of forces). Moment of force about a point, Couples, Varignon's Theorem. Force couple system. Distributed Forces in plane. 1.3 Equilibrium of the System of Coplanar Forces and Beams: Conditions of equilibrium for concurrent forces, parallel forces and non-concurrent non-parallel forces and Couples. Equilibrium of rigid bodies Free body diagrams. Types of beams, simple and compound beams, type of supports and reaction. Determination of reactions at supports for various types of loads on beams. (Including problems on internal hinges)	08
2	**Centroid and MI:** 2.1 First moment of Area, Centroid of composite plane Laminas 2.2 Second moment of Area, MI of composite plane Laminas	05
3	**Forces in Space:** 3.1 System of Non-Coplanar Force System 3.2 Resultant of Non-Coplanar Force System	05
4	**Friction:** 4.1 Static and Dynamic Friction: Systems of Statics and Dynamic/ Kinetic Friction, Coefficient of Friction, Angle of Friction, Laws of friction. Concept of Cone of friction.	06

	4.2 Wedge Friction: Equilibrium of bodies on inclined plane. Application to problems involving wedges and ladders. 4.3 Rope and Belt Friction: Block Friction including Rope and Belt Friction.	
5	**Kinematics of Particle and Rigid Body:** 5.1 Kinematics of Particle: Motion of particle with variable acceleration. General curvilinear motion. Tangential & Normal component of acceleration, Motion curves (a-t, v-t, s-t curves). Application of concepts of projectile motion and related numerical. 5.2 Kinematics of Rigid Body: Translation, Rotation and General Plane motion of Rigid body. The concept of Instantaneous center of rotation (ICR) for the velocity. Location of ICR of mechanism. Velocity analysis of rigid body using ICR	06
6	**Kinetics of a Particle:** 6.1 Kinetics of a Particle: Force and Acceleration: -Introduction to basic concepts, D'Alemberts Principle, concept of Inertia force, Equations of dynamic equilibrium, Newton's second law of motion. (Analysis limited to simple systems only.) 6.2 Kinetics of a Particle: Work and Energy: Work Energy principle for a particle in motion. Application of Work – Energy principle to a system consists of connected masses and Springs. 6.3 Kinetics of a Particle: Impulse and Momentum: Principle of linear impulse and momentum. Impact and collision: Law of conservation of momentum, Coefficient of Restitution. Direct Central Impact and Oblique Central Impact. Loss of Kinetic Energy in collision of inelastic bodies.	06

List of Experiments:

Minimum six experiments from the following list of which at least one should from dynamics.

1. Verification of Polygon law of coplanar forces
2. Verification of Principle of Moments (Bell crank lever.)
3. Determination of support reactions of a Simply Supported Beam.
4. Determination of coefficient of friction) using inclined plane
5. Collision of elastic bodies (Law of conservation of momentum).
6. Kinematics of particles. (Uniform motion of a particle, Projectile motion, motion under gravity)
7. Kinetics of particles. (collision of bodies)

Theory Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 40 marks each.

The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 35% syllabus is completed. Duration of each test shall be 90 minutes.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 15 marks.
2. 10 percentage of marks will be asked from the self-study topics.
3. Total 04 questions need to be solved.
4. Question No. 01 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.

5. Remaining questions will be mixed in nature. (e.g. Suppose Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
6. In question paper weightage of each module will be proportional to number of respective lecture hrs.as mentioned in the syllabus.

Lab Assessment:
Term Work:
It comprises Laboratory Experiments and Assignments.
The distribution of marks for term work shall be as follows:

Practical Work and Journal	: 10 marks
Assignments	: 10 marks
Attendance	: 05 Marks

The final certification and acceptance of TW ensures the satisfactory performance of laboratory work and minimum passing in the TW.

End Semester Examination:
Pair of Internal and External Examiner should conduct Oral examination of 25 marks based on entire syllabus.

Books/References:

1. Engineering Mechanics by Beer &Johnston, Tata McGrawHill
2. Engineering Mechanics (Statics) by Meriam and Kraige, WileyBools
3. Engineering Mechanics (Dynamics) by Meriam and Kraige, WileyBools
4. Engineering Mechanics by F. L. Singer, Harper& Raw Publication
5. Engineering Mechanics by ShaumSeries

Back to Scheme

Course Code	Course Name	Credits
AE105	**Basic Electrical and Electronics Engineering**	3+1

Course Objectives: The course is aimed

1. To provide knowledge on fundamentals of D.C. circuits and its applications
2. To impart knowledge on fundamentals of 1-Φ A.C. circuits and its applications.
3. To impart knowledge on fundamentals of 3-Φ A.C. circuits and its applications.
4. To provide knowledge on fundamentals of DC machines.
5. To impart knowledge of Basic Electronics circuits

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

1. To evaluate D.C. circuits using network theorems.
2. Apply the concept of ac circuit and its resonance phenomena for a given RL, RC and RLC circuit.
3. To evaluate 3-Φ AC circuits.
4. To illustrate the working principle of DC machines.
5. To apply the concept of rectification.

Theory Syllabus:

Module	Details	Hours
1	**DC Circuits** Kirchhoff 's laws, Ideal and practical voltage and current source, Mesh and Nodal analysis (super node and super mesh excluded), Source transformation, Star-delta transformation, Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem, (Source transformation not allowed for Superposition theorem, Mesh and Nodal analysis)	12
2	**AC Circuits** Generation of alternating voltage and currents, RMS and Average value, form factor, crest factor, AC through resistance, inductance and capacitance, R-L, R-C and R-L-C series and parallel circuits, phasor diagrams, power and power factor, series and parallel resonance, Q-factor	12
3	**Three Phase AC Circuits** Three phase voltage and current generation, star and delta connections (balanced load only), relationship between phase and line currents and voltages, Phasor diagrams, Basic principle of wattmeter, measurement of power by two wattmeter method.	6
4	**Electrical Machines (No Numericals)** Principle of operation of DC motors and DC generators, construction and classification of DC machines, emf equation.	3
5	**Basic Electronics** Semiconductor diode, Diode rectifier with R load: Half wave, full wave-center tapped and bridge configuration, RMS value and average value of output voltage, ripple factor, rectification efficiency,	3

	introduction to C and L filter (no derivation).CE, CB, CC transistor configuration, CE input-output characteristics	

List of Experiments

1. Mesh and Nodal analysis.
2. Verification of Superposition Theorem.
3. Verification Thevenin's Theorem.
4. Study of R-L series and R-C series circuit.
5. R-L-C series resonance circuit
6. R-L-C parallel resonance circuit.
7. Relationship between phase and line currents and voltages in three phase system (star & delta)
8. Power and phase measurement in a three phase system by one wattmeter method.
9. Power and phase measurement in a three phase system by two wattmeter methods.
10. Half wave and Full wave rectifier.

Theory Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 40 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and the second class test when an additional 35% syllabus is completed. Duration of each test shall be 90 minutes.

End Semester Theory Examination:

1. Question paper will comprise of total 05 questions, each carrying 20 marks.
2. Total 03 questions need to be solved.
3. Question No. 01 will be compulsory and based on the entire syllabus wherein 4 sub-questions of 5 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 lecture mentioned in the syllabus.

Lab Assessment:

Term work:

Term Work shall consist of a Minimum six experiments.

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

- Laboratory work (Experiments and Journal) : 10 marks
- Assignments : 10 marks
- Attendance (Theory and Tutorial) : 05 marks

The final certification and acceptance of TW ensures the satisfactory performance of laboratory work and Minimum passing in the TW.

Books/References:

1. B.L.Theraja "Electrical Technology" Vol-I and II, S. Chand Publications, 23 rd ed. 2003.
2. Joseph A EdMinorster, "Schaum's outline of theory and problems of electric circuits" Tata McGraw Hill, 2nd edition
3. Electronics Devices & Circuit Theory" by Boylestad, Pearson Education India
4. D P Kothari and I J Nagrath "Theory and Problems of Basic Electrical Engineering", PHI 13th edition 2011.

Back to Scheme

Course Code	Course Name	Credits
AE106	**Engineering Workshop**	1.5

Course Objectives:

1. To impart training to help the students develop engineering skill sets
2. To inculcate respect for physical work and hard labour
3. To get exposure to interdisciplinary engineering domain.
4. To get exposure to the spirit of team work.

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

1. To develop the necessary skill required to handle / use different fitting tools.
2. To develop skill required for hardware maintenance.
3. Able to install an operating system and system drives.
4. Able to prepare the edges of jobs and do simple arc welding.
5. Demonstrate the turning operation with the help of a simple job.

Trade	Details	Hours
1	**Fitting:**Use and setting of fitting tools for chipping, cutting, filing, marking, center punching, drilling, and tapping. Term work to include one job involving following operations: filing to size, one simple male- female joint, drilling and tapping	10
2	**Hardware and Networking:**Dismantling of a Personal Computer (PC), Identification of Components of a PC such as power supply, motherboard, processor, hard disk, memory (RAM, ROM), CMOS battery, CD drive, monitor, keyboard, mouse, printer, scanner, pen drives, disk drives etc. Assembling of PC, Installation of Operating System (Any one) and Device drivers, Boot-up sequence. Installation of application software (at least one) Basic troubleshooting and maintenance Identification of network components: LAN card, wireless card, switch, hub, router, different types of network cables (straight cables, crossover cables, rollover cables) Basic networking and crimping. NOTE: Hands on experience to be given in a group of not more than four students	8
3	**Welding:**Edge preparation for welding jobs. Arc welding for different job like, Lap welding of two plates, butt welding of plates with simple cover, arc welding to join plates at right angles.	6
4	**Machine Shop:**At least one turning job is to be demonstrated and simple job to be made for Term Work in a group of 4 students.	6
5	**Plumbing:**Use of plumbing tools, spanners, wrenches, threading dies, demonstration of preparation of a domestic line involving fixing of a water tap and use of coupling, elbow, tee, and union etc.	6
6	**Adaptive Manufacturing Technology:**History of adaptive manufacturing, 3D Printer: - how a 3D printer works, Parts of 3D Printer and their functions, Constructional details of 3D printer.	6

Note: Trade 1 & 2 are compulsory and select any one trade from trade 3 to 6.

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

1. Experiment write ups : 45 Marks
2. Attendance : 05 marks

Books/References:

1. Workshop Technology by H K Hajara Choudhary
2. Manufacturing Technology by R C Jain
3. Workshop Technology by R S Khurmi and J S Gupta
4. Workshop Technology by Chapman.

Back to Scheme

Course Code	Course Name	Credits
AE 107	**Engineering Mathematics II**	3+1

Course Objectives: The course is aimed

1. To develop the basic mathematical skills of differential equations of engineering students
2. To understand the linear differential equation with constant coefficients used in mathematical modelling.
3. To acquaint the students with the Beta, Gamma functions and DUIS.
4. To learn different techniques to solve double and triple integrations.
5. To learn the concept of vector differentiation and Integration.
6. To provide knowledge of numerical techniques using SCILAB software to handle Mathematical modelling.

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

1. Apply the basic concept of linear differential equations to solve problems in engineering.
2. Apply the basic concept of applications of higher order differential equations in mathematical modelling to solve real life problems.
3. Apply the basic concepts of beta, gamma and DUIS to solve engineering problems.
4. Apply the concept of double and triple integration in solving problems of engineering and technology.
5. Apply the concept of vector differentiation and Integration in optimization.
6. Apply the concept of differentiation and integration numerically for solving the engineering problems with the help of SCILAB software.

Theory Syllabus:

Module	Details	Hours
1	**Differential Equations of First Order and First Degree** 1.1 Exact differential Equations, Equations reducible to exact form by using integrating factors. 1.2 Linear differential equations, equation reducible to linear form. 1.3 Application of differential equation of first order and first degree in engineering.	6
2	**Linear Differential Equations with Constant Coefficients and Variable coefficients of higher order** 2.1 Linear Differential Equation with constant coefficient-complementary function, particular integrals of differential equation of the type f(D)y = X where X is e ^ax , sin($ax + b$) , cos ($ax + b$), x^n, e ^axV, xV. 2.2 Cauchy Differential equation, Method of variation of parameters two variables	7
3	**Beta and Gamma Function, Differentiation under Integral sign** 3.1 Beta and Gamma functions and its properties. 3.2 Differentiation under integral sign with constant limits of integration (One parameter).	6

4	**Double Integration** Prerequisite: Tracing of curves 4.1 Double integration- Evaluation of Double Integrals. (Cartesian & Polar), Change of order of Integration and evaluation 4.2 Evaluation of double integrals by changing to polar coordinates. 4.3 Triple integration**:** Evaluation (Cartesian, cylindrical and spherical polar coordinates)	8
5	**Vector Differentiation and Integration** 3.1 Vector function of scalar quantities, Vector operator del, Gradient, Divergence, Curl and their physical interpretation and Laplacian 3.2 Directional derivatives, Solenoidal and irrotational (conservative) vector fields. 3.3 Line integrals – definition and problems, circulation, work done, Engineering applications of Line integral.	6
6	**Numerical Techniques: -** 6.1 Numerical solution of ordinary differential equation (a) Euler's method (b) Modified Euler method, (c) Runge- Kutta fourth order method 6.2 Numerical integration- (a) Trapezoidal (b) Simpson's 1/3rd (c) Simpson's 3/8th rule	6

Theory Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 40 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and the second class test when an additional 35% syllabus is completed. Duration of each test shall be 90 minutes.

End Semester Theory Examination:

1. Question paper will comprise of total 05 questions, each carrying 20 marks.
2. Total 03 questions need to be solved.
3. Question No. 01 will be compulsory and based on the entire syllabus wherein 4 sub-questions of 5 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.

Lab Assessment:

Term Work:

General Instructions:

1. Batch wise practical are to be conducted. The number of students per batch should be as per norms.
2. Students must be encouraged to write SCILAB Programs in the laboratory. Each Student has to perform at least 4 SCILAB practical and at least 6 assignments on the entire syllabus.
3. SCILAB Practical will be based on (i) Euler's method (ii) Modified Euler method, (iii)Runge- Kutta fourth order method (iv) Trapezoidal (v) Simpson's 1/3rd (vi) Simpson's 3/8th rule(vii) Differential equations (viii) Integration. (At least four)

The distribution of Term Work marks will be as follows –

1. Attendance (Theory, Tutorial and Practicals) : 05 marks
2. Class assignments on entire syllabus : 10 marks

3. SCILAB Practicals : 10 marks

Books/References:

1. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication
2. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Eastern Limited, 9thEd.
3. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication,
4. Applied Numerical Methods with MATLAB for Engineers and Scientists by Steven Chapra, McGraw Hill.

Back to Scheme

Course Code	Course Name	Credits
AE108	**Engineering Physics II**	2+0.5

Course Objectives:

1. To impart knowledge of basic concepts in applied physics and founding principles of technology.
2. To provide the knowledge and methodology necessary for solving problems in the field of engineering.
3. To develop scientific temperament for scientific observations, recording, and inference drawing essential for technology studies.

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

1. Able to understand fundamental concepts of classical optics and applications of interference and diffraction in science and technology.
2. To comprehend the basic concepts of semiconductor physics and apply the same to electronic devices.
3. Apply the concepts of crystallography and to use XRD techniques for analysis of crystal structure.
4. Comprehend the properties of Supercapacitors to apply them in novel applications.
5. Comprehend the significance of nanoscience and nanotechnology and its current and futuristic frontier applications.

Theory Syllabus:

Module	Details	Hours
1	**Thin Film Interference** Interference by division of amplitude and by division of wave front; Interference in thin film of constant thickness due to reflected and transmitted light; origin of colours in thin film; Wedge shaped film(angle of wedge and thickness measurement); Newton's rings Applications of interference - Determination of thickness of very thin wire or foil; determination of refractive index of liquid; wavelength of incident light; radius of curvature of lens; testing of surface flatness; Anti-reflecting films and Highly reflecting film.	5
2	**Diffraction of light** Fraunhoffer diffraction at single slit, Fraunhoffer diffraction at double slit, Diffraction Grating, Resolving power of a grating, dispersive power of a grating Application of Diffraction - Determination of wavelength of light with a plane transmission grating.	4
3	**Physics of semiconductor Devices** Splitting of energy levels for band formation; Classification of semiconductors(direct & indirect band gap, elemental and compound); Conductivity, mobility, current density (drift & diffusion) in semiconductors(n type and p type); p-n junction Diode(unbiased, forward bias, reverse bias); Breakdown mechanism (zener & avalanche), Hall Effect. Applications of semiconductors: Rectifier diode, LED, Zener diode, Photo diode, Photovoltaic cell, BJT, FET, SCR., MOSFET	5

4	**Crystallography and X-Ray Diffraction Techniques** Introduction to crystallography, Miller indices of crystallographic planes & directions; interplanar spacing; X-ray diffraction and Bragg's law; Determination of Crystal structure using Bragg's diffractometer; Frenkel and Schotkey crystal defects. EDAX technique for determination of elemental composition	4
5	**Supercapacitors, Fuel cells and Hydrogen storage** Principle, construction, materials and applications, comparison with capacitor and batteries: Energy density, Power density. Concept of Hydrogen adsorption/ desorption, techniques for determination of BET (Brunauer-Emmett-Teller) pore surface area, Adsorption/desorption isotherms	4
6	**Nanoscience and Nanotechnology:** Introduction to nano-science and nanotechnology, Surface to volume ratio, Two main approaches in nanotechnology -Bottom up technique and top down technique; Important tools in nanotechnology such as Scanning Electron Microscope,Transmission Electron Microscope, Atomic Force Microscope. Nano materials: Methods to synthesize nanomaterials (Ball milling, Sputtering, Physical Vapour deposition, sol gel), properties and applications of nanomaterials.	3

Suggested Experiments: (Any five)

1. Determination of radius of curvature of a lens using Newton's ring set up
2. Determination of diameter of wire/hair or thickness of paper using Wedge shape film method and estimation of Young's modulus of the material.
3. Determination of width of a slit using single slit diffraction experiment (laser source)
4. Study of Miller Indices, Plane and direction.
5. Study of Hall Effect.
6. Determination of energy band gap of semiconductor.
7. Study of I-V characteristics of light emitting diodes (LED).
8. Determination of 'h' using Photocell.
9. Study of I-V characteristics of semiconductor photodiode and determination of its spectral response.
10. Study of I-V characteristics of a photovoltaic solar cell and finding the efficiency.
11. Zener diode as a voltage regulator.

Theory Assessment

Internal Assessment Test

Assessment consists of two class tests of 30 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and the second class test when an additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Examination

In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

1. Question paper will comprise of 3 questions, each carrying 15 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total three questions need to be solved.

Lab Assessment:

Term work:

Term Work shall consist of Minimum five experiments.

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

Laboratory work (Experiments and Journal)	**:**	10 marks
Project Groupwise or Topic Presentation	:	10 marks
Attendance (Theory and Practical)	:	05 marks

The final certification and acceptance of TW ensures the satisfactory performance of laboratory work and Minimum passing in the TW.

Books/References:

1. A text book of Engineering Physics-Avadhanulu & Kshirsagar, S. Chand
2. A textbook of Optics - N. Subramanyam and Brijlal, S.Chand
3. Fundamentals of optics by Jenkins and White, McGrawHill
4. Modern Engineering Physics – Vasudeva, S.Chand
5. Concepts of Modern Physics- ArtherBeiser, Tata McGraw Hill
6. A TextBook of Engineering Physics, S. O. Pillai, New Age International Publishers.
7. Optics - Ajay Ghatak, Tata McGraw Hill
8. Introduction to Nanotechnology- Charles P. Poole, Jr., Frank J. Owens, Wiley India edition
9. Solid State Electronic Devices- B. G. Streetman, Prentice Hall Publisher
10. Introduction to Solid State Physics- C. Kittel, John Wiley& Sons publisher
11. Ultracapacitors: The future of energy storage- R.P Deshpande, McGraw Hill
12. Nanotechnology: Principles and Practices, Dr. S.K. Kulkarni, Capital Publishing Company.
13. Physics for Engineers, M.R. Srinivasan, New Age International Publishers.

Back to Scheme

Course Code	Course Name	Credits
AE109	**Engineering Chemistry II**	2+0.5

Course objectives:

1. With the knowledge of the basic chemistry, the student will be able to understand and explain scientifically the various chemistry related problems in the industry/engineering field.
2. The student will be able to understand the new developments and breakthroughs efficiently in engineering and technology.

Course outcomes: Upon successful completion, students will be able to

1. To recognize the electrochemical processes and determine the cell potentials in various electrochemical systems.
2. To develop knowledge on electrochemical energy storage systems and familiarization with the characterization methods of batteries.
3. To identify various polymeric materials and to determine polymer molecular weights from different types of experiments.
4. To acquire theoretical background of different classes of materials used in engineering applications and would be able to choose the right materials for specific applications.
5. To describe the theoretical background of spectroscopic techniques such as NMR, IR, UV spectroscopy.
6. To assess the environmental impact and also understand and discuss some mitigation strategies.

Theory Syllabus:

Module	Details	Hours
1	**Engineering Electrochemistry** Pre - requisite: redox reaction,cell reaction, electrode and its type, salt bridge 1.1. Electrode potential, electrode reaction, derivation of Nernst equation for single electrode potential, numerical problems. 1.2 Types of Electrochemical cells 1.3 Reference electrodes -Introduction, Construction, working of SHE, Calomel electrode.	3
2	**Battery Technology** Pre- requisite: Electrochemical Reactions, Cell potential, Electrochemical series 2.1 Introduction, classification – primary, secondary and reserve batteries. Characteristics – Capacity, Electricity storage density, energy efficiency, cycle life and shelf life. 2.2 Construction, working and applications of Lead – Acid Storage cell 2.3 Lithium batteries - Introduction, construction, working and applications of Li-MnO2 2.4 Fuel Cells: Introduction, classification of fuel cells, limitations & advantages of fuel cells, Construction of Hydrogen oxygen alkaline fuel cells.	4

3	**Polymeric Materials** Pre - requisite: Polymer, Monomer, Polymerization, Degree of polymerisation, Classification of polymers, Mechanism of polymerisation. 3.1 Molecular weight of polymers: number average and weight average, numerical problems, Polydispersity Index, 3.2 Polymer crystallinity - glass transition temperature and its significance 3.3 Compounding and Processing of Polymers 3.4 Preparation, properties and uses of PMMA, Kevlar, Urea-Formaldehyde 3.5 Elastomers: Natural rubber and vulcanized rubber, mechanism of vulcanization.	6
4	**Advanced Engineering Materials** **4.1 Nanomaterials** Pre-requisite**:** Concept of nano scale, definition of nanoparticles 4.1.1 Importance of nano size, Properties of nanomaterials – Size, optical properties, magnetic properties, electrical properties 4.1.2 Nanoscale materials- carbon nanotubes, nano wires, fullerenes. 4.1.3 Synthesis of Nano particles by Chemical vapor deposition (CVD) method and Laser Ablation Method 4.1.4 Applications ofnano materials **4.2 Composite Materials** Pre requisite: Definition and basic understanding of composite materials. 4.2.1 Constitution of composite materials- Matrix and Dispersed phase 4.2.2 Particle reinforced composites, Fibre reinforced composites, structural composites - properties and applications. 4.2.3 Factors affecting the dispersion of nanoparticles in the matrix **4.3 Smart Materials** 4.3.1 Shape Memory Alloys and Applications	6
5	**Spectroscopic Techniques** Pre-requisites:Electromagnetic radiation, characteristics of electromagnetic radiation, electromagnetic spectrum. 5.1. Spectroscopy - Principle, Interaction of radiation with matter, Selection rules. 5.2 Types of spectroscopy: IR, UV, NMR, Emission Spectroscopy, (Flame Photometry), 5.3 Fluorescence and Phosphorescence, Jablonski diagram	3
6	**Environmental And Green Chemistry** Pre - requisites:Definition of Environment and Primary concept of environmental pollution**.** 6.1 Concept and Scope of Environmental Chemistry. Environmental Pollution and Control - Industrial Waste pollutionWater Pollution - BOD and COD, determination and numerical problems.Concept of 12 principles of Green chemistry, discussion with examples, numerical on atom economy.	2

List of Experiments

1. Determination of Cell potential of Zn- Cu system
2. Molecular weight determination of polymers by Oswald Viscometer
3. Preparation of Urea Formaldehyde
4. Preparation of biodegradable polymer using corn starch or potato starch.
5. Preparation of Magnetic Nanoparticles.
6. Synthesis of Biodiesel
7. Determination of electrical conductivity of unknown solution.
8. Preparation of Hand Sanitizer using ethyl alcohol
9. Determination of Caffeine in Tea
10. Determination of pH using glass electrode.

Theory Assessment

Internal Assessment Test

Assessment consists of two class tests of 30 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and the second class test when an additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Examination

In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

1. Question paper will comprise of 3 questions, each carrying 15 marks.
   Question number 1 will be compulsory and based on maximum contents of the syllabus
2. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
3. Total three questions need to be solved.

Lab Assessment:

Term work:

Term Work shall consist of a Minimum five experiments.

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

- Laboratory work (Experiments and Journal) : 10 marks
- Assignments and Viva on modules : 10 marks
- Attendance (Theory and Tutorial) : 05 marks

The final certification and acceptance of TW ensures the satisfactory performance of laboratory work and Minimum passing in the TW.

Books/References:

1. Engineering Chemistry – P.C.Jain and Monika Jain, Dhanpat Rai Publications
2. A Textbook of Engineering Chemistry, - Shashi Chawla (DhanpatRai publications)
3. A textbook of Engineering Chemistry - S.S. Dara, S. Chand Publishing House
4. Engineering Chemistry – O. G. Palanna , Tata McGraw Hill
5. Environmental Chemistry – A.K.De, New Age International
6. Fundamentals of Molecular Spectroscopy – C.N. Banwell, Tata McGraw Hill
7. Instrumental methods of chemical analysis – B.K.Sharma, Goel Publishing House
8. Textbook on Experimental and calculations in Engineering Chemistry – S.S. Dara S. Chand Publishing House
9. Experiments in Engineering Chemistry – I.K International Publishing House

Back to Scheme

Course Code	Course Name	Credits
AE110	**Engineering Drawing**	3+1

Course Objectives: The course is aimed

1. To develop graphic skills for communication of concepts, ideas and design of Engineering products.
2. To impart and inculcate proper understanding of the theory of projection.
3. To impart the knowledge of reading a drawing
4. To improve the visualization skill.
5. To teach basic utility of Computer Aided drafting (CAD) tool.

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

1. Apply the basic principles of projections in Projection of Lines and Planes
2. Apply the basic principles of projections in Projection of Solids.
3. Apply the basic principles of sectional views in Section of solids and development of surfaces.
4. Apply the basic principles of projections in converting 3D view to 2D drawing.
5. Read a given drawing and visualize an object from the given two views.
6. Apply basic AutoCAD skills to draw different views of a 3D object.

Theory Syllabus:

Module	Details	Hours
1	**Introduction to Engineering Graphics** Principles of Engineering Graphics and their significance, usage of Drawing instruments, Types of Lines, Dimensioning Systems as per IS conventions. Introduction to plain and diagonal scales. **Engineering Curves** Basic construction of Cycloid, Involutes and Helix (of cylinder) only.	4
2	**Projection of Points and Lines** Lines inclined to both the Reference Planes (Excluding Traces of lines) and simple application-based problems on Projection of lines. **Projection of Planes** Triangular, Square, Rectangular, Pentagonal, Hexagonal and Circular planes inclined to either HP or VP only. (Exclude composite planes).	5
3	**Projection of Solids** (Prism, Pyramid, Cylinder, Cone only) Solid projection with the axis inclined to HP and VP. (Exclude Spheres, Composite, Hollow solids and frustum of solids). Use change of position or Auxiliary plane method	6
4	**Section of Solids** Section of Prism, Pyramid, Cylinder, & Cone cut by plane perpendicular to at least one reference plane (Exclude Curved Section Plane). Use change of position or Auxiliary plane method. **Development of LateralSurfaces** Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones.	6

5	**Orthographic and Sectional Orthographic Projections: -** Fundamentals of orthographic projections. Different views of a simple machine part as per the first angle projection method recommended by I.S. Full or Half Sectional views of the Simple Machine parts. **Missing Views:** The identification of missing views from the given views. Create the third view from the two available views so that all the details of the object are obtained.	6
6	**Isometric Views:** - Principles of Isometric projection – Isometric Scale, Isometric Views, Conversion of Orthographic Views to Isometric Views (Excluding Sphere).	3

Lab Syllabus:

Component-1 (Use half Imperial Drawing Sheet)

Sr. No.	Activities to be completed in the Drawing Laboratory.	Hours
1	One Practice sheet on projection of solids (Minimum 2 problems)	4
2	Sheet 1: Projection of Solids (3 Problems).	4
3	One Practice sheet on Section of Solids. (Minimum 2 problems) # Term Sheet 2: Section of solids. (3 problems).	6
4	One practice sheet on Orthographic projection. (Minimum 1 problem) # Term Sheet 3: Orthographic Projection (With section 1 problem, without section 1 problem).	6
5	One practice sheet on Isometric drawing. (Minimum 2 problems) # Term Sheet 4: Isometric Projection. (3 problems).	4

Component-2

Self-study problems/ Assignment: (In A3 size Sketch book, to be submitted as part of Term Work)

1. Engineering Curves. (2 problems)
2. Projection of Lines (2 problems)
3. Projection of planes (2 problems)
4. Projection of solids. (2 problems)
5. Section of solids (2 problems)
6. Orthographic Projection. (With section 1 problem, without section 1 problem).
7. Missing views. (1 problem)
8. Isometric Drawing. (2 problems)

Component-3

Computer Graphics: Engineering Graphics Software - Orthographic Projections, Isometric Projections, Co-ordinate Systems, Multi-view Projection.

	To be Taught in laboratory.	Hours
PART - A	**Overview of Computer Graphics Covering:** Listing the computer technologies that impact on graphical communication, demonstrating knowledge of the theory of CAD software such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line (where applicable), The Status Bar, Different methods of zoom as used in	3

	CAD, Select and erase objects.	
	Customization & CAD Drawing: Consisting of set up of the drawing page and the printer including scale settings, Setting up of units and drawing limits, ISO and ANSI standards for coordinate dimensioning.	3
	Annotations, layering & other Functions Covering: Applying dimensions to objects, applying annotations to drawings, Setting up and use of layers, layers to create drawings, Create, edit and use customized layers, Changing line lengths through modifying existing lines (extend/lengthen), Printing documents to paper using the print command, orthographic projection techniques, Drawing sectional views of objects (simple machine parts).	4
PART -B	**Activities to be completed in the CAD Laboratory. (All printouts to be part of Term Work. Preferably, Use A3 size sheets for print out.)**	
	1. Orthographic Projections (without section)- 1 problem	4
	2. Orthographic Projection (with section)- 1 problem	4
	3. Orthographic Reading – 1 problem	2
	4. Isometric Drawing – 3 problems.	4

Theory Assessment:
Internal Assessment Test:
Assessment consists of two class tests of 40 marks each.
Among the two tests one is Conventional (manual drawing) and Second using CAD Software
End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 15 marks.
2. Any 4 questions need to be solved. There won't be any compulsory Question
3. Total 04 questions need to be solved.
4. Questions will be mixed in nature. (e.g., Suppose Q.2 has part (a) from module3 then part (b) will be from any module other than module 3)
5. In question paper weightage of each module will be proportional to number of respective lecture hrs.as mentioned in the syllabus.

Lab Assessment:
Term Work:

Component-1	:	7Marks
Component-2	:	6 Marks
Component-3	:	7 Marks
Attendance	:	5 Marks
Total Marks	:	25 Marks

Note: Satisfactory submission of all 3 components is mandatory to fulfill the Term.

End Semester Practical Examination: (Auto CAD) (2 hours/ 25 Marks)

1. Isometric drawing (1 problem) (10 Marks)
2. Orthographic Projection (With Section) (1 problem). (15 Marks)

Text Books:

1. N.D. Bhatt, "Engineering Drawing (Plane and solid geometry)", Charotar Publishing House Pvt. Ltd.
2. N.D. Bhatt & V.M. Panchal, "Machine Drawing", Charotar Publishing House Pvt. Ltd.

Reference Books:

1. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publisher.
2. Prof. Sham Tickoo (Purdue University) &GauravVerma, "(CAD Soft Technologies): Auto CAD 2012 (For engineers and Designers)", Dreamtech Press NewDelhi.
3. Dhananjay A Jolhe, "Engineering Drawing" Tata McGraw Hill.

Back to Scheme

Course Code	Course Name	Credits
AE111	**Programming with Python**	2

Course Objectives:

1. To introduce basic concepts of Python programming language as well as common packages and libraries.
2. To generate an ability to design, analyze and perform experiments on real life problems in mechanical engineering using python.

Course Outcomes: Learner will be able to

1. Demonstrate understand of basic concepts of python programming.
2. Identify, install and utilize python packages
3. Develop and execute python programs for specific applications.
4. Develop and build python program to solve real-world engineering problems
5. Prepare a report on case studies selected.

Module	Details	Hours
1.	Introduction to python and its applications. Installation of Python and setting up a programming environment such as Anaconda and Spyder Python Basics: Variable and variable types, Booleans, Numbers (integers, floats, fractions, complex numbers), strings, lists, tuples, sets, dictionaries. bytes and byte arrays, manipulating variables, indexing, slicing, basic operators (arithmetic, relational, logical, membership, identity). String methods, list methods, list slicing, set methods, in built python functions, input and output functions.	04
2.	Basic Coding in Python: If, else, elif statements, for loops, range function, while loops, List comprehensions, functions in python. Introduction to OOP, Classes, Objects, Reading and writing files.	02
3.	Python libraries: Installing of different libraries, packages or modules. Basic concepts of the following libraries: NumPy, Matplotlib, Pandas, SciPy Optional libraries based on case studies in Module 4: Pillow, Scikit, OpenCV, Python in Raspberry Pi	04
4.	Case Studies using Python (Select any 3): 1. Solving a linear differential equation using SciKit and plotting the result in matplotlib. Students can use differential equations from any previous topic studied in the programme such as mechanics, materials science, fluid mechanics, kinematics of machines, thermodynamics, production etc. 2. Image processing and manipulation and auto detection of any object. Applications in self-driving cars may be discussed. 3. Python programming of a Raspberry PI: Students can sense using a sensor, process the reading and then control some physical output (like motor or LED) 4. Project involving basic machine learning (Students should understand the basic concepts of machine learning and apply to specific situation) 5. Any other case study that uses Python to solve Mechanical Engineering problems. 6. Customizing applications by writing API programs using python like to create joints, get physical properties, get circle and arc data from edge.	06

Assessment:

Termwork : 50 marks (Continuous evaluation)
Practical/Oral : 25 marks

Books/References:

1. Core Python Programming, Dr. R. NageswaraRao, Dreamtech Press
2. Programming through Python, M.T.Savaliya and R.K.Maurya, StarEdu Solutions
3. Beginning Python: Using Python 2.6 and Python 3.1. James Payne,Wrox publication2.
4. Any digital resources and online guides for python or its packages. Such as "The Python Tutorial", http://docs.python.org/release/3.0.1/tutorial/

Back to Scheme

Course Code	Course Name	Credits
AE112	**Professional Communication and Ethics I**	1+1

Course Objectives:

1. To understand, compare and demonstrate the importance and relevance of communication with specific emphasis on listening skill.
2. To promote practice in speaking skill and encourage learners to compose on the spot speeches for the purpose of developing and generating ideas.
3. To train learners in reading strategies that will enhance their global understanding of the text and help them to comprehend academic and business correspondence.
4. To illustrate effective writing skills in business, academic and technical areas.
5. To inculcate confident personality traits with grooming and social etiquette
6. To train learners in producing words on the basis of contextual cues and reflect on errors in sentences.

Course Outcomes:

1. Listen, comprehend and identify potential barriers in spoken discourse with ease and accuracy.
2. Develop confidence and fluency in speaking at social,academic and business situations as well as make effective professional presentations.
3. Implement reading strategies for systematic, logical understanding, that will enhance the skill of comprehension, summarisation and evaluation of texts.
4. Understand and demonstrate effective writing skills in drafting academic, business and technical documents.
5. Communicate effectively in academic as well as business settings, displaying refined grooming and social skills.
6. Anticipate the meaning of unfamiliar words with the help of contextual cues and construct grammatically correct sentences.

Theory Syllabus:

Module	Details	Hours
1	**The Importance and Strategies of Effective Listening** **Prerequisite: Able to listen, read, speak, write and comprehend the target language** Introduction to communication 1.1 Importance and relevance of communication 1.2 Listening skill -ability to discriminate stress and intonation - Comprehend meaning of audio text-graded on the basis of vocabulary, sentence construction and theme. - potential barriers	4
2	**Developing Speaking Skills** 2.1 Intensive Speaking- on the spot topics 2.2 Responsive speaking-answering a question 2.3 Interactive speaking-conversations 2.4 Extensive speaking-speech, oral presentations-specific emphasis on plagiarism check and generating the report	4

3	**Strategies and Techniques to build Reading Skill** 3.1 Global understanding of the text- inference, anticipation and deduction 3.2 Detailed understanding of text-scanning for specific information (special emphasis on reading comprehension exercises and summarisation)	2
4	**Developing Professional Writing Skills** 4.1 Effective introduction with emphasis on general statement, opposing statement and thesis statement 4.2 Critical response to a text with special reference to purpose, evaluation of the content, theme and style of a text 4.3 Organization of ideas, sentence construction and word choice, grammar and usage 4.4 Explanation and support of ideas (special reference to writing paragraphs and business letters- Sales and complain letters}	4
5	**Etiquette and Grooming for Personality Development** 5.1 Social Etiquette 5.2 Corporate etiquette 5.3 Confidence building and Personality development	1
6	**Vocabulary and Grammar** 6.1 Contextual vocabulary Development- Word Maps 6.2 Identifying errors in a sentence.	1

Lab Syllabus:

Sr. No.	**Level** 1. Basic 2. Design 3.Advanced 4.Project/Case Study/Seminar	**Detailed Lab/Tutorial Description**
1	Assignment 1	Written record of listening activities-Listening practice tasks of 3 types (through audio recordings of (1) Monologues (2) Dialogues (3) Formal/Expert Talk or Lecture)
2	Assignment 2	Transcription of the public speech along with a plagiarism report-Practice public speech
3	Assignment 3	Summarization through graphic organisers (1. Text to graphic organizer 2. Graphic organizer to text)
4	Assignment 4& 5	1. Case studies on critical thinking 2. Business letters in complete block format
5	Assignment 6	Documentation of case studies/Role play based on Module 5
6	Assignment 7 & 8	1. Contextual Vocabulary Development 2. Aptitude Test

Theory Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and the second class test when an additional 35% syllabus is completed.

(Note: Summarization should be a compulsory question in Test II and not in the End Semester Theory Examination.)

End Semester Theory Examination:

1. Question paper will consist of 5 questions, each carrying 10 marks.
2. Total 3 questions need to be solved.
3. Q.1 will be compulsory, based on the entire syllabus.
4. Remaining questions will be randomly selected from all the modules.
5. Weightage of marks should be proportional to the number of hours assigned to each module.

Lab Assessment:

Term work:

Term Work shall consist of 8 Assignments.

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

1. Assignments : 10 marks
2. Oral Exam/ Public Speaking : 10 marks
3. Attendance (Theory and Tutorial) : 05 marks

Books/References:

1. Raman Meenakshi & Sharma Sangeeta, Communication Skills, Oxford University Press
2. Kumar Sanjay & Lata Pushp, Communication Skills, Oxford University Press
3. Locker, Kitty O. Kaczmarek, Stephen Kyo. (2019). Business Communication:
4. Building Critical Skills. Place of publication not identified: Mcgraw-hill.
5. Murphy, H. (1999). Effective Business Communication. Place of publication not identified: Mcgraw-Hill.
6. Lewis, N. (2014). Word power made easy. Random House USA.

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Course Code	Course Name	Credits
AE113	**Machine Shop Practice**	1.5

Course Objectives:

1. To familiarize with basic machining processes by working with your own hands.
2. To Acquaint to various machining operations and machine protocols

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

1. Operate a lathe machine.
2. Perform shaping operations.
3. Perform finishing operations on grinding machines.
4. Perform milling operations.
5. Perform precision turning.
6. learn machine maintenance.

Module	Details	Hours
1.	Introduction to Lathe Machine, demonstration of various machining processes performed on lathe machine. One Job on Plain and Precision Turning, Taper Turning and; Screw Cutting by setting gear train; for desired thread cutting on lathe as per chart	10
2.	Introduction to Shaping Machine and various machining processes performed on Shaping Machine One job on shaping machine to make horizontal and inclined surface	6
3.	One composite job including welding, grinding, milling	9
4.	Lathe Machine maintenance activity, like apron overhauling, tailstock overhaul ,etc	4
5.	CNC milling program making for flat job with geometric contours	3

Assessment:

Term Work:

1. Composite job mentioned above and the Welding Job
2. Complete Work-Shop Book giving details of drawing of the job and timesheet.

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

1. Job Work with complete workshop book : 45 marks
2. Attendance : 05 marks

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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 applications areas • Pattern making materials, Types of pattern 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, Hybrid joining processes. • Classification and working of various welding methods: Gas, Arc, Chemical, Radiant, Solid State etc. • Welding Joints, Welding Positions, Welding defects and their remedies.	8
3	**Forming Processes** • Introduction and classification of metalworking processes, hot and cold working processes • Introduction, classification and analysis of forging and rolling operations, Defects in rolled and forged components, • Extrusion process, Classification and analysis of wire and tube drawing processes. **Sheet metal working processes** • Classification of Sheet metal operations, types of Presses used in sheet metal operations, types of dies.	8

4	**Machine Tools, Machining Processes** ● **Machine Tools and Machining Processes:** Lathe Machines, Milling Machines, Drilling Machines, and Grinding Machines and selection of grinding wheel (Dressing and Truing), Broaching machines, Lapping/Honing machines (Super Finishing Operations) and shaping/slotting/planning Machines. ● **Gear Manufacturing** Gear milling, standard cutters and limitations, Gear Hobbing, Gear Shaping, Gear Shaving and Gear Grinding processes **Tool Engineering** ● 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.	8
5	**Non Traditional Machining Processes** ● Electro-chemical machining (ECM) ● Electric-discharge machining (EDM) ● Ultrasonic machining (USM) ● Laser Beam Machining (LBM)	4
6.	**Polymer Processing:** ● Polymer Molding Techniques for thermoplastic and thermosetting plastics. Applications of Plastics in the engineering field. **Powder Metallurgy**: ● Introduction to PM, Powder making processes, Steps in PM. Compaction and Sintering processes. Secondary and finishing operations in PM. **Intelligent manufacturing in the context of Industry 4.0**, ● Cyber-physical systems (CPS) ● Internet of Things (IoT) enabled manufacturing ● Cloud Manufacturing	6

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.

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Course Code	Course Name	Credits
AE202	**Engineering Mathematics III**	3

Course Objectives:

1. To learn the Laplace Transform, Inverse Laplace Transform of various functions, and its applications.
2. To understand the concept of Fourier Series and enhance the problem-solving skills.
3. To learn complex forms of Fourier series and Fourier Transform.
4. To acquaint yourself with the concepts of probability, random variables, and expectations.
5. To acquaint myself with the concepts of probability distributions and sampling theory.
6. To learn the partial differential equations and numerical methods to solve it which are used in engineering problems

Course Outcomes

1. Understand the concept of Laplace transform and its application to solve the real integrals, understand the concept of inverse Laplace transform of various functions and its applications in engineering problems.
2. Apply the knowledge of Fourier series in engineering problems.
3. Apply the knowledge of complex form of Fourier series and Fourier Transform in problem solving.
4. Illustrate understanding of the concepts of probability and expectation for decision making.
5. Use the concept of probability and sampling theory in data science.
6. To apply the numerical methods to find the solution of Mathematical Models of real-life problems.

Module	Details	Hours
1	**Laplace Transform and Inverse Laplace Transform** Definition, Condition of Existence, Laplace Transforms of Standard Functions. Properties of Laplace Transform: Linearity, First Shifting theorem, Second Shifting Theorem, change of scale Property, multiplication by t, Division by t, Laplace Transform of derivatives and integrals. Inverse Laplace Transform: use of standard formulae, using derivative, Partial fractions method, first shift property and second shifting property to find inverse Laplace transform, Convolution theorem (without proof) **Optional Topics** Applications of Laplace Transform to solve initial and boundary value problems involving linear ordinary differential equations of first and second order, Bilateral Laplace Transform	6
2	**Fourier Series** Orthogonal and orthonormal set of functions, Dirichlet's conditions, Fourier series of periodic function with period 2π and $2l$, Fourier series of functions with point of discontinuity, and of even and odd functions, Half range Sine and Cosine Series. Parseval's Identity (without proof)	6

3	**Fourier Integral and Fourier Transform** Complex form of Fourier Series, Fourier Integrals Fourier cosine and sine transform. Applications of Fourier Transform, Comparison of Fourier and Laplace transforms.	6
4	**Probability Theory** Conditional probability, Total Probability and Baye's Theorem. Discrete and Continuous random variables, Probability mass and density function, Probability distribution for random variables, Expectation, Variance, Co-variance. **Optional Topics:** Moments, Moment generating functions, (Four moments about the origin & about the mean).	6
5	**Probability Distribution and Sampling Theory-I** Probability Distribution: Binomial, Poisson and Normal distribution, Sampling distribution, Test of Hypothesis, Level of Significance, Critical region, One-tailed, and two-tailed test, Degree of freedom. Students't- distribution (Small sample). Test the significance of single sample mean and two independent sample means and paired t-test) **Optional Topics** Test of significance of large samples, Proportion test	6
6	**Partial Differential Equations** Introduction of Partial Differential equations Classification Method of separation of variables to solve the problem of Vibrations of string, One dimensional heat and wave equations. Numerical methods to solve PDE: Bender Schmidt scheme and Simplified Crank Nicholson scheme. **Optional Topics** Approximation of derivatives by difference schemes, Solution of Laplace equation and applications.	6

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:

General Instructions:

1. Batch wise practicals are to be conducted. The number of students per batch should be as per norms.
2. At Least 6 tutorials/assignments need to be submitted based on the entire syllabus.

Term Work assessment must be based on the overall performance of the student with every tutorial/assignment graded from time to time.

The distribution of Term Work marks will be as follows –

1. Attendance (Theory,Tutorial) : 05 marks
2. Assignments/Tutorials on entire syllabus : 20 marks

Books/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

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

Course Objectives:

1. To understand mechanical behavior of the body by determining the stresses, strains and deflections 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 struts, thin cylindrical and spherical shells

Course Outcomes:

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

1. Apply principles of statics to determine reactions & internal forces in statically determinate beams
2. Understand the different types of stresses and strains developed in the member subjected to axial, bending, shear & torsional loads.
3. Compute slope and deflection at various points of a beam.
4. Identify, formulate, and solve static engineering problems.
5. Comprehend the behaviour & 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:** **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,	07
4	**Torsion of Shafts:** Introduction to Torsion, Torsion formula – stresses and deformations in circular and hollow shafts, Stepped shafts, Design of shafts	06

	according to theories of failure. **Strain Energy:** Strain energy due to axial load (gradual, sudden and impact), Strain energy due to bending and torsion.	
5	**Deflection of Beams:** **Deflection of a beam:** Double integration method, Maxwell's reciprocal theorems for computation of slopes and deflection in beams for point and distributed loads, derivation of formula for slope and deflection for standard cases, Area moment theorems for computation of slopes and deflections in beams – Conjugate beam method	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.	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.	2
8.	Tensile Test on thin cross-section (rectangular/circular) specimens using Tensile Testing Machine.	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:

Term Work: 25 marks

Term Work consists of an ample number of assignments and experiments as decided by the Instructor. Minor-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

Back to Scheme

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

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 vapour and gas.
4. To study the overview of fuels & combustion.
5. To demonstrate the procedures for determining thermodynamic properties of pure substances from tables of property data.
6. To introduce the first law of thermodynamics, energy balances, and mechanisms of energy transfer to or from a system.

Course Outcomes:

1. Able to solve energy balance problems for closed (fixed mass) systems that involve heat and work interactions
2. Able to apply the second law of thermodynamics to cycles and cyclic devices.
3. Able to evaluate internal energy, enthalpy, entropy of simple compressible systems from properties that are more readily measured.
4. Able to calculate the enthalpy of reaction, enthalpy of combustion, and the heating values of fuels.
5. Able to investigate the performance of vapour & gas power cycles.
6. Able to do the availability analysis for the design and analysis of thermal systems.

Module	Details	Hours
1	**1.1 Introduction** Importance of Thermodynamics, concept of equation of state, energy, internal energy, specific properties, heat & work transfer, pdV work or displacement work. **1.2 First Law of thermodynamics** First law applied to the closed system undergoing a cycle and change of state, ideal gas processes, PMM1. Flow process and flow energy, First law applied to steady flow processes, − vdp work, relation between non flow work and flow work, Limitations of the 1st law.	6
2	**2.1 Second Law of Thermodynamics:** Thermal reservoir, Concept of heat engine, Heat pump and Refrigerator, Statement of the second law of thermodynamics, equivalence between Kelvin-Planck and Clausius statement, Reversible and irreversible Process, Causes of irreversibility, PMM2, Carnot cycle, Carnot theorem, Corollary of Carnot theorem, Thermodynamic temperature scale. **2.2 Entropy:** Clausius Inequality theorem, Entropy - a property of the system, Temperature-Entropy diagram, increase of entropy principle, entropy transfer and entropy generation, Entropy balance, Entropy change during a process.	7
3	**3.1 Availability:** Quality energy, available and unavailable energy, useful work and dead state, availability of closed system and steady flow process.	6

	3.2 Thermodynamic Relations Helmholtz and Gibbs functions, Maxwell equation (without derivation), TdS relations, Volumetric expansivity, Isothermal & isentropic compressibility, Clausius-Clapeyron equation, Joule Thomson coefficient – porous plug experiment, definition of third law of thermodynamics.	
4	**4.1 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, **4.2 Vapour Power Cycle:** Carnot cycle, Limitations of Carnot vapour cycle, Rankine cycle, mean temperature of heat addition, Rankine cycle with superheat, reheat.	7
5	**5.1 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
6	**6.1 Combustion Thermodynamics:** Complete and incomplete combustion, air fuel ratio, theoretical and excess air for combustion, enthalpy of formation, analysis for a non flow process involving combustion at constant volume, analysis of steady flow or constant pressure combustion, heating values, adiabatic flame temperature, combustion efficiency enthalpy and internal energy of combustion.	6

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. 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, 9thedition, 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,1stEditionTMH
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) Pvt. Ltd
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.

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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 thephase transformations in steels
5. Apply heat treatment to different components based on the property requirement
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.	6
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.	7
6.	Failure by fracture-micromechanisms-fatigue and creep. Non destructive evaluation to prevent failures.	6

Lab Syllabus:

Experiment	Details	Hours
1	Study of Characterization techniques and Metallographic sample preparation and etching	2
2	Comparison of Microstructures and 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 (Using different hardness testers to measure the Hardness)	2

5	Fatigue test – to determine number of cycles to failure of a given material at a given stress	2
6	Tension test on mild steel bar (stress-strain behaviour, determination of yield strength and modulus of elasticity)	2
7	Torsion test on mild steel bar / cast iron bar	2
8	Impact test on metal specimen (Izod/Charpy Impact test)	2
9	Hardness test on metals – (Brinell/ Rockwell Hardness Number	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.

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

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Course Code	Course Name	Credits
AE206	**Computer Aided Drafting**	2

Course Objectives:

1. To impart the 3D modeling skills for development of 3D models of basic engineering components.
2. To introduce Product data exchange among CAD systems.
3. To familiarize with production drawings with important features like GD &T, surface finish.

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

1. Visualize and prepare 2D modeling of a given object using modelling software.
2. Build a solid model of a given object using 3D modeling software.
3. Visualize and develop the surface model of a given object using modelling software.
4. Generate assembly models of given objects using assembly tools of a modelling software

Module	Details	Hours
1.	**CAD Introduction** CAD models Creation, Types and uses of models from different perspectives. Parametric modelling and Non - Parametric Modelling. **GD & T** Limits, Fits and Tolerance	4
2.	**2D Sketching** Geometric modeling of an Engineering component, sketching commands of creation, modification commands and viewing the sketch.	4
3.	**Solid Modeling** 3D Geometric modeling of an Engineering component, modeling features. Using 3D components from software library (Eg. Nut, Bolt, Screw etc.)	6
4.	**Surface Modeling** Extrude, Sweep, Trim etc and Mesh of curves, free form surfaces etc. Feature manipulation using Copy, Edit, Pattern, Suppress, History operations etc.	6
5.	**Assembly** Constraints, Exploded views, interference check. Drafting (Layouts, Standard & Sectional Views, Detailing & Plotting), Bill of materials, Giving machining symbols using software in drafting.	4
6.	**Data Exchange** CAD data exchange formats Like IGES, PDES, PARASOLID, DXF and STL along with their comparison and applicability. **Case Study**	2

Assessment:

Term work

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 modelers 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

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

1. Printouts/Plots : 20 marks
2. Attendance : 05 marks

End Semester Practical/Oral examination:

To be conducted by pair of Internal and External Examiner

1. Practical examination duration is two hours, based on Advance level of the Term work.
2. Oral examination should also be conducted to check the knowledge of CAD Modelling Tools.
3. The distribution of marks for practical examination shall be as follows:
   a. Practical Exam : 30 marks
   b. Oral Exam : 20 marks
4. Evaluation of practical examination to be done based on the printout of students work
5. Students work along with evaluation report 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 Kanheya

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

Course Objectives:

1. To familiarize with subtractive manufacturing processes in particular CNC systems.
2. To acquaint with basic of part programing concept for specific operations.
3. To familiarize with the additive manufacturing process
4. To acquaint with basic process of developing 3D model using biomedical data.

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

1. Develop and execute CNC part programme for any given specific operation.
2. Build any given object using various CNC operations.
3. Develop 3D model using available biomedical data
4. Build any given real life object using the 3D printing process.
5. Understand the integration between various manufacturing systems

Module	Details	Hours
1	Part programming and part fabrication on CNC Turning trainer (Involving processes like Step turning, facing, Taper turning, threading, etc.)	2
2	Part programming and part fabrication on CNC Milling trainer (Involving processes like contouring, drilling, facing, pocketing etc.)	2
3	Part Programming Simulation for any Unconventional Machining Process (Electric Discharge Machining, laser cutting Machining, Plasma Cutting Machining etc.)	2
4	Tool-path generation by translation of part geometry from computer aided design (CAD) to computer aided manufacturing (CAM) systems.	4
5	Development of physical 3D mechanical structure using any one of the rapid prototyping processes.	4
6	Creation of 3D model from 2D images using any image processing software and printing it. (3D Slicer open source) (Application: Any body organ like Heart, Gallbladder etc. as per available DICOM files)	2
7	Manufacturing Simulation and Integration	4
8	Case Study: Report on a visit conducted to any Commercial CNC Machining Centre explaining the Design features, preprocessing in CAM software and its capabilities.	4

Assessment:

Termwork:

Distribution of marks:

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

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
AE 291	**Minor Project I**	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 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
AE208	**Automotive Engines & Combustion**	3+1

Course Objectives:

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

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
AE209	**Theory of Machines & Mechanisms**	3+1

Course Objectives:

1. To provide students with the knowledge on mechanisms and inversions.
2. To impart students with knowledge about forces acting on machine parts.
3. To enable students to understand the fundamental concepts of machines.
4. To study functioning of motion and power transmission machine elements.
5. To facilitate students to understand the functions of cams, gears, belt drives, chain drives and brakes.

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

1. Identify mechanisms and their inversions.
2. Compute velocity and acceleration of various plane mechanisms by different methods.
3. Apply the principles for analyzing cams, gears and gear trains.
4. Synthesize mechanisms for following useful paths.
5. Draw cam profile for specific follower motion.
6. Develop and design mechanisms.

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:** **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 mechanisms. (limit to only 4 link mechanisms) **Instantaneous center of rotation (ICR) method:** Definition of ICR, Types of ICRs, Methods of locating ICRs (limit to only 6 link mechanisms), Kennedy's Theorem, Coriolis component of acceleration.	08

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. **Brakes:** Introduction, types and working principles, Introduction to braking of vehicles.	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 210	**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**: 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	6

	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
AE211	**Elements of Machine Design**	3

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

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

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

Back to Scheme

Course Code	Course Name	Credits
AE 212	**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 on the different ethical dilemmas at the work place and society.
3. To inculcate the ethical code of conduct in writing technical article 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 Presentation of Information	07

	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
AE213	**Data Science**	2

Course Objectives:

1. To introduce concepts of Data Science using R programming language.
2. To introduce basic concepts of R programming language as well as common packages and libraries.
3. To generate an ability to utilize Data Science concepts with R programming to solve mechanical engineering related problems.

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

1. To understand concepts of data science with R programming language.
2. To understand fundamentals of R programming and data frame.
3. To be able to visualize the data using R programming package.
4. To be able to prepare the data for analysis.
5. Understanding hypothesis testing and being able to make decisions.

Module	Details	Hours
1.	**Introduction to business analytics** What is analytics & why is it so important - Applications of analytics - Different kinds of analytics - Various analytics tools - Analytics project methodology	04
2.	**Fundamentals of R** Installation of R & R Studio - Getting started with R - Basic & advanced data types in R - Variable operators in R - Working with R data frames - Reading and writing data files to R - R functions and loops - Special utility functions - Merging and sorting data	10
3.	**Data visualization in R** Need for data visualization - Components of data visualization - Utility and limitations - Introduction to grammar of graphics - Using the ggplot2 package in R to create visualizations	08
4.	**Data preparation and cleaning using R** Needs & methods of data preparation - Handling missing values - Outlier treatment - Transforming variables - Derived variables - Binning data - Modifying data with Base R - Data processing with dplyr package	08
5.	**Understanding the data using univariate statistics in R** Summarizing data, measures of central tendency - Measures of variability, distributions - Using R to summarize data **Hypothesis testing and ANOVA in R to guide decision making** Introducing statistical inference - Estimators and confidence intervals - Central Limit theorem - Parametric and non-parametric statistical tests - Analysis of variance (ANOVA) - Conducting statistical tests	10
6.	**Correlation and Linear regression** Correlation - Simple linear regression - Multiple linear regression - Model diagnostics and validation - Case study **Logistic regression** Moving from linear to logistic - Model assumptions and Odds ratio - Model assessment and gains table - ROC curve and KS statistic - Case Study	10

Assessment:

Term Work:

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

Experiment write ups : 45 Marks
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:

Practical Exam : 15 marks
Oral Exam : 10 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.

Back to Scheme

Course Code	Course Name	Credits
AE301	**Finite Element Analysis**	3+1

Course Objectives:

1. To equip with the Finite Element Analysis fundamentals.
2. To apply finite element formulation for the solution of mechanical engineering problems.
3. To make the students use simulation techniques to get results for complex problems.

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

1. Apply weighted residual methods to solve governing differential equations of the problem domain.
2. Discretize the problem domain using appropriate elements and apply boundary conditions.
3. Apply the finite element formulation to solve one-dimensional mechanical engineering problems.
4. Apply the finite element formulation to solve two-dimensional mechanical engineering problems.
5. Apply the finite element method to solve one-dimensional dynamic problems.
6. Use professional-level finite element analysis software to solve real life problems.

Theory Syllabus:

Module	Details	Hours
1.	**Introduction:** Weighted Residual Methods, Variational formulation of boundary value problems, Principal of Minormum Potential Energy, Ritz Method.	4
2.	**Basic concept of Finite Element Method:** Mathematical modeling of field problems in engineering with One dimensional second order equation, discretization, Element types, 1D linear and higher order elements, derivation of shape functions in local and natural coordinate systems, Stiffness matrix and force vectors, assembly of elemental matrices.	8
3.	**1D Analysis:** Application of element stiffness matrix to find Solution of problems from solid mechanics (Step bar, trusses, beams, torsion etc.), heat transfer, fluid flow etc.	8
4.	**Dynamic Analysis:** Dynamic equations of motion, consistent and lumped mass matrices, free vibration analysis.	6
5.	**2D Analysis:** Two dimensional equations, variational formulation, finite element formulation, Plane stresses and plane strain problems, body forces and thermal loads, plate and shell elements, triangular elements - shape functions, elemental matrices, stress analysis and RHS vectors, quadrilateral and higher order elements, isoparametric elements and its shape functions, Convergence and compatibility condition.	8
6.	**Application of FEA:** Discussion of various case studies in different fields and its simulation in FEA software (may include special cases like composites, nonlinear analysis, multi domain analysis etc.).	5

Laboratory Syllabus:

Exercise	Details	Hours
1	Introduction to ANSYS (APDL and Workbench)	2
2	Analysis of Rod subjected to axial Load (Step bar, taper rod)	2
3	Truss Analysis	2
4	Beam Analysis	2
5	Thermal Analysis	2
6	Modal analysis	2
7	Axis-symmetry Analysis	2
8	Convergence Study	2
9	Comparison of results while solving the same problem in 1D, 2D or 3D.	2
10	Writing a program using any programming language (Python, R, Matlab, Scilab, C++, etc.) for a finite element solution to any 1D/2D problem.	2
11	Course Project: Simulation of any assembly / Multi domain Analysis / Nonlinear analysis / Analysis of Composites etc.	4

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

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Laboratory Assessment:

Internal Assessment: 25 marks

Term Work:

A. Minimum 6 exercises from 2-10 of the above list need to be undertaken.
B. Validation of the simulation results obtained through software with calculation.
C. Exercise 11 is compulsory. Presentation/Seminar of the study done is required.

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

Part A : 10 marks

Part B : 5 marks
Part C : 10 marks

End Semester Practical/Oral Examination:

A pair of Internal and External Examiner 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. J. N. Reddy; An Introduction to Finite Element Method; 3rd Edition, McGraw Hill.
2. R. D. Cook, Davis S. Malkus, Michael E. Plesha and Robert J. Witt; Concepts and Applications of Finite Element Analysis; 4th Edition, Wiley.
3. S. S. Rao; The Finite Element Method in Engineering; 5th Edition, Elsevier, Butter Worth Heinemann.
4. O. C. Zienkiewicz and R. L. Taylor; The Finite Element Method, Vol. I and II, 6th Edition, Elsevier, Butter Worth Heinemann.
5. K.L. Bathe and E.L. Wilson; Finite Element Methods; Prentice Hall.
6. David V Hutton; Fundamentals of Finite element analysis; 7th Edition Tata McGraw Hill.
7. T. R. Chandrupatla and A. D. Belegundu; Introduction to Finite Elements in Engineering; 4th Edition, Pearson.
8. D. L. Logan; A first course in Finite Element Method; 5th Edition, Cengage Learning.
9. P. Seshu; Text book of Finite Element Analysis; 10th Edition, Prentice Hall of India.
10. N. S. Gokhale, S. S. Deshpande, S. V. Bedekar and A. N. Thite; Practical Finite Element Analysis; 1st Edition, Finite to Infinite.

11. Understanding of Differential equations including degree, order, boundary conditions. Solution of Ordinary Differential equations.
12. Understanding of Basic Algebra and Matrices.
13. Understanding of Solid Mechanics, thermal, fluid systems along with their governing equations and variables.

Back to Scheme

Course Code	Course Name	Credits
AE302	**Heat Transfer**	3+1

Course Objectives:

1. To understand the fundamentals of heat transfer in fluids and solids during steady state and unsteady state.
2. To Study mathematical modeling and designing concepts of heat exchangers

Course Outcomes: Learner will be able to

1. Understand the basic laws of heat transfer
2. Identify, formulate, and solve heat transfer problems in thermal analyses of engineering systems.
3. Analyze problems and develop solution for steady state and unsteady state heat conduction problem in simple geometries
4. Understand the fundamentals of convective heat transfer process Evaluate heat transfer coefficients for natural convection and forced convection.
5. Calculate radiation heat transfer between black body and grey body surfaces.
6. Analyze heat exchanger performance and estimate an effectiveness of heat exchanger.

Theory Syllabus:

Module	Detail Content	Hrs.
1	**Basic concepts of heat transfer** Difference between heat transfer and Thermodynamics, Physical mechanism of different modes of heat transfer, Steady and unsteady heat transfer, one dimensional, two dimensional and three dimensional heat transfer, Fourier law of heat conduction, Thermal conductivity, Thermal resistance concept in heat transfer, Thermal diffusivity, Governing law of convection, Free and forced convection.	6
2	**Conduction** Generalized heat conduction equation in rectangular, cylindrical and spherical coordinates (only equation for cylindrical and spherical coordinates, no derivation), Steady state heat conduction through plane wall, Composite wall, cylinder, composite cylinder wall, sphere, and composite sphere wall, Critical radius of insulation in cylinder and sphere, Thermal contact resistance, Internal Heat generation concept.	7
3	**Heat transfer from Extended Surface** Types of extended surface and its significance Governing differential equation for fin and its solution, Fin performance: Fin effectiveness and Fin efficiency, Thermowell **Unsteady state heat transfer** Applications of unsteady state heat transfer, Lumped system Analysis, characteristic length, Biot Number, Thermal time constant and Response of a thermocouple, Heisler Charts	6
4	**Convection** Determination of heat transfer coefficient, Dimensional Analysis, Dimensionless numbers in free and forced convection and their	7

	significance. **External Flow** Velocity Boundary layer and Thermal Boundary layer, Laminar and turbulent, flow over a flat plate, Flow across cylinder and sphere, Flow across bank of tubes **Internal Flow** Velocity Boundary layer and Thermal Boundary layer, Laminar and Turbulent, flow in tubes, General thermal analysis: Constant heat flux and constant surface temperature **Heat Pipe** Introduction and application	
5	**Radiation** Emissivity, transmissivity, reflectivity, absorptivity, black body, Grey body, Opaque body, Radiation intensity, Basic laws of radiation, Radiation heat exchange between black bodies, Reciprocity theorem, Shape factor algebra, Radiation heat exchange between nonblack bodies, Electrical network approach for radiation heat exchange: Radiosity and irradiation, Radiation shield	6
6	**Boiling and Condensation:** Boiling heat transfer, Pool boiling: different regimes and pool boiling curve, Flowboiling: Different Regimes and Boiling curve, Condensation heat transfer, Film condensation, Dropwise Condensation. **Heat Exchangers:** Types of heat exchangers, Overall heat transfer coefficient, Fouling factor Analysis of heat exchangers, LMTD, Effectiveness –NTU method, Correction factor Effectiveness of heat exchangers.	7

Laboratory Syllabus:

SN	Details	Hrs.
1	Measurement of thermal conductivity of insulating powder	2
2	Measurement of thermal conductivity of metal rod	2
3	Performance analysis of extended surfaces under free and force convection	2
4	Unsteady state heat transfer in cylinder/rod/wall	2
5	Measurement of Emissivity of Grey surface	2
6	Estimation of overall heat transfer coefficient and effectiveness of double pipe heat exchanger (parallel flow and Counter flow arrangement)	2
7	Simulation to estimate effect of various parameters on heat transfer	2
8	Heat Transfer analysis/estimation using numerical methods/computational techniques	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

Lab Assessment:

Term Work:

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

Experiment write ups : 20 Marks
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:

Practical Exam : 15 marks
Oral Exam : 10 marks

Books/References:

1. Introduction to thermodynamics and Heat transfer by Yunus A Cengel 2nd Edition, McGraw Hill International
2. Fundamentals of Heat and Mass Transfer by FPIncropera and D P deWitt, Wiley India
3. Heat Transfer by P S Ghoshdastidar, 2nd Edition, Oxford University Press
4. Heat and Mass Transfer, by R Rudramoorthy and L Malaysamy,2ndEdition, PEARSON
5. Heat Transfer by J P Holman, Mcgraw Hill
6. Heat Transfer by S P Sukhatme, University Press
7. Heat and Mass Transfer by PK Nag, TMH
8. Heat and Mass Transfer by Mahesh Rathod, Laxmi Publications
9. Heat and Mass Transfer byR K Rajput, S Chand and company

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Course Code	Course Name	Credits
AE303	**Automotive Systems**	3+1

Course Objectives:

1. To study basic and advance automotive systems.
2. To study working of different automotive systems and subsystems.
3. To study different types of frames and vehicle layout.
4. To have basic idea about how automotive systems are developed.

Course Outcomes: Learner will be able to

1. Identify different types of frames and axles.
2. Comprehend working of Clutches and transmission systems in automobiles.
3. Interpret the need of driveline components in automobiles.
4. Compare different types of steering systems and analyze steering geometry.
5. Comprehend use of brakes, wheels and tires in automobiles.
6. Identify and Understand working of different vehicle systems and subsystems.

Theory Syllabus:

Module	Details	Hours
1	**Frames and Axles-** Frames-Layouts, types, material, construction, loads acting Front and Rear axles – Types of Front Axles and Stub axles,Construction and Materials **Automotive Clutch**- Necessity of clutch in a automobile, Working and Construction of Single plate, Multi-plate, Centrifugal, Semi Centrifugal, Electromagnetic clutches, Fluid Flywheel	06
2	**Automotive Transmission**- Purpose and Elements of Gear Box, Characteristic Curves, Types-Sliding mesh, Constant Mesh, Synchromesh, Determination of gear ratios for vehicles, **Hydrodynamic Transmissions** - Torque converter – Principle - constructional details, Multistage torque converters and Polyphase torque converters. **Epicyclic Gearboxes used in automatic transmissions-** Principle of Planetary gear trains-Wilson, Cotal electromagnetic transmission, Continuously Variable Transmission-Types and Operation of typical CVT Automotive Powertrain, Powertrain Analysis and Transmission Matching	8
3	**Drive Line**: UV joint, CV joint, Propeller Shaft construction and arrangement, Elements of drive line, 2WD, 4WD, Part time and Full time 2WD and 4WD.Driving thrust and its effects, Torque reaction and Side thrust, Hotchkiss drive, Torque tube drive, Radius rods, Stabilizers **Final Drive** –Types of Final drive gears and Bearing **Differential** –Principle, Constructional details of Differential unit, Housing, Non slip differential and differential locks, gears and bearing	08
4	**Steering**-Introduction to steering systems, Manual Steering, Ackerman and Davis Steering Mechanisms, Steering Linkages Different types of Steering gear boxes, Reversible and Irreversible steering, Slip angle, Over and under steer Power steering systems, Front Wheel Geometry, Wheel alignment	06
5	**Brakes**- Introduction to Brake System, Components of Brake System, Hydraulic Brake, Air Brake, Antilock Brake System, Braking Analysis.	06

6	**Suspension**- Introduction to Suspension System, Components of Suspension System, Dependent and Independent Suspension, Types of Suspension Springs-Single leaf, Multileaf spring, Coil, Torsion Bar, Rubber, Pneumatic and Hydro elastic suspension spring systems. **Wheels and Tyres**- Tire requirement, tire characteristics, Constructional detail and retreading, tire dimensions and specifications, Types of wheels and Hubs.	08

Lab Syllabus:

A. List of Experiments

1. Dismantling and reassembling of Clutch.
2. Dismantling and reassembling Gear box.
3. Dismantling and reassembling of the Propeller Shaft.
4. Dismantling and reassembling of Differential.
5. Dismantling and reassembling of Steering gear linkages and steering gear box.
6. Dismantling and reassembling any one type of braking system.

B. Case Study

Case study and detail report explaining all systems and subsystems on any two of following

1. Passenger Vehicle
2. 2/3 Wheeler
3. Off Road Vehicles
4. Military vehicles

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:

Comprises both A & B

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

1. Part A: 10 marks
2. Part B: 10 marks
3. Attendance (Theory and Practical): 05 marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and Minimum passing in the term work.

Text Books:

1. Newton, Steed & Garret, Motor Vehicles, Butterworth Heinemann.
2. N. K. Giri, Automotive Mechanics, Khanna Publishers.

3. D. Crolla, D. E. Foster, T. Kobayashi and N. Vaughan (Editors-in-Chief), Encyclopedia of Automotive Engineering, Parts 1-6, Wiley, 2015.

Reference Books:

1. Crouse. W. H, Automotive Chassis and Body, McGraw Hill New York.
2. Jack Erjavec, Automotive Technology – A systems approach, Cengage Learning.
3. M. J. Nunny, Automotive Technology, SAE Publication.

Back to Scheme

Course Code	Course Name	Credits
AE304	**Controls Engineering and model based system**	3+1

Course Objectives:

1. To study concept of mathematical modelling of the control system
2. To acquaint with control system under different time domain
3. To study concepts of stability & various methods.
4. To study Multi-Input Multi-Output systems using state space
5. To study application of control systems for automobile systems.

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

1. Design mathematical models of system/process.
2. Analyse error and differentiate various types of control systems using time domain specifications
3. Analyse various methods and problems associated with stability
4. Analyse systems using graphical methods in frequency response
5. Understand the concept of state space methods for system analysis
6. Comprehend and apply concepts of control systems in automobile applications.

Module	Details	Hours
1.	**Introduction to the Control Systems** Introduction to control systems, Classification of control system. Open loop and closed loop systems. Mathematical modelling of control systems (Spring mass damper, electrical systems, thermal, fluid systems), concept of transfer function, Block diagram algebra	06
2.	**Time Response Analysis** Transient and steady state analysis of first and second order systems. Time Domain specifications. Step response of second order system. Steady-state error, error coefficients, steady state analysis of different type of systems using step, ramp and parabolic inputs	08
3.	**Stability analysis** Introduction to concepts of stability, Concept of S-plane Routh-Hurwitz Criteria for stability; Relative stability analysis; Root-Locus technique and construction of root-loci.	08
4.	**Frequency Response Analysis** Introduction to frequency response; Frequency response plots: Polar plot and Bode plot; Performance specifications in frequency domain. Stability margins in frequency domain; Mapping contours in s-plane; The Nyquist criterion; Relative stability using Nyquist criterion.	08
5.	**State space modeling** Concept of state, state variable, state model. State space representation using physical and phase variables, decomposition of transfer function, diagonalisation. State transition matrix. Transfer function from state model. Controllability and observability of linear systems.	06
6	**Applications of Control system** Analysis of Spring mass damper system, Analysis of motor controller (DC, Stepper, PMSM, Induction motor),Analysis of cruise control system, Analysis of electric vehicle charger	04

Laboratory Syllabus:

Sr. No.	Experiment Title
1	To study the time response of a first-order system to standard input signals.
2	To study the time response of a second-order system to standard input signals.
3	To study the frequency response of a second-order system to standard input signals.
4	To solve a differential equation model using simulation software.
5	To study the steady-state errors for type-0, 1 and 2 systems.
6	To perform stability analysis of control systems using Root Locus Technique.
7	To perform stability analysis of control systems using Bode plots.
8	To perform stability analysis of control systems using Nyquist plots.
9	To study controllability and observability of control systems.
10	To introduce the PID controller and its tuning.
11	Study the effect of PI & PD controller on System Performance
12	To design Lag, Lead and Lag -Lead compensator.

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:

Experiment write ups : 20 Marks
Attendance : 05 marks

End Semester Practical/Oral Examination: 25 Marks

Pair of Internal and External Examiner 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. Norman Nise, "Control Systems Engineering", Wiley, 8th edition, 2019.
2. M. Gopal, "Control Systems: Principles and Design", 3rd edition, Tata McGraw Hill, 2008.
3. Richard Dorf, Robert Bishop, "Modern Control Systems", 11th edition, Pearson Education, 2008

Reference Books:

1. Golnaraghi Farid, B. C. Kuo, "Automatic Control Systems", 10th edition, McGraw Hill, 2017.
2. K. Ogata, "Modern Control Engineering", 6th edition, Prentice Hall, 2010.
3. I. J. Nagrath, M. Gopal, "Control System Engineering", New Age International, 2009.

Back to Scheme

Course Code	Course Name	Credits
AE305	**Electrical Machines**	3

Course Objectives:

1. To study the concepts of magnetism and energy conversion.
2. To familiarize with the operational characteristics of DC machines and their applications.
3. To familiarize with the operational characteristics of AC machines and their applications
4. To familiarize with the operational characteristics of Synchronous and Special purpose machines and their applications

Course Outcomes: Learner will be able to

1. Explain the importance, working and applications of DC Machines
2. Understand and analyze the significance of the DC machines performance parameters.
3. Explain the importance, working and applications of AC Machines
4. Explain the importance, working and applications of Synchronous Machines
5. Analyze performance of DC and AC Machines
6. Describe stepper, servo motor and its drive systems along with its applications

Module	Details	Hours
1	**Introduction to Electrical machines** Aspects of Electromechanical Energy conversions, Features of Energy conversion, Energy balance equation, Energy in magnetic systems, Energy and co energy,Rotary Electrical machines, Motors and Generators, Basic construction of Electrical machines, Commonly used Electrical machines, Comparison of AC and DC drives, Four quadrant operation, Motor selection for industrial and miscellaneous application.	06
2	**DC Machines** Review of construction and components of DC machine, Commutator and brushes, concept of back EMF, and torque equations, Types of DC machines; Armature reaction, Characteristics of DC generators and motors (speed – torque and performance), Necessity of starter and types, Speed control and braking methods, Losses and efficiency, motor, Applications.	08
3	**Testing of DC Machines** Brake test. Swinburnes test, Advantages and disadvantages of Swinburne's test, Regenerative or Hopkinson's Test, Alternative connection for Hopkinson's test, Retardation test, and Fields test for Series motor.	06
4	**AC Machines** Three phase Induction motors: Classification, Principle, Construction of Squirrel cage Rotor and phase wound rotor motor, Relation between torque and rotor power factor, Starting torque for squirrel cage and slip ring motor, condition for maximum torque, Torque-slip characteristics, Slip and its effect on rotor frequency and EMF, Applications	08
5	**Synchronous Motors** Construction, Operating principle, Equivalent circuit, Pull out torque, Motor phasor diagram, Effect of changing field excitation at constant load ,power developed by motor, Stopping synchronous motor,	06

	Comparison of Synchronous and Induction motor, Applications	
6	**Special purpose Electric Machine** Stepper motor, PM Stepper motor, DC Servomotor, AC Servomotor, Switched Reluctance motor, PMDC, Brushless DC Motor.	06

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

Text Books:

1. Bimbhra P. S., Electric Machinery, Khanna Publisher,
2. M. V. Deshpande, Electric Machines, PHI
3. B.L.Theraja, A.K.Theraja, Electrical technology Volume-II,S chand Publications.

Reference Books:

1. Gopal Dubey,Fundamental of Electrical Drives,Narosa Publication
2. S. K. Pillai, A first course on Electrical Drives, New Age Publication
3. Ashfaq Husain, Electric Machines, Dhanpat Rai and Co. Publications

Back to Scheme

Course Code	Course Name	Credits
AE306	**CAD for Additive Manufacturing**	3

Course Objectives:

1. To provide detailed understanding of additive manufacturing processes.
2. Understand the manufacturing procedure of a prototype

Course Outcomes: Learner will be able to…

1. Understand the evolution and need of AM processes. It will develop the ability of select the process for particular application.
2. Understand the basic principle of curing type, extrusion and layer deposition type AM processes. The students will learn the pros & cons of these processes and their applications.
3. Understand the use of pre requirement of AM process. Basic knowledge about the software requirement and processing of drawing.
4. Select and use correct CAD formats in the manufacture of a 3D printed part.
5. Identify STL file problems and apply repair algorithms

Module	Details	Hours
1	**Introduction to Additive Manufacturing (AM):** Introduction to Additive Manufacturing and classification. Applications of additive manufacturing in rapid prototyping, rapid manufacturing, rapid tooling, repairing and coating	4
2	**AM technologies**: Introduction to 3D-printing, Stereolithography apparatus (SLA), Fused deposition modelling (FDM), Laminated Object Manufacturing (LOM)),Powder Bed Fusion Processes(PBF)	6
3	**CAD for Additive Manufacturing:** CAD Data formats, Data translation, Data loss, STL format. Softwares used for slicing	4
4	**Pre-Processing in Additive Manufacturing**: Preparation of 3D-CAD model, Reverse engineering and Reconstruction of 3D-CAD model, Part orientation and support generation, STL Conversion, STL error diagnostics, Slicing and Generation of codes for tool path, Surface preparation of materials.	9
5	**CAD & Reverse Engineering:** Basic Concept, Digitization techniques, Model Reconstruction, Data Processing for Additive Manufacturing Technology: CAD model preparation — Part Orientation and support generation — Model Slicing —Tool path Generation, Softwares for Additive Manufacturing Technology	9
6	**Post-Processing in Additive Manufacturing**: Support material removal, improvement of surface texture, accuracy and aesthetic; property enhancements.	6

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

Text Books:

1. Gibson, I, Rosen, D W., and Stucker, B., Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, 2015
2. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", Third Edition, World Scientific Publishers, 2010
3. Chee Kai Chua, Kah Fai Leong, 3D Printing and Additive Manufacturing: Principles and Applications: Fourth Edition of Rapid Prototyping, World Scientific Publishers, 2014
4. Gebhardt A., "Rapid prototyping", Hanser Gardener Publications, 2003

Reference Books:

1. Ian Gibson, David W. Rosen, Brent Stucker, Additive manufacturing technologies: rapid prototyping to direct digital manufacturing Springer, 2010.
2. C.K. Chua, K.F. Leong and C.S. Lim, Rapid prototyping: principles and applications, 3rd Edition, World Scientific, 20 10.
3. Liou L.W. and Liou F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2007
4. Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer, 2006
5. Mahamood R.M., Laser Metal Deposition Process of Metals, Alloys, and Composite Materials, Engineering Materials and Processes, Springer International Publishing AG 2018
6. Ehsan Toyserkani, Amir Khajepour, Stephen F. Corbin, "Laser Cladding", CRC Press, 2004

Back to Scheme

Course Code	Course Name	Credits
AE307	**Material Selection and manufacturing**	3

Course Objectives:

1. To understand the requirements for selection of any material.
2. To select and appropriate material as per requirement
3. To be able to manufacture the chosen material

Course Outcomes:

1. Evaluate the need for material selection for a new product or to improve an existing product
2. Estimate the requirement in terms of mechanical properties
3. Decide an appropriate processing route for a selected material
4. Able to make selection of material based on material index

Module	Details	Hours
1	**Motivation for Selection** New Product Development, Improving an existing product, Cost effectiveness and value analysis, Establishing the service requirements, Selection and design in relation to anticipated service	06
2	**Selection of Materials for Mechanical Properties:** Understanding the stress-strain diagram for different classes of materials, Static Strength, Stiffness, toughness, fatigue and creep and the material selection criteria, Ashby diagrams for correlating any two properties	07
3	**Material Selection and Material Processing** Purpose of processing and background to process selection. Casting of alloys, wrought alloys, processing of polymers, composites, powders processing-new trends in additive manufacturing, Joining and fastening processes, Importance of the structure -property-processing	07
4	**Ashby 's Selection of Materials** Defining Function, Objective, Constraints, Free variable and modelling the material index for Light and Stiff material selection, Cheap and Stiff material, Light and strong material. Using Material Index to select the most appropriate material	07
5	**Racing Cars and Technical Specifications** Materials Used in Formula One, making of NASCAR, Off Road trucks, GT,Ferrari	06
6	**Case study:** 1. Material Selection for Vehicle Body, commercial vs racing cars 2. Automobile Structures and materials used 3. Recent trends with green biocompositesin race cars	06

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

Text Books/References:

1. M. F. Ashby, Materials Selection in Mechanical Design, Elsevier Publication, 2005
2. J. G. Gerdeen, H. W. Lord and R. A. L. Rorrer, Engineering Design with Polymers and Composites, Taylor & Francis, 2005
3. J. A Charles, JAG Furness, Selection and use of Engineering Materials, JBH Publishers, 3rd edition.
4. Kenneth. G Budinski & Michael K. Budinski., Engineering Materials: Properties and Selection, 9th edition, 2010
5. M. F. Ashby and K. Johnson, Materials and Design, Butterworth Publication, 2002

Back to Scheme

Course Code	Course Name	Credits
AE391	**Minor Project III**	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 **oneyear 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
AE308	**Automotive Body and Chassis Systems**	3+1

Course Objectives:

1. To Understand fundamentals of Vehicle Body design
2. To Study different vehicle structural design and their requirements.
3. To Study Vehicle Aerodynamics.
4. To Study different vehicle body structures and Loads acting on them.
5. To study various materials related to body structures

Course Outcomes: Learner will be able to

1. Apply aerodynamics principles while vehicle body designs.
2. Apply Aesthetic and Ergonomic principles while designing vehicle body.
3. Differentiate different vehicle body styles.
4. Select material for different vehicle components.
5. Identify and draw various types of body design according to shape and frame structures.
6. Design passenger and commercial vehicle bodies for different loading conditions.

Theory Syllabus:

Module	Details	Hours
1	**Aerodynamics** Vehicle Body Styles, Vehicle drag and types, Various types of forces and moments, Effect of forces and moments, Side wind effect on forces and moments, Body optimization techniques to reduce drag, Wind tunnels-Principle of operation and types, Wind tunnel testing such as: Flow visualization techniques, Air flow management test-measurement of various forces and moment by using wind tunnel.	06
2	**Car Body Details** Types of Car Bodies, Visibility, Drivers Visibility, Improvement in visibility and test for visibility, Driver Seat design, Car body construction, Various panels used in car bodies Safety -Safety aspects during design, Safety equipments, Design criteria, Prototype making, Initial tests, crash test on full models, Dummies and Instrumentation.	06
3	**Bus Body Details** Types of bus body: based on capacity, distance travelled and based on construction: Mini bus, Single decker, Double decker, Two level and articulated, Bus body layout-Floor height, Engine location, Entry and exit location, seating dimensions. Constructional details-Conventional and Integral, Frame construction, Double skin construction, metal sections types,	06
4	**Commercial vehicle detail** Types of commercial vehicle bodies-Flat platform, drop side, fix side, tipper body, tanker body, Trailer body, Light commercial vehicle body types, Dimensions of driver seat in relation to controls, Drivers cab design and Regulations Special commercial vehicles: Refrigerated vehicles, paramedic ambulances, pickup van.	06

5	**Body Materials, Trim and Mechanisms** Types of materials used in body construction-Sheet steel, timber, plastics, GRP, Carbon fiber, fibreglass, Shape memory alloys, technologies to reduce NVH properties of materials, Corrosion- anticorrosion methods, Selection of paint and painting procedure and paint problems. Body trim items and Body mechanisms, Body repair tools-Hand tools, power tools, repairing sheet metal, repairing plastic body, fillers, passenger compartment service.	06
6	**Vehicle structure and Body design** Loads on frames, Construction and cross sections of frame, Basic requirement of strength and stiffness, Vehicle structure types, Demonstration of Simple structural surface (SSS), Idealized structure-structure surface, shear panel method, Layout of design, preliminary design, vehicle body weight analysis and Vehicle Weight distribution **Body loads** Symmetric and asymmetrical vertical loads in car, longitudinal loads, Different loading situations, Calculation of loading cases, Stress analysis of vehicle body structure under bending and torsion.	06

Laboratory Syllabus:

A. Drawing sheet

1. Minimum 3 A2 size sheets based on Vehicle body styles layouts for Car body, Bus body and Commercial Vehicle body details
2. Transforming Sheets into Solidwork/Ansys Modelling using Dimensions used for drawing sheets.

B. List of Experiments

Analysis of Chassis Frame using any FEA Software's for different sections (C-section, I-section, L-section, O-section, Hat section, Tubular section etc)

1. Structural Analysis of Chassis Frame
2. Modal Analysis of Chassis Frame
3. Harmonic Analysis of Chassis Frame.

C. Mini Project

Analysis of Chassis frame containing a 3D Model of any existing Automobile Chassis or Body or combination of both (Min 2 Max 4 Students per Group)

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:

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

Assignment/Drawing sheets	: 10 marks
Laboratory work (Experiments)	: 05 marks
Mini project	: 05 marks
Attendance (Theory and Practical)	: 05 marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Practical/Oral examination

To be conducted by pair of Internal and External Examiner

The distribution of marks for practical examination shall be as follows:

Practical Exam	: 15 marks
Oral Exam	: 10 marks

Text Books:

1. J. Powloski - "Vehicle Body Engineering"-Business Books Ltd, London,1989
2. John Fenton - "Vehicle Body Layout and analysis-Mechanical Engg. Publications Ltd, London, 1982.
3. J. Reimpell - "The Automotive Chassis: Engineering Principles "Reed Elsevier and Professional publishing Ltd, 2001.

Reference Books:

1. Crouse. W. H, Automotive Chassis and Body, McGraw Hill New York.
2. Wolf Heinrich Hucho, Aerodynamics of Road Vehicles, SAE International, USA
3. Giles J.C Body Construction and Design, Illife Books Butterworth & Co., 1971

Back to Scheme

Course Code	Course Name	Credits
AE309	**Automotive Vibrations**	3+1

Course Objectives:

1. To study the basic concepts of vibration analysis.
2. To estimate the natural frequency/frequencies of vibration systems in free vibration, using both exact and numerical methods.
3. To estimate the response of 1 degree of freedom under forced vibration.
4. To acquaint with the basic principles of vibration measuring instruments.
5. To study the balancing of rotating and reciprocating mass systems.

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

1. Develop mathematical models to represent dynamic system.
2. Estimate natural frequency of mechanical system using various methods.
3. Analyze vibratory response of mechanical system under forced vibration.
4. To estimate the natural frequencies and mode shapes of multi-degree of freedom system, using both exact and numerical methods.
5. Balance an existing unbalanced system partially/completely.

Theory Syllabus:

Module	Details	Hours
1	**1.1 Basic Concepts of Vibrations:** Vibration and oscillation, causes and effects of vibrations, vibration parameters—spring, mass and damper, minimum number of parameters required for vibration to occur, vibration terminology, classification of vibrations, steps involved in vibration analysis. **1.2 Free Undamped Single Degree of Freedom Vibration Systems:** Methods to formulate differential equations — Newton's method or D'Alembert's principle, and Energy methods — Based on conservation of total energy, Rayleigh's energy method, Lagrange's energy method, equivalent system method. Springs in series and parallel combination, inclined spring, effect of spring's own mass to calculate natural frequency of system. Application of these methods in longitudinal, transverse and torsional single degree of freedom vibration systems, or a combination of these.	7
2	**2.1 Free Damped Single Degree of Freedom Vibration Systems:** Need of damping in vibration systems, introduction to damper models—viscous, Coulomb (dry friction), slip/interfacial, solid/structural/hysteresis damping (Note: only basic introduction to slip and solid dampings, no calculations expected). Viscous damping—Derivation of differential equation of motion, derivation of solution (response) equations, damping ratio or damping factor, critical damping coefficient, underdamped, critically damped and over damped systems. Logarithmic decrement, Work done by viscous damper, inclined damper, dampers in series and parallel combinations. Coulomb/dry-friction damping—derivation of differential equation, number of cycles covered by the mass to stop once disturbed (disturbance in the form of initial displacement only), comparison of viscous and Coulomb dampings.	8
3	**3.1 Free Undamped Multi Degree of Freedom Vibration Systems:** Exact methods for derivation of differential equations of motion for multi	7

	degree of freedom systems—Newton method and Lagrangian energy method, matrix analysis to estimate eigenvalues and eigenvectors & hence natural frequencies and mode shapes for multi-mass undamped vibration systems (limited to 2 degree of freedom only), Holzer's method for longitudinal and torsional unbranched vibration systems, Dunkerley's and Rayleigh's methods for estimating fundamental frequency of tranverse vibration of simply supported and cantilever beams (up to a maximum of 4 point loads only), influence coefficients and Maxwell's reciprocal theorem.	
4	**4.1 Forced Single Degree of Freedom Vibration Systems:** Analysis of linear and torsional systems subjected to harmonic excitation in terms of force and motion (viscous damping only), force isolation and transmissibility, isolators and mounts. **4.2 Vibration Measuring Instruments:** Principle of seismic instruments, vibrometer, accelerometer, velometer - with and without measurement errors. Principle of frequency-measuring instruments, Fullarton's tachometer and Frahm's reed tachometer.	7
5	**5.1 Balancing of Rotating Masses:** Static and dynamic balancing of multi-rotor system. **5.2 Balancing of Reciprocating Masses:** Approximate analytical method for finding acceleration of reciprocating piston (mass of connecting rod and crank neglected), primary and secondary unbalanced forces, inline engine, direct and reverse crank method.	7
6	**6.1 Whirling of Shafts / Rotor Dynamics / Critical Speed:** Critical speed of a single rotor—undamped and damped.	3

Laboratory Syllabus:

Sr. No.	Title of the Experiment	Hours
1.	Determining the undamped natural frequency / time period of free undamped vibrations/oscillations of the following systems, theoretically and experimentally: (a) Simple spring-mass system (b) Simple pendulum (c) Compound pendulum (d) Single rotor-shaft system (e) Bifilar suspension system	10
2.	Free damped torsional oscillations.	2
3.	Forced vibration of one degree of freedom system, subjected to frequency-squared excitations (rotating unbalance).	2
4.	Computer program on frequency-domain plots of dimensionless steady-state amplitudes for various values of damping ratio.	2
5.	Vibration measurement of rotating machinery using accelerometer, DAQ system and LabView software; or similar.	2
6.	Balancing of rotating masses.	2
7.	Virtual Laboratory Experiments using Sakshat VLab portal.	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:

Term Work: 25 marks

Term Work consists of an ample number of assignments and experiments as decided by the instructor. Minor-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.

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

Experiment write ups : 20 marks
Attendance : 05 marks

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. Mechanical Vibrations - S. S. Rao - Pearson Education
2. Mechanical Vibrations - G. K. Grover
3. Fundamentals of Mechanical Vibrations - S. Graham Kelly - Tata McGraw Hill
4. Mechanical Vibrations - Schaum's outline series - S. Graham Kelly- McGraw Hill
5. Mechanical Vibrations - Den, Chambil, Hinckle
6. Mechanical Vibrations - J.P. Den Hartog - McGrawhill Book Company Inc.
7. Introduction to Dynamics and Control - Leonard Meirovitch - Wiley, New York
8. Elements of Vibration Analysis - Leonard Meirovitch - McGraw-Hill, New York
9. Principles of Vibrations - Benson H. Tongue - Oxford University Press.
10. Theory of Vibrations with Applications - W. Thomson - Pearson Education
11. Vibrations - Balakumar Balachandran, Edward Magrab - CENGAGE Learning.
12. Vibration Monitoring, Testing, and Instrumentation (Mechanical Engineering Series) - Clarence W. deSilva - CRC Press.
13. Vibration Testing: Theory and Practice - Kenneth G. McConnell, Wiley.
14. Modal Testing: A Practitioner's Guide - Peter Avitabile - Wiley.
15. Vibration Analysis - P. Srineevasan - Tata McGraw Hill
16. Mechanical Vibrations - Schaum's outline series - William W. Seto- McGrmvHill.
17. Theory and Practice of mechanical vibrations - J. S. Rao, K. Gupta - New Age International Publications.
18. Leonard Meirovitch, Introduction to Dynamics and Conti'oJ. Wiley, New York
19. Leonard Meirovitch, Elements of Vibration Analysis. McGrmv-Hill, New York
20. Leonard Meirovitch, Dynamics and Control of Structures. Wiley, New York.
21. Antony J. Pettofrezzo, Matrices and Transformations. Dover, New York.
22. Benson H. Tongue, Principles of Vibration. Oxford University Press.

Back to Scheme

Course Code	Course Name	Credits
AE310	**Professional Communication and Ethics II**	1+1

Course Objectives:

1. To enable learners to formulate professional documents in a structured manner that meets the corporate requirements.
2. To provide an appropriate environment, opportunity and scope to the learners to acquire skills such as collaboration, leadership qualities, assertiveness etc. necessary for group discussion and team building.
3. To promote the importance of having an impressive personality that will enhance self esteem, build self confidence and sensitize the learners in appropriate behaviour.
4. To prepare the learners for campus placement, employability and competitive examination required for lifelong learning.
5. To inculcate the ethical code of conduct and corporate etiquettes.
6. To develop effective presentation, research and organisational and creative skills necessary for global and industrial set up.

Course Outcomes:

1. Learners will be able to acquire the writing skills necessary for professional documents to meet the corporate requirement.
2. Learners will be able to demonstrate the skills required for self-improvement and effective communication.
3. Develop self-confidence and behave professionally.
4. Learners will be able to perform successfully in competitive exams like GRE, CET and TOEFL
5. Able to determine the importance of ethics and etiquettes in social and professional situations.
6. Able to illustrate effective presentation, research organisational and creative skills necessary for lifelong learning.

Theory Syllabus:

Module	Details	Hours
1	**Structure, Style and Language of Report Writing:** 1.1 Introducing the purpose, aim, objective and format of report 1.2 Literature review-ability to gather and analyze information from different sources and summarize. Specific emphasis on plagiarism, use of quotation marks appropriately. 1.3 Research Methodology 1.4 Presenting data-figures, diagrams and labeling 1.5 How and why to write discussion 1.6 Citing and referencing- IEEE format 1.7 Writing an abstract	4
2	**Writing Technical Proposals:** 2.1 Format 2.2 Executive summary 2.3 Defining the problem and presenting the solution 2.4 Summarizing a technical proposal	3
3	**Oral Skills for Employability:** 3.1 Group Discussion- with special reference to leadership qualities, assertiveness, analyzing the topic, developing different perspectives, introducing and concluding the discussion.	2

	3.2 Interview-with special reference to introducing oneself and answering questions with confidence. 3.3 Presentation Skills-with special reference to preparing slides, dress code, non-verbal communication including paralinguistic features, introduction and conclusion.	
4	**Personality Development and Social Etiquettes:** 4.1. Personality Development ● Improving self-awareness-analyzing our own experiences, looking at ourselves through the eyes of others ● Knowing and Building your own identity ● Discovering and Developing your talents ● Teamwork/collaboration 4.2. Social Etiquettes ● Formal Dining Etiquettes ● Cubicle Etiquettes ● Responsibility in Using Social Media ● Showing Empathy and Respect ● Learning Accountability and Accepting Criticism ● Demonstrating Flexibility and Cooperation ● Selecting Effective Communication Channels	2
5	**Ethics and Ethical codes of conduct:** 5.1Writing Resume and statement of purpose 5.2 Business and corporate activities(special emphasis on business meetings) 5.3 Personal ethics, conflicting values, choosing a moral response, the process of making ethical decisions.	2
6	**Content writing:** 6.1 Research Skills 6.2 Organisational skills 6.3 Creative Writing- Blog posts, Web pages etc.	2

Lab Syllabus:

SN	Details of Assignments	Details of Activities	Hours
1.	Written assignment on Literature Review 20 page report on technical topic-(to be included as part of term work)	Sample IEEE papers to be shared with students and train them to identify contributions of each author. These contributions can then be written in the format required in journals.	4
2.	Written assignment on summarising a technical proposal. 4 page technical proposal (to be included as part of term work)	Example of summarising techniques to be demonstrated.	4
3.	Oral Skills for Employability - to be included in term work.	Role play and mock interviews, Mock group discussion, Mock presentation	6
4.	Written Assignment on Documentation of Business Meeting	Mock meetings	2
5.	Written Assignment on Resume writing/Statement of Purpose.	NA	2
6.	Written Assignment on Blog Posts	NA	2

Term work

1. Assignments - 10 marks
2. Group Discussion - 10 marks
3. Interviews - 5marks
4. Report - 5 marks
5. Technical Proposal - 5 marks
6. Attendance - 5 marks
7. Presentation - 10 marks

Text /Reference Books:

1. Raman Meenakshi & Sharma Sangeeta, *Communication Skills,* Oxford University Press
2. Kumar Sanjay & Lata Pushp, *Communication Skills*, Oxford University Press
3. Virendra Singh Nirban, Krishna Mohan, RC Sharma, *Business Correspondence and Report Writing*

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Course Code	Course Name	Credits
AE311	**Power Electronics**	3

Course Objectives:

1. To introduce different power conversion topologies such as ac to dc, dc to dc, dc to ac and the underlying principles of converter operation aiding to analyse their performance.
2. To keep abreast with the latest technologies and research going on in different domains related to power electronics.

Course Outcomes: Learner will be able to

1. Explain the importance and working of Choppers.
2. Explain the working of Single phase and three phase DC drives with applications.
3. Explain the working of three phase AC drives with applications.
4. Comprehend the working of synchronous motor drives.
5. Analyze dc to dc converter circuits and their applications.
6. Apply the basic concepts to select devices and converters for various applications

Theory Syllabus:

Module	Details	Hours
1	**Introduction to Power Electronics** Concept, Applications, Types of Power electronics converters, Advantages and Disadvantages of Power electronics converters, **Choppers** Principle, Control strategies-Time Ratio control and current limit control, Step up choppers, Types of chopper circuits-Type A, B, C, D and E Chopper.	06
2	**Single Phase DC Drives** Concept of Electric drives, DC drives, Performance equation of DC Motor, Single phase DC drives: Half wave, Semi converter, Full converter, Dual converter **Three Phase DC drives** Half wave, Semi converter, Full converter, Dual converter **Chopper drives** Power control or motoring control, Regenerative braking control, Two quadrant chopper drives, and Four quadrant chopper drives.	06
3	**AC Drives** Induction Motor drives Speed control of Three phase induction motor: Stator Voltage control, Stator frequency control, Stator Voltage and Frequency control, Stator current control	06
4	**Synchronous motor drives** Cylindrical rotor motors, Salient pole motors, reluctance motors, permanent magnet motors.	06
5	**DC to DC Converter** Introduction, Switching mode regulators – Buck, Boost, Buck-Boost, Cuk converters, Full bridge DC-DC converters.	06
6	**Power Electronics Applications** a) Renewable energy sources and their interconnections for Photovoltaic array and wind generators	06

	b) Battery chargers c) Emergency lighting systems d) Switch mode welder	

Laboratory Syllabus:

Sr. No.	Detailed Lab/Tutorial Description
1	To Study the working of Step down Chopper
2	To Study the working of Step up Chopper
3	To Study the working of Single Phase DC Drives
4	To Study the working of Three Phase DC Drives
5	To Study the working of AC Drives
6	Study of Buck Converter
7	Study of Boost Converter
8	Study of Buck-Boost Converter
9	Study of Cuk Converter
10	Study of Battery charger
11	Case study 1. Renewable energy sources 2. Emergency lighting systems 3. Switch mode welder

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

Term Work consists of an ample number of assignments and experiments as decided by the Instructor. Minor-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.

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

Experiment write ups : 20 Marks
Attendance : 05 marks

Text Books:

1. M. H. Rashid, Power Electronics: Circuits, Devices, and Applications, Pearson Education, 2009.
2. N. Mohan and T. M. Undeland, Power Electronics: Converters, Applications and Design, John Wiley & Sons, 2007.
3. R.W. Erickson and D. Maksimovic, Fundamentals of Power Electronics, Springer Science & Business Media, 2007.

Reference Books:

1. C.W. Landers, Power Electronics, McGraw Hill, 1993
2. Ashfaq Ahmed, Power Electronics for Technology, Pearson, 1998
3. Joseph Vithayathil, Power Electronics, Tata McGraw hill, 1995.

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Course Code	Course Name	Credits
AE312	**Additive Manufacturing in Biomedical Applications**	3

Course Objectives:

1. Know the Principles, Methods, areas of usage, Possibilities and Limitations as well as environmental effects of the additive manufacturing technologies,
2. Be familiar with the characteristics of various materials that are used in AM technologies

Course Outcomes: Learner will be able to

1. Describe the Difference of various AM processes
2. Select and use correct CAD format for various 3D printed parts
3. Selection Of correct Materials for Biomedical Application
4. Understand various principles for various types of AM technologies and their application in Bio medical parts.
5. Describe various process parameters for Bio medical manufacturing and determine suitable additive technique.

Theory Syllabus:

Module	Details	Hours
1	**Introduction & need of new materials** Materials used in bio-medical applications Overview-history-materials-tooling-applications	4
2	**Basic Concepts -** digitization Techniques-model reconstruction, Data Processing for Manufacturing Technology, Cad Model Preparation, Part Orientation and support generation, model slicing, tool path generation, softwares for AM technology, Research methodology.	7
3	**Polymer -** Based Additive Manufacturing Biomedical Applications: direct applications in the orthopaedics, cardiovascular, drug delivery, ear-nose-throat, and tissue engineering fields Liquid Based Additive Manufacturing Systems Classification-Liquid Based System, Stereolithography Apparatus-Principle, Process, Advantages and Application, Study of Materials for liquid based Additive Manufacturing Systems for different Applications.	6
4	**Rapid Tooling Techniques:** Rapid prototyping biomedical engineering, structural intricacies, hard tissues, laser additive manufacturing, solid free-form fabrication **Tooth Implantation:** Powder Based Additive manufacturing, Materials and Techniques used, Selective Laser Sintering (SLS) and Selective Laser Melting (SLM),Fused Deposition Modelling (FDM) **Orthopaedic Implants:** Techniques used like Electron Beam Melting (EBM)	6
5	**Medical And Bio-additive Manufacturing:** Image Developing and Processing for Bio-additive Manufacturing, Customized Implants and Prosthesis, Design and Production, Bio-additive Manufacturing, Computer Aided Tissue Engineering(CATE)	8
6	**Case Studies:** Using 3D Printing Machines Case study on Different Organs Of Human Body	6

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

Text /Reference Books:

1. ASTM International, "F2792-12a - Standard Terminology for Additive Manufacturing Technologies," Rapid Manuf. Assoc., pp. 10–12, 2013.
2. I. Gibson, D. Rosen, and B. Stucker, Additive Manufacturing Technologies. 2015.
3. Royal Academy of Engineering, "Additive Manufacturing: Opportunities and Constraints," in Additive Manufacturing: Opportunities and Constraints, 2013, no. May 2013, p. 21. [
4. D. Eyers and K. Dotchev, "Technology review for mass customisation using rapid manufacturing," Assem. Autom., vol. 30, no. 1, pp. 39–46, 2010.
5. A. Rosochowski and A. Matuszak, "Rapid tooling: the state of the art," J. Mater. Process. Technol., vol. 106, no. 1–3, pp. 191–198, 2000.
6. J. W. Choi and N. Kim, "Clinical application of three-dimensional printing technology in craniofacial plastic surgery," Arch. Plast. Surg., vol. 42, no. 3, pp. 267–277, 2015.
7. Materialise, "AM software system and service provider." [Online]. Available: www.materialise.com.

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Course Code	Course Name	Credits
AE313	**Race Car Designing**	3

Course Objectives:
The objective is for engineers to understand the interaction and performance balance between the major vehicle subsystems including Chassis and Bodyworks, Powertrain, Drive train; to design and optimize the same

Course Outcome: Learner will be able to
1. Design wheels and tyres for selected layout
2. Design and optimise race car layout, chassis and seat
3. Design engine systems in context with race car
4. Design and optimise drivetrain and brakes.
5. Select and design suspension and steering systems
6. Get acquainted with vehicle set up and testing and gg diagrams.

Theory Syllabus:

Module	Details	Hours
1	**Introduction to race car designing** Basic layout used for racing cars, design methodology, location of CG loads acting on wheels, design of tyres for selected layout	7
2	**Chassis and Bodyworks** Types of Chassis, Chassis Loads, stress analysis of chassis design of chassis for crash safety, seat design and mountings design	7
3	**Powertrain** Engine systems, Design modifications in context with race car, Engine tuning, Engine management systems	6
4	**Drive Train and Brakes** Types of drives, gearbox design, differentials and brake design	7
5	**Suspension and Steering** Suspension selection, Suspension geometry and links, Optimising setup, uprights design, steering design	8
6	**Driver Vehicle Relations and Ergonomics** Vehicle Setup and testing, Vehicle and driver relation, Driver Safety, Ergonomics	5

Laboratory:
6-8 experiments based on the modules mentioned in the theory 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: 25 marks

Term Work consists of experiments and/or assignments as decided by the Instructor. Students can also avail NPTEL or equivalent Certification for this course, which shall be considered in place of the assignment work.

Text Books:

1. Racing and sports car (chassis Design) - Michael Costin, David Phipps B T BATSFORD London
2. Race car design – Derek Seward, Palgrave, Macmillan Publishers
3. Tune to win – Caroll Smith, Aero publishers
4. Racing Car Vehicle Dynamics – Millikens and Millikens, SAE international

Reference Books:

1. Chassis Engineering/Chassis Design, Building & Tuning for High Performance Handling by Herb Adams
2. Competiton Car Suspension: Design, Construction, Tuning by Allan Staniforth
3. Race Car Chassis: Design and Construction [Powerpro] by Forbes Aird
4. Engineer to Win: The Essential Guide to Racing Car Materials Technology or How to Build Winners Which Don't Break by Carroll Smith
5. How to Make Your Car Handle by Fred Puhn
6. Supercharging, Turbocharging, & Nitrous Oxide Performance Handbook [Powerpro] by Earl Davis, Diane Davis
7. Maximum Boost: Designing, Testing, and Installing Turbocharger Systems by Corky Bell
8. Turbochargers by Hugh MacInnes
9. Supercharged! Design, Testing and Installation of Supercharger Systems by Corky Bell
10. Four-Stroke Performance Tuning by A. Graham Bell
11. Engine Management: Optimizing Carburettors, Fuel Injection and Ignition Systems by Dave Walker
12. Fiberglass & Composite Materials: An Enthusiast's Guide to High Performance Non-Metallic Materials for Automotive Racing and Marine Use by Forbes Aird
13. Racer's Encyclopedia of Metals, Fibers & Materials by Forbes Aird

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Course Code	Course Name	Credits
AE314	**Electronics in Race Cars**	3

Course Objectives:
The objective is for engineers to know the electronics used in race cars to improve performance of the cars.

Course Outcomes: Learner will be able to

1. Understand the basics of electronics and control theory
2. Differentiate between types of sensors and actuators based on their function.
3. Understand the working, use and types of ECUs
4. Setup a basic Data Acquisition System.
5. Gain knowledge about power train and vehicle motion control system
6. Understand the principle and working of automotive instrumentation, telematics and navigation systems.

Module	Details	Hours
1	**Basics of Electronics and control theory** use of feedback in op amps, microprocessor, control theory and instrumentation, microcomputer applications in race cars, electronics control system diagnostics	8
2	**Sensors and Actuators in Automobiles** Types of sensors and their working, Types of actuators modelling of actuators	8
3	**Engine Control Unit (ECU) Fundamentals** Functions of an ECU, Working of ECU, Controlling engine parameters using ECU, Difference between Piggyback ECU & Standalone ECU, Speeduino (Arduino based programmable ECU) basics.	7
4	**Setup of DAQ system** Types of data acquisition systems, Requirements of DAQ system, software and hardware required, use of DAQ systems in race cars	5
5	**Power train and Vehicle motion control system** control modes for crank, warm up, acceleration deceleration, differential, hybrid electric powertrain control,Electronic cruise control, electronic steering, Electronic suspension control	7
6	**Telematics and navigation system** Automotive Instrumentation, telematics used in cars, GPS systems used in race cars, GPS structure	4

Laboratory:
6-8 experiments based on the modules mentioned in the theory 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: 25 marks
Term Work consists of experiments and/or assignments as decided by the Instructor. Students can also avail NPTEL or equivalent Certification for this course, which shall be considered in place of the assignment work.

Books/References:

1. Understanding Automotive Electronics (An Engineering Perspective) - William Ribbens, Butterworth Heinemann imprint of Elsevier
2. Analysis Techniques for Racecar Data Acquisition Second Edition - Jörge Segers SAE international
3. Automotive Mechatronics (Automotive Networking, Driving Stability Systems, Electronics) - Konrad Reif , Bosch Professional Automotive Information, Springer
4. Handbook of power electronics - Ali Emadi, CRC Press Taylor and Francis

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Course Code	Course Name	Credits
AE315	**Fundamentals of Transportation Engineering**	3

Course Objectives:

1. To become familiar with transport system.
2. To be aware of the organisational structure of transport corporations and their interactions.
3. To learn about depot facilities and terminals.
4. To understand economic analysis of transport projects.
5. To provide knowledge of traffic control devices and its techniques in transportation interaction.

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

1. Able to know about MVA and traffic rules.
2. Able to understand concept of taxation and insurance in automotive industry.
3. Able to select effective and economic mode of transport.
4. Able to identify the roles of research organization in motor industry.

Module	Details	Hours
1.	**Motor vehicle Act**: Short title, extent and commencement, terminologies, Licensing of driving motor vehicle, Necessity for driving licence, Responsibility of owner and drivers of different types of motor vehicle, Rules and regulation to issue different types of driving license, Extent of effectiveness of licences to drive motor vehicles, Powers of licensing authority , Powers of Honourable. Court (Judiciary) to disqualify licensing, Powers of state and central government to make rules, RTO forms, Rules regarding registration of motor vehicle (Different types of registration marks available in India eg. Temporary registration , Special provision for registration of motor vehicles of diplomatic officers , Effectiveness in India of registration and its transfer in various cases) , Maintenance of State Registers of Motor Vehicles , Penalties and offences under Motor vehicle act , Power of Central and State Government to make rules regarding construction and maintenance of vehicles, Provision of permit, Power of Central and State Government to make rules regarding permit, Power of Central Government to make rules regarding motor vehicles temporally leaving or visiting India, amendments in motor vehicle act 2019 .	08
2.	**Motor vehicle Taxation :** Short title, extent and commencement , Levy of tax (environment tax , Road Safe Cess) , Payment of tax and issuance of tax certificate , Payment of additional tax , Refund of tax, Special provision for fleet owners , Destination and utilisation of the proceeds of tax, Arrears of tax and interest recoverable as arrears of land revenue , Restrictions on use of motor vehicles in certain cases. , Power to seize and detain motor vehicle in case of non-payment of tax. , Exemptions, Power of Police Officer and the Motor Vehicles Department Officers , Penalty for possession or control of motor vehicle without payment of tax and interest for incomplete and untrue declaration, etc. , Other penalties, Compounding of offences.	06
3.	**Motor vehicle Insurance:** Need and objectives of insurance, Types of policies , Claims initiation and settlement (Total loss claim, third party	06

	claim, theft claim, Compromise settlement , Motor accident claims tribunal, Jurisdiction of MACT , Compensation settlement under MACT , Factors Affecting the Claim for Compensation of Motor Vehicle Accident in India, Duties of Owner and driver in case of accident, Section 64UM of the Insurance Act , Surveyor and loss assessor duties,	
4.	**Passenger and Goods transport operation system:** Terms used in transportation like Transport and public service vehicle, Goods carriage vehicle. Methods of transportation and its comparison. Elements of transport management system: - Market potential, selection of vehicle, Organization set-up, Legal compliance, Policies of Government bodies towards Employee and passenger service, Bus and crew scheduling, Bus depot layout, Record keeping, Maintenance management of State Transport Undertaking (STU), Bus Rapid Transport system (BRTS), THE PETROLEUM ACT, 1934, Green corridor, importance and benefits of green corridor	06
5.	**Motor transport and research organization:** Structure of transport organization like, MSRTC. Functions of research organizations like Central institute of road transport, Automotive research association of India, Vehicle Research and Development Establishment, CRRI-Central Road Research Institute, Petroleum Conservation Research Association, Role of Engineer in Motor transport industry.	06
6.	**Traffic management and control system:** Basic components of traffic flow, road user, vehicle, environment and their characteristics, speed–volume–density relationship, homogenous and heterogonous traffic flow, PCU concept, vehicle operating cost, Traffic regulations,driver, vehicle,flow and general controls traffic devices control, signs, homogenous and heterogonous traffic flow, traffic management authorities, road lighting, Signalling system to manage traffic, GPS.	06

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. Kadiyali, L.R., Traffic Engineering & Transport Planning, Khanna Publishers, New Delhi
2. Jotin Khisty, S.C. and Kent Lall, B., Transportation Engineering – An Introduction, Prentice-Hall, NJ
3. S.C. Saxena Traffic Planning and Design. Dhanpat Rai Pub, New Delhi Reference Books:

4. Hutchison, B.G., Introduction to Transportation Engineering, & Planning, McGraw Hill Book Co.
5. John W. Dickey, Metropolitan Transportation Planning, Tata McGraw Hill Pub. Co.
6. Vukan R. Vuchic, Urban Public Transportation System & Technology, Prentice Hall, Inc.
7. Papacostas, C.S., Fundamentals of Transportation System Analysis, PHI
8. Economics of Transport, S.K. Shrivastava
9. Transport Development in India, S. Chand & Co. Pvt. Ltd., New Delhi.
10. Peter R. White: Public Transport: Its Planning, Management and operation (Natural and Built Environment Series, Kindle Edition, September 2008.)
11. John Doke-Fleet Management
12. Kitchin L.D. - Bus Operation, Illiffe and sons Co. London, III edition.
13. Sudarshan, P. -Passenger Amenities in STU, Manual of Central Institute of Road Transport, Pune.
14. Sudarshan, P. -Bus Station management, Manual of Central Institute of Road Transport, Pune.
15. Sudarshan, P. -Bus and Crew Scheduling, Manual of Central Institute of Road Transport, Pune.
16. Minorstry of transport,Central M.V Rules 1989, Central Government, Govt of India.
17. Kitchin, L. D., Bus Operation, Iliffe and Sons Ltd. London,2nd Edition,1952,ISBN No.9780408028103
18. Rex W, Faulks, Bus and Coach operation, Butterworth Heinneman,1987.1st edition,1952,ISBN No.9780408028103
19. Khilery, V. S., Sharma Satpal, Gupta Shaman, Motor Vehicle Act And Transport Management, Ishan Publication,1st Edition, ISBN No.13:978-9381551950.

Back to Scheme

Course Code	Course Name	Credits
AE316	**Motor Vehicles Acts & Loss Assessments**	3

Course Objectives:

1. To study in detail about transport authority and its hierarchy.
2. To study rules and regulation regarding Construction and maintenance of motor vehicle
3. To study in detail about vehicle insurance types.
4. To study claim compensation procedure.

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

1. Able to Describe motor vehicle acts.
2. Able to understand guide lines for different offences & penalty procedure for traffic control.
3. Describe different provisions of motor insurance.
4. Analyse effect of impact on accidental vehicle.
5. Use claim procedure for assessing various losses of accidental vehicle

Module	Details	Hours
1	**Transport Authority:** Different transport authority and its functions, Anatomy of different types of vehicle, Permit and its types, Provisions regarding issuance of permit, Provisions for state and transport undertakings , Power of Central and State Government to make rules regarding permit, Motor vehicle department and its operational hierarchy.	06
2	**Construction and maintenance of motor vehicle**: Rules and regulation regarding construction of motor vehicle, Provisions regarding: Lamps, Brakes, Horn, Silencer, Mirror, Safety glass, Wind screen wiper, Tyres, Speedometer, Steering, Springing, Direction indicator and stop light, First Aid Box, Emission of smoke, vapour and grit, for attaching side-car to a motor-cycle, Power of Central and State Government to make rules regarding construction and maintenance of vehicles	08
3	**Traffic offences and Traffic control:** Limits of Speed and loading limit of vehicle with respect to power to weight ratio, Provisions regarding vehicle with Left-hand control, The duties of driver and owner. The provisions regarding 1. Motor vehicle temporarily leaving or visiting India. 2. Payment of compensation on the principle of no fault. 3. Punishment of offences. 4. Disobedience, obstruction and refusal of information 5. Allowing driving of vehicle by unauthorized person 6. Offences relating to Licences 7. Using the vehicle without registration of permit 8. Driving the vehicle exceeding permissible weight 9. Driving the uninsured vehicle 10. Power to detain the vehicles used without certificate of registration of permit. Guide Line for following offences such as: 1. Driving recklessly or dangerously 2. Driving while under the influence of drink or drugs 3. Taking part in unauthorized race or trial of speed	08

	4. Driving when disqualified 5. Obtaining or applying for a licence without giving particulars of endorsement 6. Failing to stop the occurrence of an accident. 7. Basic components of traffic flow, road user, vehicle, environment and their characteristics, speed–volume–density relationship, homogeneous and heterogeneous traffic flow, PCU concept, vehicle operating cost, Traffic regulations,driver, vehicle,flow and general controls traffic devices control, signs	
4	**Vehicle insurance types:** Origin, history and development of insurance, Act liability only, Third party only. Comprehensive policy. Policies with Zero Depreciation Option, Policy term and condition.	06
5	**Vehicle Impact analysis:** Causes of accidents. Effect of Impact from any one side Head on collision. Vehicle topples. Failure of vehicle. Detailed analysis has to be done.	06
6	**Insurance survey and claim investigation:** Claims initiation and settlement (Total loss claim, third party claim, theft claim, Compromise settlement , Motor accident claims tribunal, Jurisdiction of MACT , Compensation settlement under MACT , Factors Affecting the Claim for Compensation of Motor Vehicle Accident in India, Duties of Owner and driver in case of accident, Section 64UM of the Insurance Act , Important aspects of survey , Fraud claims , Surveyor and loss assessor duties , Licensing authority and controller of insurance.	06

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. Motor Vehicles Act, 1989 -Government of India.
2. The Gujarat Motor Vehicles Rules,1989-Government of Gujarat.
3. The Central Motor Vehicle Rules,1989-Government of India.
4. Universal's Legal Manual, "Motor Vehicles laws (Act and Regulations) ISBN-978-81-7534-936-0", Universal Law Publishing Co. Pvt Ltd.
5. Dr. L. P. Gupta, "Insurance claims Solutions, ISBN-978-9383303038",.
6. Rudolf Limpert, "Motor vehicle Accident Reconstruction & Cause Analysis 7th Addition", Lexisnexis Publication.

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Course Code	Course Name	Credits
AE317	**Supply Chain management**	3

Course Objectives:

1. To learn objectives of supply chain management and its interrelationships within companies.
2. To study logistics, Warehousing, transportation, outsourcing

Course Outcomes: Learner will be able to

1. Understand the primary difference between logistics and supply chain management
2. Understand the fundamentals of elements and functions of supply chain
3. Design supply chain for various industries considering facility locations
4. Understand the individual processes of supply chain management and their interrelationships within individual companies and across the supply chain
5. Learn about logistics, transportation, warehousing and outsourcing decisions.

Module	Details	Hours
1	**Objectives of a Supply Chain:** Stages of Supply chain, Value Chain Process, Cycle view of Supply Chain Process, Key issues in SCM, logistics & SCM, Supply Chain Drivers and obstacles, Supply chain strategies, strategic fit, Best practices in SCM, Obstacles of streamlined SCM.	6
2	**Logistics:** Evolution, Objectives, Components and Functions of Logistics Management, Distribution related Issues and Challenges; Gaining competitive advantage through Logistics Management, Transportation-Functions, Costs, and Mode; Network and Decision, Containerization, Cross docking.	8
3	**Supply Chain Performance:** Bullwhip effect and reduction, Performance measurement: Dimension, Tools of performance measurement, SCOR Model. Demand chain management, Global Supply chain- Challenges in establishing Global Supply Chain, Factors that influence designing Global Supply Chain Network.	7
4	**Warehousing:** Concept and types, Warehousing strategy, Warehouse facility location & network design, Reverse logistics, Outsourcing-Nature and concept, Strategic decision to Outsourcing, Third party logistics (3PL), Fourth party logistics (4PL).	7
5	**Supply Chain and CRM**: Linkage, IT infrastructure used for Supply Chain and CRM, Functional components for CRM, Green supply chain management, Supply Chain sustainability.	6
6	Difference between traditional supply chain management and trending supply chain management Green Supply chain management system design and development in Manufacturing industries Sustainable Supply Chain management system design and development in Manufacturing industries	6

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. Chopra, Sunil, Meindl, Peter and Kalra, D. V.; Supply Chain Management: Strategy, Planning 1. and Operation; Pearson Education
2. Altekar, Rahul V.; Supply Chain Management: Concepts and Cases
3. Ballou, Ronald H.; Supply Chain Management; Pearson Education
4. Sahay, B.S.; Supply Chain Management; Macmillan
5. Ballou, R.H. Business Logistics Management. Prentice-Hall Inc.
6. Bowersox D.J., Closs D.J., Logistical Management, McGraw-Hill, 1996; Chopra, S, and P. Meindl, 2004, Supply Chain Management Strategy, Planning and Operation, 2nd edition, Pearson Education (ISBN 81-297-0172-3)

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Course Code	Course Name	Credits
AE318	**Production & Operations management**	3

Course Objectives:

1. To provide an exposure to Production Planning & Systems and its significance in Manufacturing Industries
2. To give exposure to forecasting methods, aggregate planning and capacity planning techniques.
3. To give insights of various inventory control techniques and system approach of MRP
4. To give exposure to production scheduling and sequencing so as to optimize resources
5. To understand heuristics methods for design of manufacturing system.

Course Outcomes: Learner will be able to

1. Understand the role of Production/Operations Management in business processes.
2. Learn various production processes and service systems
3. Do the quantitative analysis of problems arising in the management of operations
4. To learn the scientific decision making and modern trend in the management process
5. To study Inventory Management and its types.
6. Learn various manufacturing operation systems.

Module	Details	Hours
1	**Introduction to production management**: Objectives; Introduction; Production Management; Scope of Production Management; Production System; Types of Production; Benefits of Production Management;Responsibility of a Production Manager; Decisions of Production Management	6
2	**Production planning and control**: Objectives of Production Planning and Control; Characteristics; Stages of Production Planning and Control; Functions /scope of production planning & Control; Challenges in Production Planning and Control; Factors Affecting Production Planning and Control; Production Planning System; Making the Production Plan; Process Planning; Manufacturing Planning and Control System; Role of Production Planning and Control in Manufacturing Industry	8
3	**Project Analysis**: Project Controlling and Project Control Systems; Types of Project Management; Role Technique - CPM/PERT; Planning, Scheduling & Control; The Framework for PERT and CPM; CPM/PERT Network; Tabulation & Analysis of Activities; PERT Calculations for the Social Project; Estimating Risk; Expected Length of a Project; Probability of Project Completion by Due Date	6
4	**Plant location and layout**: Factors affecting location, theory and practices, cost factor in location - Plant layout principles - space requirement; Different types of facilities; Innovation Management - Function and Intention of Innovation Management; Classifications in Innovation Management; Phases of an Innovation Management Process;Uses of Innovation Management; Aggregate Product Planning	6
5	**Manufacturing Operation systems**: Aggregate Planning, Master Production schedule (MPS), Material Requirements planning (MRP-1), Capacity Requirements Planning (CRP), Production Activity control (PAC), Shop Floor Control (SFC)	6

6	**Inventory management:** Different Types of Inventory; Need for Inventory Management; Finished Goods Inventory; Independent and Dependent Demand Inventories; Inventory Costs; Inventory Classification; Factors affecting Inventory Operations; Inventory Planning; Good Inventory Management Practices; Inventory Management Techniques	6

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. Operations Management by William J. Stevenson. Eighth Edition, Irwin / McGraw-Hill,2005.
2. Production and operations management by S.N. Chary
3. Production and operations management - manufacturing and services by Nicholas J. Aquilano and Richard B. Chase
4. Production and operations management by R. Panneerselvam

Back to Scheme

Course Code	Course Name	Credits
AE319	**Concept Sketching, Rendering and Modelling**	3

Course Objectives:

1. To conceptualise and develop design ideas
2. To communicate and be able to interpret graphical information

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

1. Build up different views starting from a point
2. Conceptualization and rendering of different automobiles and its parts.
3. Sketching for Automobiles
4. Animation and its types.
5. Concept modelling for graphical, physical and virtual models.

Theory Syllabus:

Module	Details	Hours
1	**Concept sketching:** Introduction to Prospective views, Single-point Perspective Two-Point Perspective, Horizon Lines, Importance of Perspective, Perspective Grids – How to Draw Equal Size Boxes in Perspective **Proportion:** Introduction, Working Out the Proportions, Box Design, One-Box, Two-Box, Three-Box Designs **Tools and Equipment:** Requirements, Usage & Importance of Papers, Pens/Pencils, markers, Colors, Guides & Templates	6
2	**Sketching for Automobiles** Copying and Tracing, Drawing views (Side, front, top etc.) **Case studies:** Role of Angle, Prospective, Proportion & stance (Comparison study of different companies and automobile models)	6
3	**Object Rendering:** Introduction Object-Rendering, Hardware requirements rendering **Texturing:** Different types of Texture. Render to texture tool. Various scene elements into texture Ray Tracing, Ray Casting, Radiosity **Lighting:** Types of lights spot, point, directional, natural, diffused, ambient Uses of Lighting, **Shades Shadows & Reflections Shading**: Flat Shading, Polygon Mesh Shading, Gouraud Shading Model, Phong Shading, Transparency Effect, Shadows	8
4	**Introduction to animation**, Key-Frame Animation, Construction of an Animation Sequence, Motion Control Methods, Procedural Animation, Key-Frame Animation vs. Procedural Animation, Introduction to Morphing, Three-Dimensional Morphing	6
5	**Concept Modeling:** Definition, Process, Types of models Graphical, Physical, Virtual **Case studies:** of different Automobile Models	5
6	**Course work submission:** Clay modeling / Digital modeling(2D using sketchbook and 3D using blender) of a concept from a sketch	6

Theory Assessment:
Internal Assessment:
Internal Tests First based on approximately 40% of contents – **40 Marks**
End Semester Examination – Jury / Viva on a course project following can be marks distribution – Total 60 Marks (15 Marks each)

- File submission 6-8 assignments based on hand sketching different types of vehicles.
- Project submission on concept model – including hand sketches, Digital Sketches, Clay model (Min 1:20 to 1:15 scale)
- Final Concept Presentation / Poster / Demonstration in external viva
- Oral Examination in external.

Books/References:

1. The British Car Sketch Book, Barber Edward,Lulu.com,ISBN:9781716508011,
2. Sketching, BIS Publishers B.V.,ISBN:9789063695330, 9789063695330,2019
3. The Car Book, Dorling Kindersley Ltd, ISBN: 9781405361750, 1405361751,Edition: 2011
4. Design, Construction and Manufacture of Automobiles, Salzwasser - Verlag Gmbh, ISBN: 9783861952589, 9783861952589

Back to Scheme

Course Code	Course Name	Credits
AE320	**Introduction to Self Driving Cars**	3

Course Objectives:

1. To Understand fundamentals of self-driving/autonomous cars
2. To Identify the main components of Hardware and Software
3. To familiarize with concepts of Functional safety and automotive cyber security

Course Outcomes: Learner will be able to…

1. Understand levels of Autonomy
2. Identify the main components of Hardware used in Self-driving cars
3. Apply the data gathered from Hardware (Sensors) to perceive the dynamic environment
4. Understand the architecture and safety environment of vehicles.
5. Apply the knowledge gathered to prepare and test the vehicle environment.
6. Describe the importance of functional safety and automobile cyber security from the perspective of self-driving vehicles

Module	Details	Hours
1	**Introduction to Self-driving Technology and Background** History of Self-driving vehicles, SAE Levels, Need, Challenges of Self-driving cars, the Basic framework of Self-driving cars,	4
2	**Hardware** Sensors: Considerations and types of sensors Automotive Radar and Lidar Computation platform: considerations and few examples of computing platforms Actuators: Components of actuator interfacing,	8
3	**Perception** Localisation, Mapping, SLAM, Object detection, Multi-sensor data fusion	6
4	**Architecture** Functional Architecture: Perception, Planning(Route, Behavioral, Motion) and Vehicle control **What is ADAS?** ADAS, Adaptive cruise control, Blind spot detection, Occupant and pedestrian protection, Lane departure warning,360 surround view, Driver monitoring, Driver drowsiness assists, Emergency brake assist System architecture: Hardware layer, Middleware layer, and Application layer ROS (Robotic Operation System)	8
5	**Bringing everything together** Preparation: Choose vehicle, Vehicle network, Sensor selection, and calibration Development: OSCC, Installing middleware and drivers, Map building and localization, Reading data and sending commands. Testing: Unit, Integration testing, system and acceptance testing Road runner environment in MATLAB/Simulink	6
6	**Future technological aspects:** Automotive Functional safety: ISO26262 and challenges Automotive Cybersecurity: Standards and Challenges	8

	V2X communication: Standards and challenges Backend systems (OTA, HD Maps)	

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

Text Books/References:

1. Theories and Practices of Self-driving vehicles, Zhou,Shen, Yong,Zhao and Zhi, Elsevier
2. Autonomous Vehicles: Opportunities, Strategies, and Disruptions, Michael E. McGrath
3. Driverless: Intelligent Cars and the Road Ahead, HOD Lipson and Melba Kurman, The MIT Press
4. Driver in the Driverless Car, Vivek Wadhwa and Alex Salkever, Berrett-Koehler Publishers
5. Self-Driving Car, Stephen Currie, Norwood House Press

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Course Code	Course Name	Credits
IL 360	**Entrepreneurship**	**3**

Course Objectives:

1. To understand the basic concepts of entrepreneurship.
2. To understand the role of entrepreneurship in economic development
3. To understand the importance of opportunity recognition and internal and external analyses to the success of a business venture
4. To enable the learners to know the factors contributed in failure of the enterprise

Course Outcomes: Learner will be able to

1. Analyse the business environment in order to identify business opportunities
2. Identify the elements of success of entrepreneurial ventures
3. Evaluate the effectiveness of different entrepreneurial strategies,
4. Interpret their own business plan

Module	Detailed Contents	Hrs
1	Conceptual definition of entrepreneurs and entrepreneurship, Advantages and Disadvantages of Being an Entrepreneur, Entrepreneurial motivation, Entrepreneurial characteristics	8
2	Recognizing, assessment and Exploiting the Opportunity, Conducting Internal and External Analyses, Determining the Feasibility of the Concept, Selecting a Marketing Strategy	6
3	Entrepreneurial Business Types A. Overview of Franchising and Their Advantages and Disadvantages B. Overview of Buyouts & Their Advantages and Disadvantages C. Overview of Family Businesses and Their Advantages and Disadvantages	6
4	The Overall Business Plan, Purpose of the Business Plan, Components of the Business Plan, Presentation of the Business Plan, Matching the Business Plan to the Needs of the Firm	6
5	The Marketing Plan, Conducting a Market Analysis, Understanding the Target Market, Reaching the Target Market through Locale and Engagement	8
6	Entrepreneurial failure, early stage failure, late stage failure	6

Assessment:
Internal Assessment: 40 marks
End Semester Examination: 60 Marks

Reference Books:

1. Fundamentals of Entrepreneurship by H. Nandan, PHI
2. Entrepreneurship by Robert Hisrich, Michael Peters, Dean Shepherd, Sabyasachi Sinha, Mc Graw Hill
3. Why startups fail: A new roadmap for entrepreneurial success by Tom Eisenmann

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Course Code	Course Name	Credits
IL 361	**IPR and Patenting**	**3**

Course Objectives:

1. To introduce fundamental aspects of Intellectual property Rights to learner who are going to play a major role in development and management of innovative projects in industries.
2. To get acquaintance with Patent search, patent filing and copyright filing procedure and applications, and can make career as a patent or copyright attorney.
3. To make aware about current trends in IPR and Govt. steps in fostering IPR,

Course Outcomes: Learner will be able to…

1. Understand the importance of IPR, types of Patent type and its importance in industries.
2. Able to search, draft and file the patent and copyright application to patent office.
3. Learn the recent trends of IPR and can open the way for the students to catch up Intellectual Property (IP) as a career option:
   a) R&D IP Counsel in research organization
   b) Government Jobs – Patent Examiner
   c) Private Jobs
   d) Patent agent and Trademark agent.

Module	Detail Content	Hrs.
1	**Overview of Intellectual Property:** Introduction and the need for intellectual property right (IPR) - Kinds of Intellectual Property Rights: Patent, Copyright, Trade Mark, Design, Geographical Indication, Plant Varieties and Layout Design – Genetic Resources and Traditional Knowledge – Trade Secret - IPR in India : Genesis and development – IPR in abroad - Major International Instruments concerning Intellectual Property Rights: Paris Convention, 1883, the Berne Convention, 1886, the Universal Copyright Convention, 1952, the WIPO Convention, 1967,the Patent Co-operation Treaty, 1970, the TRIPS Agreement, 1994	9
2	**Patents:** Patents - Elements of Patentability: Novelty, Non-Obviousness (Inventive Steps), Industrial Application - Non - Patentable Subject Matter - Registration Procedure, Rights and Duties of Patentee, Assignment and licence, Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies & Penalties - Patent office and Appellate Board	7
3	**Copyright:** Nature of Copyright - Subject matter of copyright: original literary, dramatic, musical, artistic works; cinematograph films and sound recordings - Registration Procedure, Term of protection, Ownership of copyright, Assignment and licence of copyright - Infringement, Remedies & Penalties – Related Rights - Distinction between related rights and copyrights	6
4	**Trademark:** Concept of Trademarks - Different kinds of marks (brand names, logos, signatures, symbols, well known marks, certification marks and service marks) - Non-Registrable Trademarks - Registration of Trademarks - Rights of holder and assignment and licensing of marks - Infringement, Remedies & Penalties - Trademark's registry and appellate board.	6
5	**Patent Acts:** Section 21 of the Indian Patent Act, 1970 (and corresponding	9

	Rules and Forms) with specific focus on Definitions, Criteria of Patentability, Non-Patentable Subject Matters, Types of Applications, and Powers of Controllers. Section 25 - Section 66 of the Indian Patent Act, 1970 with specific focus on the Oppositions, Anticipation, Provisions of Secrecy, Revocations, Patent of Addition, and Restoration of Patents. Section 67 - Section 115 of the Indian Patent Act, 1970 with specific focus on Patent Assignments, Compulsory Licensing, Power of Central Government, and Infringement Proceedings. Section 116 - Section 162 of the Indian Patent Act, 1970 with specific focus on Convention/PCT Applications, Functions of Appellate Board and other Provisions. Amendment Rules 2016 with emphasis on important revisions to examination and Hearing procedures; provisions for start-ups and fees.	
6	**Indian IP Policy:** India`s New National IP Policy, 2016 – Govt. of India step towards promoting IPR – Govt. Schemes in IPR – Career Opportunities in IP – IPR.	3

Assessment:
Internal Assessment: 40 marks
End Semester Examination: 60 Marks

Books/References:

1. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.
2. Neeraj, P., & Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited.
3. Ahuja, V K. (2017). Law relating to Intellectual Property Rights. India, IN: Lexis Nexis.
4. World Intellectual Property Organisation. (2004). WIPO Intellectual property Handbook. Retrieved from https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub _489.pdf

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Course Code	Course Name	Credits
IL 362	**Introduction to Bioengineering**	**3**

Course Objectives:

1. To understand and analyze the human body as a mechanical assembly of linkages and describe the fundamentals of biomechanics.
2. To Study the deformability, strength, visco elasticity of bone and flexible tissues, modes of loading and failure and describe the types and mechanics of skeletal joints.
3. To describe movement precisely, using well defined terms (kinematics) and also to consider the role of force in movement (kinetics).
4. To teach students the unique features of biological flows, especially constitutive laws and boundaries.
5. To teach students approximation methods in fluid mechanics and their constraints.
6. To consider the mechanics of orthopedic implants and joint replacement, mechanical properties of blood vessels and Alveoli mechanics

Course Outcomes: Learner will be able to

1. Apply a broad and coherent knowledge of the underlying principles and concepts of biomechanics, particularly in the fields of kinematics and kinetics as applied to human and projectile motion.
2. Understand and describe the properties of blood, bone and soft tissues like articular cartilage tendons and ligaments.
3. Gain broad knowledge about the mechanics of moving systems and familiarity with human anatomy to competently analyze gross movement of the human body.
4. Be able to computationally analyze the dynamics of human movement from the most commonly used measurement devices in the field, such as motion capture and force platform systems.
5. Use knowledge gained to competently interpret the current understanding of human movement and present recommendations for further study.

Module	Detail Content	Hrs.
1	**Introduction:** Definition of Biomechanics, Selected Historical highlights, The Italian Renaissance, Gait century, Engineering Physiology & Anatomy	6
2	**Tissue Biomechanics:** Bone structure & composition mechanical properties of bone, cortical and cancellous bones, viscoelastic properties, Maxwell& Voight models – anisotropy. Structure and functions of Soft Tissues: Cartilage, Tendon, Ligament, and Muscle	8
3	**Joints Biomechanics:** Skeletal joints, forces and stresses in human joints, Analysis of rigid bodies in equilibrium, free body diagrams, types of joint, biomechanical analysis of elbow, shoulder, hip, knee and ankle.	7
4	**Biomaterials:** Brief Anatomy, Bone, cartilage, ligament, tendon, Muscles, biofluid their physical properties	6
5	**Implants:** General concepts of Implants, classification of implants, Soft tissues	6
6	Application of advanced engineering techniques to the human body, case studies.	6

Assessment:
Internal Assessment: 40 marks
End Semester Examination: 60 Marks

Books/References:

1. Nigg, B.M.and Herzog, W., "BIOMECHANICS of Musculo skeleton system", John Willey & Sons, 1st Edition.
2. Saltzman, W.L., "BIOMEDICAL ENGINEERING: Bridging medicine and Technology", Cambridge Text, First Edition.
3. Winter, D., "BIOMECHANICS and Motor Control of Human Movement", WILEY Interscience Second edition
4. Prof. Ghista,Biomechanics, Private Publication UAF, 2009
5. White &Puyator, Biomechanics, Private publication UAE, 2010
6. R. M. Kennedy, A textbook of Biomedical Engineering, GTU, 2010
7. Richard Shalak & ShuChien, Handbook of Bioengineering,
8. Sean P. Flanagan, Flanagan, Biomechanics: A case based Approach, Jones & Bartlett Publishers, 2013
9. Y. C. Fung, Yuan-Cheng Fung, Biomechanics: mechanical Property of living Tissue, Springer, 1996.
10. Carol A. Oatis, The Mechanics and Pathomechanics of Human Movement, Lippincott Williams & Wilkins, 2010

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Course Code	Course Name	Credits
IL 363	**Product Design**	**3**

Course Objectives:

1. To familiarize with fundamental product design concepts
2. To acquaint with product design methodologies
3. To understand product design needs and issues in industry

Course Outcomes: Learner will be able to

1. Demonstrate product design and development process.
2. Analyze a product in perspective of aesthetic and ergonomic considerations.
3. Illustrate considerations of Design for Manufacturing and Assembly in product development.
4. Apply appropriate tools and techniques in the design of solutions that are usable and functional for various applications.
5. Design the products as per the customer/industry requirements
6. Apply principles of economy and demonstrate legal and social issues pertaining to product development.

Module	**Detail Content**	**Hrs.**
1	Product definition, specification, Phases of product development: conceptual, embodiment and detailed design, product and technology development cycle, Concept generation and evaluation methods, product architecture, Product life cycle Management with case studies, Product analysis. Creativity and Idea generation technique, importance of Quality Dimensions: Performance, Features, aesthetics, Ergonomics, Reliability, Sustainability, Serviceability, Brand value, Value Vs cost, Importance of shape, color, feature & Resemblance.	06
2	Design Factors: Ergonomics, Aesthetics, Anthropometry, Comforts, Economic factors Axiomatic design principles and case studies. Design Thinking, Design by Innovation and collaboration Material and Process selection Methods, Expert systems. Computer Database Approach,performance indices decision matrix, AHP and fuzzy approach, Introduction to material and process selection software.	06
3	Design for Manufacturing (DFM) and Design for Assembly (DFA) Designs for Maintainability and Reliability and some methods for reliability assessment, Designs for Environment, Design for Robustness: Taguchi Designs & Design of Experiments (DOE).	08
4	Product Design Tools and Techniques: Value Engineering / Value Analysis: definition, methodology-FAST, Benchmarking, Supplier involvement robust design, QFD, Design & process FMEA. Reverse Engineering, Concurrent engineering & Sequential engineering, Case studies.	08

5	Product Development Cycle and Importance of Prototyping. Types of prototypes. Principal and advantages & Different Type of Generative Manufacturing process, Viz. Stereo lithography. FDM, SLS etc. Factors Concerning to RP: Consideration for Adoptions, Advantages, Accuracy and Economic Consideration. Introduction to Assembly Modeling, Top-Down and Bottom-Up Approaches of AM, Mating Conditions, representation Schemes. Generation of Assembly Sequences. Case studies	06
6	Economics of Product Development: Product costing, Principals of Economy, Engineering Economy and Design Process, Economic Analysis, Inflation, Time Value of Money, Numerical on Internal Rate of Return and Net Present Value (NPV) method. Legal and social issues, Patents and IP acts.	06

Assessment:
Internal Assessment: 40 marks
End Semester Examination: 60 Marks

Reference Books:

1. Product Design and Manufacturing by A.K.Chitale, R.C.Gupta, PHI.
2. Product Design and Development by Ulirich Karl T. and Eppinger Steven D, McGraw Hill.
3. Engineering Design by Dieter George E., McGraw Hill.
4. Handbook of Product Design for Manufacturing by Bralla, James G, McGraw Hill.
5. Product Design by Kevin Otto & Kristin Wood

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Course Code	Course Name	Credits
IL 364	**Visual Art**	**3**

Course Objectives:

1. To enable learners to develop aesthetic judgement, visual perception, critical thinking skills in the different forms of art and understand its application.
2. To promote the concept of visual design and understand the different meanings assigned to colours, its impact and problems.
3. To provide the opportunity and scope to use the image editing software for creating images for Web and Video.
4. To inculcate the basic skills required in drawing and painting through exposure in nature and study of still objects.
5. To train students to express their feelings and write imaginatively.
6. To prepare the learners for the use of clay modelling techniques and its industrial applications.

Course Outcomes: Learner will be able to

1. Acquire the skills necessary for aesthetic judgement, visual perception and critical thinking required in different forms of art.
2. Demonstrate the understanding of the concept of visual design with respect to the different meanings assigned to colours and the problems associated.
3. Illustrate effective use of image editing software for creating images for the Web and Video.
4. Determine the importance of drawing and painting with respect to nature and still objects.
5. Perform successfully in expressing their feelings creatively.
6. Develop the techniques required for clay modelling and sculpture for industrial use.

Module	Detail Content	Hrs.
1	History of Art and Architecture- Changing needs and forms of art from the Palaeolithic period to The Renaissance period with special reference to Roman, Indian and Chinese art	4
2	Introduction and concepts of visual design with special emphasis on the psychological impact of colour	5
3	Introduction to image editing software, tools, application and creating Images for Web and Video. With special reference to Adobe Photoshop	7
4	Fundamentals of Drawing- study of forms in nature, study of objects and study from life, creative painting- basic techniques, tools and equipment, medium of painting.	6
5	Creative writing- Movie critique, book reviews, Poems, short plays and skits, Humorous Essays, Autobiography and short stories.	7
6	Creative sculpture- Introduction to clay modelling techniques, study of natural and man-made objects in clay, Sculpture with various materials - Relief in Metal Sheets – Relief on Wood – Paper Pulp - Thermocol. Sculpture with readymade materials.	7

Assessment:
Internal Assessment: 40 marks
End Semester Examination: 60 Marks

Reference Books:

1. Gill Martha. (2000). Color Harmony Pastels: A Guidebook for Creating Great Color Combinations. Rockport Publishers.
2. Janson, Anthony F. (1977). History of art, second edition, H.W. Janson. Instructor's manual. Englewood Cliffs, N.J.: Prentice-Hall.
3. Brommer, Gerald F. (1988). Exploring Drawing. Worcester, Massachusetts: Davis Publications.
4. Wendy Burt Thomas. (2010). The Everything Creative Writing Book: All you need to know to write novels, plays, short stories, screenplays, poems, articles, or blogs: All You Need ... - Stories, Screenplays, Blogs and More. Fw Media; 2nd edition.
5. Élisabeth Bonvalot. (2020). Sculpting Book: A Complete Introduction to Modeling the Human Figure.

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Course Code	Course Name	Credits
IL 365	**Journalism, Media and Communication Studies**	**3**

Course Objectives:

1. Provide a good grounding in the basic concepts of Journalism, Mass communication and Media.
2. Familiarize learners with reporting and editing practices.
3. Teach students to write editorials, feature articles, interviews, reviews, criticism etc.
4. To inculcate the skills required for writing in online newspapers, blogs, email and cell phone.
5. To prepare the learners for understanding the importance of Press laws and Ethics.
6. To train learners in advertising techniques and Public Relation Communication

Course Outcomes: Learner will be able to

1. Acquire conceptual and theoretical knowledge of Journalism, Mass Communication and Media Studies and learn to think critically about issues and topics of the subject.
2. Demonstrate the understanding of reporting and editing from Newspaper and the Organization.
3. Perform successfully in writing effective editorials, featured articles reviews etc.
4. Illustrate the skills required for writing in online newspapers, blogs, emails etc.
5. Determine the importance of Press Laws and Ethics.
6. Develop an understanding of the techniques required for advertising and Public Relation Communication.

Module	Detail Content	Hrs.
1	Introduction to Journalism, Communication, Media and Cultural Studies- Basics of Mass communication, Pioneers of Indian Journalism, Introduction to newspapers, magazines and other publications. Introduction to broadcast journalism with special reference to television	5
2	Reporting and Editing Practices-Reporting different news, stories from Newspaper, and Organization. Principles of editing, rewriting, and translation	7
3	Writing for Print-Newspaper Content Writing Opinion pieces, editorials, feature articles, interviews, profiles, reviews, criticism etc.	7
4	Writing for Media- Introduction to New Media Writing for Online newspapers Blogs Cell phone Communication E-mail	6
5	Press Laws and Ethics- Origin and definition of Law, Law and Morality, Types of Law – Civil and Criminal, Press Legislations, Freedom of the Press Defamation Contempt of Court	4
6	Public Relations and Advertising- Introduction to Public Relations Stages of PR Communication with Public Need and Meaning of Advertising, Advertising strategies and Sales Promotion	7

Assessment:
Internal Assessment: 40 marks
End Semester Examination: 60 Marks

Books/References:

1. Rangaswamy, Parthasaratihi, (1985). *Journalism in India*, Sterling Publication, New Delhi.
2. Jeffrey, Robin, (2009). *India's Newspaper Evolution*, Oxford University Press, Delhi.
3. Singh, Devvrat. (2012). *Indian Television: Content, Issues and Challenges*, HarAnand Publications Delhi.
4. Daryl L. Frazell, George Tuck. (1996). *Principles of Editing: A Comprehensive Guide for Students and Journalists Principles of Editing: A Comprehensive Guide for Students and Journalists.* McGraw-Hill
5. Barry Newman. (2015). *News to Me: Finding and Writing Colorful Feature Stories*. Paperback
6. The Associated Press. (2017).*The Associated Press Stylebook: and Briefing on Media Law*. Revised, Updated Edition. Paperback.
7. Kristina Halvorson. (2012) *Content Strategy for the Web*, 2nd Edition. New Riders

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Course Code	Course Name	Credits
IL 366	**Computational Physics**	**3**

Course Objectives:

1. To expose the students to the vast field of computational physics.

Course Outcomes: Learner will be able to

1. To understand various approaches of simulating physical systems on a computer.
2. To choose the correct method to solve a computational problem.

Module	Detail Content	Hrs.
1	**Introduction to Statistical Mechanics:** Thermodynamics and kinetic theory, specification of state of system, Concept of ensemble, phase space, microcanonical ensemble (NVE), statistical concept of temperature, canonical ensemble (NVT), equipartition theorem, Maxwell-Boltzmann velocity distribution, grand canonical ensemble (μVT), chemical potential	6
2	**Molecular Dynamics (MD):** Integrating equation of motion of a few variables, role of molecular dynamics (MD), the basic machinery, Lennard-Jones potentials modeling physical system, boundary conditions, time integration algorithm	7
3	Starting a simulation, simulation of microcanonical (NVE) and canonical ensemble (NVT), controlling the system (temperature, pressure), thermostats and barostats, equilibration, running, measuring and analyzing MD simulation data, measurement of statistical quantities, interatomic potentials, force fields.	7
4	**Monte Carlo (MC) Method:** Random number: Definition, True and Pseudo random number generators (RNG), uniform and non-uniform RNG, Linux RNG, testing a RNG.	6
5	**Monte Carlo simulations:** Buffon's needles, MC Integration, hit and miss (estimation of pi and e), stochastic processes, sample mean integration, importance sampling, Markov Chain, Metropolis method, master equation, introduction to 2D-Ising model. **Random walk:** 1-D and 2-D random walk, calculation of rms displacement.	7
6	Introduction to Simulations of quantum systems	3

Assessment:
Internal Assessment: 40 marks
End Semester Examination: 60 Marks

Books/References:

1. Statistical Physics – Vol. 5 (from the series of Berkeley Physics Course)
2. Introduction to Computational Physics by Tao Pang (Cambridge University Press)
3. An Introduction to Computer Simulation Methods: Applications to Physical Systems by Harvey Gould and
4. Jan Tobochnik, (Pearsom Publications)
5. Understanding Molecular Simulations by Frenkel and Smit (Academic Press)

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Course Code	Course Name	Credits
IL 367	**Polymers and Polymeric Materials**	**3**

Course Objectives:

1. To impart a scientific approach and to familiarize the applications of polymeric materials in the field of engineering.
2. The student with the knowledge of the basic polymer science will understand and explain scientifically the various problems related to polymeric materials in the industry/engineering field.
3. To develop abilities and skills that are relevant to the study and practice of polymer science and engineering.

Course Outcomes: Learner will be able to

1. To understand and analyze various polymeric materials and to establish the structure property relationship.
2. To select the proper polymeric material for specific industrial applications.
3. To become familiarized with various characterization techniques related to polymeric materials.

Module	Detail Content	Hrs.
1	**Basic understanding of Polymeric aspects:** Monomers, functionality, degree of polymerizations, classification of polymers, glass transition, melting transition, criteria for rubberiness, polymerization methods: addition and condensation; metallocene polymers and other newer techniques of polymerization, copolymerization, monomer reactivity ratios and its significance, different copolymers, random, alternating, azeotropic copolymerization, block and graft copolymers, concept of average molecular weight, determination of number average, weight average	9
2	**Polymer Technology:** Compounding of plastics, Polymer compounding-need and significance, different compounding ingredients for rubber and plastics, crosslinking and vulcanization	5
3	**Polymer Processing:** Fabrication of plastics by different moulding process, Compression molding, transfer molding, injection molding, blow molding, reaction injection molding, extrusion, pultrusion, calendaring, rotational molding, thermoforming, rubber processing in two-roll mill, internal mixer	6
4	**Polymer blends:** Thermo- dynamical aspects of polymer blends and its miscibility, Role of compatibilizer, Composition based structure (dispersed and co-continuous), properties and its application, choice of polymers for blending, thermodynamics, phase morphology, polymer alloys, polymer eutectics, plastic-plastic, rubber-plastic and rubber-rubber blends	6
5	**Polymer composites:** Fundamentals of polymer composites, Advanced polymer nanocomposites, Fillers used for polymer composites, Effect of processing condition and composition, Polymer composites structure, characterisation and design, physical and chemical modification of polymer composites. 1-D and 2-D random walk, calculation of rms displacement.	6

6	**Testing of Polymeric Materials:** Samples preparation, Mechanical-static and dynamic tensile, flexural, compressive, abrasion, endurance, fatigue, hardness, tear, resilience, impact, toughness. Conductivity-thermal and electrical, dielectric constant, dissipation factor, power factor, electric resistance, surface resistivity, volume resistivity, swelling, aging resistance, establishment of structure property relationship	7

Assessment:
Internal Assessment: 40 marks
End Semester Examination: 60 Marks

Books/References:

1. "Fundamentals of Polymer Engineering" by Anil Kumar and Rakesh Gupta.
2. "Principles of Polymer Systems" by F Rodriguez.
3. "Polymer Science" by V R Gorwankar.
4. "Textbook of Polymer Science" by F W Billmeyer. 5. "Polymer Chemistry" by P C Heimenz.

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Course Code	Course Name	Credits
IL 368	**Vehicle Safety**	**3**

Course Objectives:

1. To familiarize basic concepts of vehicle safety.
2. To familiarize accident reconstruction analysis methods
3. To acquaint with different issues related to vehicle safety in India

Course Outcomes: Learner will be able to

1. Comprehend Vehicle design from safety point of view.
2. Apply concepts of accident reconstruction analysis in real world.
3. Enumerate interrelationship among occupant, restraint systems and vehicles in accidents.
4. Illustrate role and significance of seat in Rear crash safety
5. Demonstrate different active and passive safety systems available in vehicles
6. Contribute to the society by being proactive to the cause of safety on roads and in vehicles

Module	Detailed Contents	Hrs.
1	Introduction to vehicle safety-the integrated approach and itsclassification SAVE LIVES- by WHOImportance of Risk evaluation and communication, Concepts of Universal design, India's BNVSAP and its outcomes	6
2	Crash and distracted driver, Human error controlCrash Testing, Use of Dummies, evolution and built of dummies. Relevance of Star ratings,NCAPs around the world-Accident Data, Biomechanics and Occupant SimulationVehicle Body Testing, Dynamic Vehicle Simulation TestsOccupant Protection,Compatibility, Interrelationship Among Occupants, Restraint Systems and Vehicle in Accidents	8
3	Significance of Rear Crash SafetyRole of seat in Rear crash safety Self aligning head restraintsPedestrian Protection testing and systemsUnder run Protection Devices	6
4	Introduction to Accident Analysis Reconstruction methodsSkid distances and Critical speed from Tire Yaw marksReconstruction of Vehicular Rollover AccidentsAnalysis of CollisionsReconstruction Applications Impulse Momentum TheoryCrush EnergyPhotogrammetry for accident constructions	8
5	Antilock braking system Electronic Stability Program Low tire pressure warning system Collision avoidance systems	5
6	Basic Vehicle Operations and Road/Helmet Safety Activity	6

Assessment:
Internal Assessment: 40 marks
End Semester Examination: 60 Marks

References Books:

1. Automotive vehicle safety by George Peters and Barbara Peters, CRC Press, 2002.
2. Vehicle Accident Analysis and Reconstruction Methods by Raymond M. Brach and R. Matthew Brach, SAE International, Second Edition, 2011.
3. Role of the seat in rear crash safety by David C. Viano, SAE International, 2002.
4. Automotive Safety Handbook by Ulrich W. Seiffert and LotharWech, SAE International, 2007.
5. Public Safety Standards of the Republic of India

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Course Code	Course Name	Credits
IL 369	**Maintenance of Electronics Equipment**	**3**

Lab Objectives:

1. To demonstrate use of different types of hand tools
2. To understand testing of different active and passive components mounted on PCB
3. To understand functionality TTL and CMOS digital IC tester
4. To demonstrate computer assembling, troubleshooting and software installation
5. To understand/demonstrate concept of circuit diagram of LED/LCD TV, DTH and mobile phone troubleshooting
6. To understand concept of medical equipments

Lab Outcomes:

1. Demonstrate use of different types of hand tools
2. Understand testing of different active and passive components mounted on PCB
3. Understand functionality TTL and CMOS digital IC tester
4. Demonstrate computer assembling, troubleshooting and software installation
5. Understand/demonstrate concept of circuit diagram of LED/LCD TV, DTH and mobile phone troubleshooting
6. Understand concept of medical equipments

Sr. No.	**Detailed Lab/Tutorial Description**	**Hrs.**
1	Demonstrate use of various hand held tools.	2
2	Test the performance of different passive electronic components (fixed/variable)	2
3	Test the performance of active electronic components like general purpose transistor/FET/MOSFET/SCR/ DIAC/TRIAC with DMM and CRO OR Components Tester	4
4	Verify the functionality of TTL and CMOS Digital IC's using IC tester	4
5	Explore a datasheet of minimum any five electronics components and analog/ Digital IC's.	2
6	Draw the given regulated power supply circuit/ SMPS (from any television/fridge/ computer system/ laboratory etc)	2
7	Identify basic sections of a personal computer/Laptop	2
8	Demonstrate Assembling of Personal Computer/Laptop	4
9	Troubleshoot the booting process of computer system and install different hardware associated with computer (HDD, LAN Card, Audio System etc)	4
10	Study Installation of Software and Configure Internet	4
11	Explore circuit diagram of LED/LCD TV.	2
12	Demonstrate Installation of DTH system	4
13	Demonstrate installation Solar power system	4
14	Practice steps for mobile troubleshooting	4
15	Visit to Medical Equipment Industry/Laboratory	8

Assessment:
Internal Assessment: 40 marks
End Semester Examination: 60 Marks

Books/References:

1. Troubleshooting and Maintenance of Electronics Equipment, Singh K. Sudeep, Katson Book,New Delhi,II edition, Reprint 2014
2. Mobile repairing Books, Manohar Lotia, BPB Publication, New Delhi, latest edition
3. Troubleshooting Electronic Equipment: Includes Repair and Maintenance, Second Edition, Khandpur R. S., Tata McGraw-Hill Education, New Delhi,India, latest edition.
4. Data Books, National semiconductor.

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Course Code	Course Name	Credits
AE392	**Major Project I**	**3**

Course Objectives:

1. To acquaint with the process of undertaking literature survey or market survey or feasibility study /industrial visit and identifying the problem
2. To familiarize the process of problem solving in a group
3. To acquaint with the process of applying basic engineering fundamental in the domain of practical applications
4. To inculcate the process of research

Course Outcomes: Learner will be able to

1. Do literature surveys based on market or feasibility study/industrial visit and identify the problem.
2. Apply basic engineering fundamentals in the domain of practical applications
3. Cultivate the habit of working in a team
4. Attempt a problem solution in the right approach.
5. Correlate the theoretical and experimental/simulations results and draw the proper inferences
6. Prepare project reports as per guidelines and with proper references/citations.
7. Exhibit and explain project ideas/models at various platforms.

Guidelines for Project

- Students should do literature survey/Market survey/ feasibility study/visit industry/analyze current trends and identify the problem for Project and finalize the project title in consultation with Guide/Supervisor.
- Students should use multiple literatures and understand the problem.
- Students should attempt a solution to the problem by experimental/simulation methods.
- The solution to be validated with proper justification and report to be compiled in standard format.

Assessment:

Project I should be assessed based on following points

1. Quality of problem selected
2. Clarity of Problem definition and Feasibility of problem solution
3. Relevance to the specialization
4. Clarity of objective and scope
5. Breadth and depth of literature survey
6. Societal importance
7. Presentation skill/ Question-answer session.

Project I should be assessed through a presentation by the student project group to a panel of Internal and External examiners appointed by the Head of the Department/Institute of respective Programme.

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Course Code	Course Name	Credits
AE401	**Hybrid and Electric Vehicles**	3+1

Course Objectives:

1. To appreciate the need of Sustainable transportation options available.
2. To familiarize with basic Concepts of Hybrid, Electric and Fuel Cell vehicles.
3. To acquaint with various aspects of hybrid and electric drive train and Battery Management Systems.
4. To study various challenges involved with Fuel cell technology.

Course Outcomes: Learner will be able to

1. Identify and describe the history and evolution of electric & hybrid electric vehicles.
2. Identify and describe the working principle of different EV/HEV's configurations.
3. Compare various energy sources and storages for EV and HEV's
4. Design drivetrain parameters for HEV's
5. Elaborate use of fuel cells in vehicular applications
6. Appreciate the need of BMS and chargers in EV's and perform sizing calculations for Batteries and Electric Motors.

Module	Details	Hours
1	**Introduction** Environmental Impact: Air pollution, Global Warming, Petroleum Resources, Importance of Different transportation development, History of Electric Vehicles, History of Hybrid Vehicles and History of Fuel Cell Vehicles, Well to Wheel Analysis, GoI Initiatives,Indian and global scenario in EV/HEV	06
2	**Electric Vehicles** 1. Drive train Configurations 2. Traction Motor characteristics, Tractive effort, transmission requirement and Vehicle Performance 3. EV Parameters-Weight, Size, Force, Energy Consumed and Performance	08
3	**Hybrid Electric Vehicles** 1. Configurations-Series, Parallel, Series-Parallel and Complex 2. Power flow control for above configurations 3. Torque Coupling, Speed coupling and combined Torque and speed coupling Hybrid electric drivetrain. **Design of Series and Parallel Hybrid drivetrain** 1. Control strategies for Series and Parallel hybrid drivetrain 2. Sizing of drivetrain parameters	08
4	**Energy Storages and Drives and Regeneration** 1. Specific Energy, Specific power, Energy Efficiency, Electrochemical reactions and voltages 2. Batteries for EV's and HEV's-Lead Acid, Nickel Based and Lithium-Ion Battery Chemistries 3. Ultra-capacitors 4. Ultra-High speed flywheels 5. Hybridization of Energy storages 6. Motors for Electric Vehicles-DC Motors, Induction Motors and Switched Reluctance Motors (SRM) 7. Energy consumption in braking, Brake systems for EV's and HEV's	08

5	**Fuel Cell Electric Vehicles** 1. Operating Principles of fuel cell 2. Electrode potential and current voltage curve 3. Fuel Cell Technologies-PEMFC,AFC,PAFC,MCFC,SOFC,DMFC 4. Hydrogen storage and Production 5. Fuel cell hybrid electric drive train-Configuration, control strategy	08
6	**BMS, Chargers for EV'S and Case Study** 1. Need of Battery management systems (BMS) for Electric Vehicles 2. Basics of Electric Vehicles Chargers-AC and DC Chargers 3. Battery Swapping 4. V2X or V2G and G2V concepts	06

List of Experiments (any 8 of following)

1. Vehicle Performance Calculations for HEV and EV's
2. Battery Sizing calculations for 2W/3W/4W Electric Vehicles
3. Motor selection and sizing calculations for 2W/3W/4W Electric Vehicles
4. Simulate Vehicle performance calculations in Matlab/Simulink
5. Vehicle Performance analysis using ADVISOR toolbox
6. Modeling of Li-ion Battery/Battery pack in Matlab/Simulink
7. Modeling a Lead acid /Li-ion Battery using Simscape
8. Modeling an Ultra capacitor model using Simscape
9. Designing EV using QSS toolbox
10. Modeling and Analysis of HEV using QSS toolbox
11. Modeling BMS in Matlab/Simulink
12. Case study on Hybrid Electric Vehicle Model
13. Case study on Electric Vehicle Model
14. Case study on Fuel cell electric vehicle model

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 Exam 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) Experiments (any 8 from list) - **20 marks**

2) Attendance (Theory and practical) **- 05 marks**

Practical and oral Examination:

Pair of Internal and External Examiner should conduct practical/Oral based on contents.

The distribution of marks for practical examination shall be as follows:

Practical Exam : **15 marks**

Oral Exam : **10 marks**

Evaluation of practical examination to be done based on the experiment performed and the output of the experiment during practical examination. Students work along with evaluation report to be preserved till the next examination

Books:

1. Robin Hardy, Iqbal. Hussein, Electric and Hybrid Vehicles, CRC Press,ISBN-0-8493-1466-6.
2. J. Lar Minore and J. Lowry, Electric Vehicle Technology Explained, Wiley, 2003
3. C. MI, M. Abul and D. W. Gao, Hybrid Electrical Vehicle Principles and Application with Practical Perspectives, Wiley 2011

References:

1. Sandeep Dhameja, "Electric Vehicle Battery Systems",Newnes,Massachusetts,2002
2. C.C.Chan and K.T.Chau, "Modern Electric Vehicle Technology", Oxford University Press,2001
3. I. Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003

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Course Code	Course Name	Credits
AE402	**Vehicle Dynamics**	3+1

Course Objectives:

1. To familiarize with basic concepts of vehicle dynamics.
2. To analyze the vehicle in context of ride, handling and longitudinal dynamics of vehicle.
3. To get acquainted with simulation process using software in the domain of vehicle dynamics.

Course Outcomes: After completion of this course, Learner will be able to

1. Analyze the vehicle directional stability.
2. Enumerate the suspension systems, tire dynamics & directional stability of the vehicle.
3. Develop physical and mathematical models to predict the dynamic response of vehicles
4. Demonstrate the ride characteristic of the vehicle.
5. Analyze the vehicle roll behaviour
6. Comprehend the various trends in Vehicle Dynamics.

Module	Details	Hours
1	**Introduction** History of Road and Off-Road Vehicle dynamics, Road Load, Aerodynamics-Drag, Side force, Lift force, Rolling Resistance Total Road Loads, Introduction about Longitudinal vehicle Dynamics, Introduction about control theory applied to Longitudinal dynamics	4
2	**Tyres** SAE Tyre axis system, Tyre forces, Moments, Lateral force V/S Slip Angle, Aligning Torque V/S Slip Angle, Tyre Construction, Tractive Properties, Cornering Properties, Camber Thrust, Aligning Moment, Combined braking and Cornering, Conicity and Ply Steer, Tire Vibration, Tyre Properties affecting Vehicle Roll over, Introduction to Magic Tyre Formula, Tyre testing on various road surfaces	6
3	**Suspension** Solid Axles, Independent suspensions, Variable Rate Leaf Spring., Anti Squat and Anti Pitch Suspension Geometry, Anti Dive Suspension Geometry, Equalizing Suspension, Roll Centre Analysis, Motion Analysis of Wheel Suspension, semi active and Active Suspensions, Introduction about control theory applied to Suspension systems	8
4	**Vertical Dynamics** Lumped mass, Equation of Simple Spring Mass System with to degrees of freedom system, pitch and bounce motion frequencies, Conjugate Points, Elastic, Dynamic, doubly Conjugate Points, Calculation of Conjugate Points Sources for vehicle vibration, vibration isolation, Effects of damping the vibration, vibration absorbers.	10
5	**Lateral Dynamics** Steering geometry, Front wheel geometry, Steering system forces and moments, Steering system effects, Influence of front wheel drive, four wheel steering, Suspension effect of cornering, High speed cornering, understeer, oversteer, Jack Knifing of articulated vehicles, Introduction	6

	about control theory applied to Lateral dynamics	
6	**Recent Trends in Vehicle dynamics** Vehicle dynamic Control (ESP and active steering), Actuators, Sensors for Automobile Control, Sensors for Detecting Vehicle Environment, Central Tyre Inflation system.	4

List of Experiments:

1. To plot characteristic curves for shock absorber.
2. Simulation of Quarter car model for pitch and bounce.
3. Simulation of Quarter car model for different road profiles
4. Simulation of Half car model for pitch and bounce.
5. Simulation of Half car model for different road profiles.
6. Experimental studies of measurements of drag and lift coefficient for different geometry vehicle using wind tunnel apparatus.
7. To perform test on chassis dynamometer

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 5 exercises, from the list, 6 assignments covering maximum portion of the syllabus (one on each module) or case study or Minor project based on topics related to vehicle Dynamics. The case study or Minor project is assigned for group of students and number of students in a group should not be more than two. The introduction of vehicle dynamics systems using any of the Dynamics software (like CARSIM etc.) can be given to the students as a part of term work.

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

Experiment write ups : 20 Marks
Attendance : 05 marks

Practical and oral Examination:

Pair of Internal and External Examiner should conduct practical/Oral based on contents.

The distribution of marks for practical examination shall be as follows:

Practical Exam : 15 marks
Oral Exam : 10 marks

Evaluation of practical examination to be done based on the experiment performed and the output of the experiment during practical examination. Students work along with evaluation report to be preserved till the next examination

Books:

1. Gillespie T.D, ―Fundamentals of Vehicle Dynamics‖, SAE USA 1992
2. Giri N.K – Automotive Mechanics, Khanna Publishers, 2007.
3. Colin Campbell - Automobile Suspension and Handling
4. William F Milliken and Douglas L Milliken - Race Car Vehicle Dynamics
5. Konrad Reif Ed. – Automotive Mechatronics Bosch Professional Automotive Information, Springer

References:

1. J. Y. Wong, "Theory of Ground Vehicles", 3rd ed., John Willey & Sons, New York, 1997.
2. Hans B, Pacejka - Tyre and Vehicle Dynamics - SAE Publication – 2002
3. Vehicle Dynamics Theory and application – Reza Jazar, Springer
4. Heinz Heisler, "Advanced Vehicle Technology ", 2nd Edition, Butterworth-Heinemann, 2002
5. Rajesh Rajamani "Vehicle Dynamics and Control "
6. Road and Off-Road Vehicle system Dynamics. Hand Book
7. Mechanics of Road Vehicle, Steeds
8. Car Suspension: Bastow
   Links for online NPTEL/SWAYAM courses:
   https://nptel.ac.in/courses/107/106/107106080/

Back to Scheme

Course Code	Course Name	Credits
AE403	**Automotive Embedded Systems**	3

Course Objectives:

1. To provide broad introduction to automotive embedded systems.
2. To understand communication techniques.
3. To understand various types of X by wire technologies.
4. To study concepts involved in embedded hardware for systems realisation.
5. To apply hardware and software knowledge to develop automotive embedded system applications according to requirement and constraints.
6. To provide a comprehensive overview about existing and future automotive electronic systems.

Course Outcomes:

1. Illustrate basic concepts of embedded systems.
2. Interpret the various types of communication protocols used in Automobiles.
3. Demonstrate various types of X by wire technologies with its challenges and opportunities.
4. Identify various hardware modules used in embedded systems.
5. Recognize Tools for software development from Automobile viewpoint.
6. Comprehend embedded systems used in Automobiles using different case studies.

Module	Details	Hours
1	**Introduction**: Definition of Embedded System, Embedded Systems Vs General Computing Systems, Introduction to microprocessors, microcontrollers. Overview of Embedded System Architecture with function of each block in brief, Memory, Sensors and Actuators, Electronic Control Units (ECU'S), Harvard and Von Neumann architecture, RISC and CISC processors, Categories of embedded systems, Quality attributes (Design Metric) of embedded system and Major Application Areas.	06
2	**Embedded Communication:** Modes of data communication: serial, parallel, synchronous and asynchronous communication. Serial communication protocols: I2C, CAN, USB, Parallel communication protocols: ISA, PCI. A Review of Embedded Automotive Protocols , CAN Protocol: Introduction, Features, Networks Organization, CAN Frame Types (Standard CAN Frame and Extended CAN Frame), Bus Arbitration and Different message types in CAN. Flex Ray Protocol: Introduction, Features, Bus Level, Networks Organization, Flex Ray Frame.	08
3	**Drive By Wire:** Challenges and opportunities of X by Wire: System and design requirements steer by wire, brake by wire, suspension by wire, gas by wire, power by wire, and shift by wire. Future of automotive electronics.	06
4	**Hardware Modules:** MC9S12XD family features, Modes of operation, Functional block diagram overview, Programming model Map Overview, Pulse width Modulator (PWM) and on chip ADC serial communication protocol: SCI, SPI, I2C, CAN.	08

5	**Software Developments Tools:** Introduction to Arm Cortex-M group of family processors/HCS12XDT512 Student learning kit & PBMCU (Project board), Introduction to code warrior IDE: editing, debugging and simulating simple programs. Flashing code into HCS12XDT512 SLK board and testing.	06
6	**Integration of Software and Hardware:** Downloading the software from Host Machine to target Machine, Implementing Application Prototype: Power windows and automotive lighting system. **Case Studies** on Adaptive Cruise Control, Anti-lock brake system and Air Bag system in Automobiles.	06

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. Shibu K.V," Introduction to Embedded Systems", Mc Graw Hill, 2nd edition.
2. Automotive Electronics By Tom H.Denton
3. Automotive Electrical and Electronic Systems by John F. Kershaw, James D. Halderman / Pearson Education
4. Automotive Embedded System Handbook by Nicolas Navet/CRC PRESS
5. Distributed Automotive Embedded System
6. Embedded System Handbook by Richard Zurawski

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Course Code	Course Name	Credits
AE404	**Automotive Product Design and Development**	3

Course Objectives:

1. To familiarize with basic concepts of automotive design
2. To acquaint with product design methodologies
3. To acquaint with product design needs and issues in industry

Course Outcomes: Learner will be able to

1. Develop a holistic understanding of the whole process from idea to production level design Demonstrate product design and development process.
2. Illustrate considerations of Design for Manufacturing and Assembly in product development.
3. Analyze a product in perspective of aesthetic and ergonomic considerations.
4. Illustrate concepts of QFD aspects in product development.
5. Demonstrate applicability of value engineering in product optimization.
6. Demonstrate legal and social issues pertaining to product development.

Module	Details	Hours
1	Introduction 1.1 Introduction to product design. 1.2 Classification/ Specifications of products. 1.3 Product life cycle & Product mix. 1.4 Major milestones at each stage 1.5 Innovative thinking. 1.6 DFMEA, DVP preparation and Concern resolution	08
2	Conceptual Design 2.1 Generation, selection & embodiment of concept. 2.2 Vehicle architecture and types of Vehicle construction 2.3 Significance of Industrial design process, differences between industrial design and engineering design. 2.4 Introduction to Design Of Experiments (DOE) for Robust Design, Taguchi Designs.	08
3	Design For Manufacturing and Assembly 3.1 Methods of designing for manufacturing & assembly. 3.2 Designs for maintainability. 3.3 Designs for environment. 3.4 Product costing.	10
4	Design Methodologies 4.1 Value engineering and Value analysis. 4.2 Failure Mode Effect Analysis (FMEA) 4.3 Concurrent engineering 4.4 Quality Function Deployment (QFD) 4.5 Reverse engineering 4.6 Vehicle platforms and modular designs	10
5	Design Factors 5.1 Ergonomic Factors and Aesthetics, H point . 5.2 Anthropometry. 5.3 Man-Machine interaction. 5.4 Concepts of size and texture, color	06

	5.5 Comfort criteria. 5.6 Psychological & Physiological considerations.	
6	Product Design Needs and Issues in Industry 6.1 Customer needs: types, models and collection of customer needs information, analysis of information, Rapid prototyping, Tools for product design – Drafting / Modeling software, CAM interface. 6.2 Creativity Techniques: Creative thinking, conceptualization, Brain storming, primary design, drawing, simulation, detail design, Data Management (SAP Introduction). 6.3 Legal and social issues. Engineering ethics and issues of society related to design of products, Patents & IP Acts. Overview, Disclosure preparation. BOM, PLM and engineering release, Design of Frame	06

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

Text Books:

1. Automotive Product Development A Systems Engineering Implementation, Vivek D Bhise, Taylor & Francis.
2. Product Design and Development, Karl T. Ulrich Steven D. Eppinger Maria C. Yang .

References:

1. Karl T Ulrich, Steven D Eppinger, “Product Design & Development.”, Tata McGraw-Hill New Delhi 2003.
2. David G Ullman, “The Mechanical Design Process.” McGraw hill Inc.
3. N J M Roozenberg, J Ekels, N F M Roozenberg “Product Design Fundamentals and
4. Methods”, John Willey & Sons 1995.
5. Hollins B & Pugh S “Successful Product Design.” Butterworths London.
6. Baldwin E. N. & Neibel B. W. “Designing for Production.”, Edwin Homewood Illinois
7. Jones J. C. “Design Methods.” Seeds of Human Futures, John Willey New York.
8. Bralla J. G. “Handbook of Product Design for Manufacture, McGraw hill New York.
9. K. Chitale; R.C. Gupta, Product Design and Manufacturing, Prentice - Hall India.
10. Dieter George E., Engineering Design McGraw Hill Pub. Company, 2000.

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Course Code	Course Name	Credits
AE405	**Race Car Dynamics**	3

Course Objectives:
The objective is for engineers to understand the race car behaviour while it is in motion and improve the performance and stability by optimizing the design in context of dynamics.

Course Outcome: Learner will be able to
1. Understand importance of gg diagrams and to design for aerodynamics
2. Calculate performance of tyres for stability of vehicle
3. Analyze and optimize the suspension for ride analysis
4. Analyze handling performance while turning motion
5. Analyze longitudinal performance while acceleration and braking
6. Get acquainted with advanced technologies in dynamics

Module	Details	Hours
1	**Introduction to race car dynamics** Introduction**,** g-g diagrams, road loads, aerodynamics forces for race car, aids to reduce aerodynamic forces in race car	7
2	**Tyres** Tyre axis, Tyres for race cars, forces generated by tyres, friction circle, magic formula	6
3	**Vertical Dynamics** Types of suspension, ride analysis, Suspension set up and optimization.	8
4	**Handling Dynamics** Steering geometry for racing cars, roll analysis, effect of roll on performance	6
5	**Longitudinal dynamics** Longitudinal weight transfer, acceleration performance and Braking forces, treatments to reduce squat and dive	7
6	**Advanced Technologies** Active suspension, active steering, vehicle dynamics control with traction control and ABS, Simulation used for dynamics	4

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. Race Car Vehicle Dynamics – 30 December 1995by William F. Milliken (Author), Douglas L. Milliken
2. Tire and Vehicle Dynamics – 12 April 2012 by Hans Pacejka
3. Fundamentals of Vehicle Dynamics (Premiere Series Books) Hardcover – Import, 29 February 1992by Thomas D. Gillespie
4. Race Car Aerodynamics: Designing for Speed (Technical (including tuning & modifying), 8 March 1996by J Katz
5. Tune to win – Caroll Smith, Aero publishers
6. Theory of Ground vehicles - J Wong

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Course Code	Course Name	Credits
AE406	**Simulation for Racing Cars**	3

Course Objectives:

1. Simulation of structural loads that can be applied to race car.
2. Design basic racing simulator.

Course Outcomes: Learner will be able to

1. Understand the effects suspension setups have on the handling of racing cars.
2. Simulate the structural loads that can be applied to a race car chassis.
3. Use data acquisition methods to verify simulation data
4. Understand the effects of wings and other aerodynamic devices on a race car.
5. Design and Setup a basic racing simulator

Module	Details	Hours
1	**Introduction to race car simulation** Types of simulations, introduction to soft wares used, Methodology of performing simulations, Importance of data verification, Simulation technology (time stepping, eventing) Data structures for track description and cars, choices for coordinate system	6
2	**Motorsport Vehicle Dynamics** Suspension kinematics, Suspension systems and its components, Push/Pull rod suspension systems, Setting up the suspension geometry, Effects of suspension geometry on handling. Suspension kinematics, lap time simulation applied for ride, Race strategy applied for ride	7
3	**Structural Analysis of race car chassis/monocoque** Static load analysis, Dynamic load analysis, Torsional rigidity and its effects on handling, Effects of vibrations on chassis, Effect of resonance on chassis failure.	7
4	**Motorsport Data Acquisition** Motorsport data acquisition, Systems used in data acquisition, Using data to optimise setup, Interconnection between data acquisition and driver feedback.	7
5	**Motorsport Aerodynamics and Aerodynamic devices** Wings and simulation of wings, Impact of turbulent air on aerodynamic performance, Use of ground effect in racing cars, Introduction to aerodynamic devices (eg. Diffuser, winglets, Drag reduction system, etc.) Race strategy applied for acceleration and braking	6
6	**Design of simple racing simulator** Importance of racing simulator, Components of a simulator rig, Comparison of simulator data with acquired data, Hardware requirements, data acquisition system, Interconnection between data acquisition and driver feedback. Programming language (scripting) driver in lap simulation	6

Laboratory:

6-8 experiments based on the modules mentioned in the theory to be performed. IPG Car maker is recommended to be used.

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: 25 marks

Term Work consists of experiments and/or assignments as decided by the Instructor. Students can also avail NPTEL or equivalent Certification for this course, which shall be considered in place of the assignment work.

Books/References:

1. James Hakewill. Lap time simulation. Graduate thesis, Mechancial Engineering Department, Jan 2000
2. Racing Car Vehicle Dynamics – Millikens and Millikens , SAE international
3. The Physics of Racing Series by Brian Beckman
4. Analysis Techniques for Racecar Data Acquisition - Jorge Segers SAE international

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Course Code	Course Name	Credits
AE407	**Spatial Mapping Techniques**	3

Course Objectives:

1. To introduce the science and technologies involved in Spatial Technologies
2. To explain the earth and mapping principles.
3. To impart knowledge on traditional, conventional and advance surveying technologies.
4. To learn basics about Geodata & WebGIS.
5. To apply Geoinformatics in various fields
6. Classify the photogrammetry methods and their applications

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

1. Analyse the basic components of GIS.
2. Classify the maps, coordinate systems and projections.
3. Process spatial and attribute data and prepare thematic maps.
4. Identify and rectify mapping inaccuracies.
5. Formulate and solve geospatial problems

Module	Details	Hours
1.	Meaning and Scope of Geoinformatics – Science and Technologies involved: Cartography- Geodesy- Geology- Remote Sensing- Geographical Information System Photogrammetry - Information & Communication Technologies- Global Positioning System- Digital Image Processing - Map as decision tool.	08
2.	Earth – Origin, Interior, Age, size, shape and Physiography of the Earth - Sources and methods of acquiring geodata Atmosphere: Origin and nature, Composition and layers of the atmosphere. Fundamental principles of acquiring earth related information: geodetic information - lat - long - time - altimetry – bio-physical and bio-chemical information.	08
3.	Basic principles of surveying – Classification and applications- Scales - Conventional signs - Survey instruments, their care and adjustment - traversing, trilateration and triangulation - conventional, electronic (total station) - Aerial and Satellite based survey techniques (Photogrammetry, RADAR, LiDAR) - Survey by GPS.	08
4.	Fundamentals of GIS – Information Systems, Modelling Real World Features Data , Data Formats – Spatial and Non-spatial, Components, Data Collection and Input, Data Conversion, Database Management – Database Structures, Files; Standard Data Formats, Compression Techniques, Hardware – Computing, printing and scanning systems; Software – Standard Packages like Arcview, ArcGIS, Autocad Map, Map Info etc	08
5.	Topology – Types of Errors, Editing and Error Rectification, Types of Topology, Modelling topological Relationships, Tolerances. Spatial Analysis and Modelling – Proximity Analysis, Overlay Analysis, Buffer Analysis, Network Analysis, Spatial Auto Correlation, Gravity Modelling, DTM/DEM, Integration with Remote Sensing data.	10
6.	GIS Project Planning and Implementation – Under Standing the Requirements, Phases of Planning, Specifications, Data Procurement,	10

	Tendering, Human Resources, Back Up, Monitoring Progress. Fundamentals of Aerial Photography Systems: Historical development – classification, application – aerial cameras – aerial films and processing, – geometry of vertical photographs – scale – coordinate transformation, relief displacement – titled photographs.	

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. LO. C.P., and Albert K.W.Yeung, Concepts and Techniques of Geographic Information Systems, Prentice-Hall of India, New Delhi, 2006.
2. Peter A. Burrough and Rachael A. Mc. Donnell, Principles of Geographical Information System, Oxford University Press Inc., New York, 2004.
3. Ian Heywood, Sarah Cornelivs and Steve Carver, An Introduction to Geographical Information System, Pearson Education Pvt.Ltd., New Delhi, 2007.
4. Arthur H. Robinson et al. Elements of Cartography, V Edition, John Wiley & Sons, New Delhi, 2002.
5. Misra, R.P. and Ramesh, A, Fundamentals of Cartography, Concept Publishing Company, New Delhi, 2002.
6. Lillesand M. Thomas and Ralph W. Kiefer, Remote Sensing and Image Interpretation, John Wiley & Sons, New York, 2007.
7. Thanappan Subash, Geographical Information System, Lambert Academic Publishing, 2011. 2. Paul Longley., Geographic Information systems and Science, John Wiley & Sons, 2005
8. John E. Harmon & Steven J. Anderson., The design and implementation of Geographic Information Systems, John Wiley & Sons, 2003.
9. Marble, D.F & Calkins, H.W., Basic Readings in Geographic Information System, Spad System Ltd, 1990.
10. ArcGIS 10.1 Manuals, 2013.
11. Kang Tsung Chang., Introduction to Geographic Information Systems, Tata Mc Graw Hill Publishing Company Ltd, New Delhi, 2008.
12. Burrough, P.A., Principles of GIS for Land Resource Assessment, Oxford Publications, 2005.
13. C. P. Lo & Albert K. W. Yeung, Concepts and Techniques of Geographic Information Systems, Prentice Hall India Pvt. Ltd, 2002.
14. Moffitt, Francis H. & Mikhail, Edward M., Photogrammetry, Harper and Row Publishers, 1980.
15. Hallert, B., Photogrammetry, McGraw Hill Book Company, 1960.

16. Lueder, D.R., Aerial Photographic Interpretation, McGraw Hill Book Company, New York, 1959. 17.. Krauss, J., Photogrammetry, vol. I, Springler – Verlag Publications,1997
17. Wolf P. R., Elements of Photogrammetry with Application in GIS, McGraw Hill International Book Company,2013.

Back to Scheme

Course Code	Course Name	Credits
AE408	**Mass Transport Systems**	3

Course Objectives:

1. To introduce the issues of transportation planning and transportation policy
2. To introduce travel survey method for understanding travel behaviour
3. To introduce the key concepts of the urban transportation planning system
4. To introduce the fundamental concepts of public transport system such as system, technology and quality of service

Course Outcomes:

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

1. Basic understanding of what transportation planning is, its theoretical backgrounds and applications
2. The students will gain an experience in the implementation of planning transportation routes in new developing towns and cities.
3. The students will get a diverse knowledge to solve the problem of congestion and inconvenience.
4. The students would be able to understand and evaluate current scenarios of traffic management and improve it.

Module	Details	Hours
1	Introduction Development plans, objectives and goals; level of planning; role of transportation at national, regional and urban level. Urbanization Definition of urban area; trends in urbanization; urban class groups; metropolitan city; transportation problems & identification. Travel Demand Concepts of travel demand; factors affecting demand and the demand functions; calibration methods; sequential	08
2	Transportation survey: The transportation study area definition; division into traffic zones; network identification and coding; types of travel and characteristics of various surveys; home interview; roadside survey; goods, mass transit and intermediate public transport surveys; sampling and expansion factors; accuracy checks, screen line checks, consistency checks.	08
3	Travel Forecasting: Growth factor methods and urban transportation planning system; growth factors; average growth factor method and Furness method, Transport Planning Process, Problem Definition, Solution Generation, Solution Analysis, Evaluation and Choice, Implementation, Sequence of Activities Involved in Transport Analysis, Trip Production Analysis; Category Analysis; Trip Attraction Modelling. Mode Choice Modelling: Influencing Factors, Earlier Modal Split Models, Trip-End Type Modal Split Model, Trip-Interchange Modal Split Model, Disaggregate Mode-Choice Model, Logit Model of Mode-Choice, Binary Choice Situations	10
4	UTP System Trip generation; zonal regression methods and category analysis; trip distribution method; gravity models and opportunity models; modal split methods; factors affecting modal split; trip end models and trip distribution models; route assignment; factors affecting route choice; diversion curve; shortest paths; all or nothing assignment.	08

5	Corridor Identification Prediction issues and forecasting of the travel demand and future desires; corridor identification and corridor screen line analysis.Mass Transit Systems Bus and rail transit; characteristics, capacities, route planning. Transportation Plan Preparation Urban forms and structures; point, linear, radial, poly-nuclear developments and preparation of plan, comprehensive and traffic system management plans.	08
6	Transport Related Land-use Models: Development of Land-use Models, The Lowry Model, Application of Lowry Model. Urban Structure: Urban Activity Systems, Urban Movement Hierarchies, Types of Urban Structure, Centripetal - Type Urban Structure, Grid-Type Urban Structure, Linear Type Urban Structure, Directional Grid Urban Structure. Urban Goods Movement: Classification of Urban Goods Movements. Methodology of Approach to Analysis of Goods Movement. Modelling Demand for Urban Goods Transport.	08

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. Ortuzar, J.D.D. and Willumsen, L.G. “Modelling Transport”, John Wiley & Sons, 1990.
2. Ben Akiva, M.E. and Lerman, S. R., “Discrete Choice Analysis: Theory and Application to Travel Demand”, The MIT Press, Cambridge, Massachusetts, 1985.
3. Hutchinson, B. G., “Principles of Urban Transport Systems Planning”, McGraw Hill Book Company, 1974.
4. Kadiyali, L. R., “Traffic Engineering and Transport Planning” Khanna Publishers, New Delhi, 2006.
5. Jotin Khisty, S.C. and Kent Lall, B., Transportation Engineering – An Introduction, Prentice-Hall, NJ 3
6. Salter, R J., Highway Traffic Analysis and Design, ELBS
7. John W. Dickey, Metropolitan Transportation Planning, Tata McGraw Hill Pub. Co.
8. Vukan R. Vuchic, Urban Public Transportation System & Technology, Prentice Hall, Inc.
9. Papacostas, C.S., Fundamentals of Transportation System Analysis, PHI
10. Jotin Khisty, C. and Kent Lall, B., Transportation Engineering – An Introduction, Prentice-Hall, NJ

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Course Code	Course Name	Credits
AE409	**Procurement and Materials Management**	3

Course Objectives:

1. To make the learners aware about importance of planning and procurement
2. To make the learners accountable for materials and their rightful utilisation

Course Outcomes: Learner will be able to

1. Understand the concept of Purchasing and Materials Management.
2. Identify purchasing activities and know the importance of purchase management.
3. learn the importance of materials in Industry
4. Develop a procurement strategy for an organization

Module	Details	Hours
1	Purchasing policies and activities - Introduction to procurement, importance of purchasing, policies to provide guidance and direction in procurement, efficient purchase	6
2	Purchase Management - Objectives and Functions of Purchasing Department, Purchase Procedure, Purchase of High Capital Equipment and their feasibilities, Implementation of Supply Chain Principles within a Company.	6
3	Supplier selection - Suppliers Selection, Source of Supply, Price Determination and Negotiation Vendor Rating and Vendor Rating Technique	6
4	Materials management - scope and functions of Materials Management, Objectives and Advantages of Materials Management, interfaces of Materials Management - Internal and external interfaces, organisation for Material Management	8
5	Material requirement planning - Determination and Description of Material Quantity, MRP Lot sizing methods, MRP and JIT, Determination and Description of Material Quality - Receiving and Incoming Quality Inspection, Cost-Reduction Techniques - Standardization, Simplification & Variety Reduction, Legal Aspects of Purchasing, International Purchasing - Procedures and Documentation	10
6	Value analysis - Purchasing Research, Price Forecasting, Make or Buy Decision, Stores Layout, Classification and Codification, Material Logistics Warehousing Management, Material Handling, disposal of Scrap, Surplus and Obsolete Materials	8

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. Dobler, D W. et al, Purchasing and Materials Management, McGraw Hill
2. Burt, David N., Proactive Procurement, Englewood Cliffs, Prentice Hall Inc.
3. Tersine R.J, "Material Management & Inventory Control", Worth Holand, New York
4. Gopalkrishnan, P. "Purchasing & Materials Management", TMH, New Delhi, 2004
5. Introduction to Materials Management by J R Tony Arnold, PHI

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Course Code	Course Name	Credits
AE410	**Logistics and Distribution Management**	3

Course Objectives:

1. To prepare the learners about importance of logistics and inventory
2. To make the learners the dynamics of distribution management

Course Outcomes: Learners will be able to

1. Understand the concept of logistics as a system
2. To understand the relation between transport systems, sourcing and procurement and Supply chain management
3. Learn different elements of logistics system

Module	Details	Hours
1	Fundamentals of Logistics - Logistics, Types of logistics, Logistical Operations, Modern Concepts in Logistics, Logistics and Supply Chain Management, Core and support activities of logistics	8
2	Logistics management - Types of logistics, Components of logistics management, logistics activities in the manufacturing organisation, role of logistics in an economy	8
3	Warehousing - Strategic Warehousing, Warehouse Operations,Warehouse Decisions, Warehouse Management Systems	6
4	Inventory management - Different Types of Inventory. Need for Inventory Management, Finished Goods Inventory, Independent and Dependant Demand Inventories, Inventory Costs, Inventory Classification, Inventory Management Techniques	8
5	Distribution - Transportation Infrastructure; Transport Functionality, Principles & Participants, Regulations, Transport Structure, Transport Service, Transport Operations; Transport Economics and Pricing, Transportation, Administration, Documentation	6
6	Packaging and Material Handling - Packaging Perspectives, Packaging for Material Handling Efficiency, Materials Handling, Supply Chain Logistics Design: Global Strategic Positioning, International logistics	8

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. Pierre A. David International Logistics: the Management of International Trade Operations 5th Edition 2017
2. Richard Lloyd Successful Integrated Planning for the Supply Chain: Key Organizational and Human Dynamics Kogan Page 1 edition March 2018
3. Logistic and Supply Chain Management by Donald J. Bowerson, Publisher: Prentice Hall of India
4. Logistics and distribution management by Alan Rushton, Phil Croucher, Peter Baker
5. Logistics management by S. L. Ganapathi, S.K. Nandi

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Course Code	Course Name	Credits
AE411	**Aesthetics and Ergonomics**	3

Course Objectives:

1. To study the importance of human factors in design.
2. To understand aesthetics and ergonomics design considerations.
3. To study Automotive ergonomics of occupant packaging.
4. To study design considerations in interiors of automobiles.
5. To study the effect of Field of view and visibility in automobiles.

Course Outcomes:

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

1. Understand the effects of other human factors
2. Learn the effect of biomechanics, biothermodynamics, bioenergetics on the design and development of new products.
3. Understand the importance of Aesthetics and ergonomics in design.
4. Learn the concept of Automotive ergonomics and occupant packaging considerations.
5. Understand ergonomics in Controls, Displays, and Interior Layouts for automobiles.
6. Learn about Field of View and visibility issues in automobiles.

Module	Details	Hours
1.	**Automobile Aesthetics-** Design concepts of consumer products, specification requirements and rating of their importance in design, functions and use, standard and legal requirements, body/dimensions. Ergonomic considerations, interpretation of information, conversions for style, forms, colors.	06
2.	**Ergonomics:** Brief history of Ergonomics and Human Factors. Perspectives and Aspects of Ergonomics. Clarification of Ergonomics, Physical/Cognitive/Organizational/Industrial/Occupational. Applications of Ergonomics. Idea of System & Man – Machine – Environment. Preliminary Anatomy – Musculoskeletal system. Body Dynamics. Basic Body Mechanics. Postures – Sitting, standing, etc., and relation to task/job. Posture and body supporting devices	08
3.	**Aesthetic and Ergonomic consideration in Design:-** Basic types of product forms, Designing for appearance, shape, Design features, Materials, Finishes, proportions, Symmetry, Contrast etc. Morgan's Colour code. Ergonomic considerations Relation between man, machine and environmental factors. Design of displays and controls. Practical examples of products or equipments using ergonomics and aesthetic design principles	08
4.	**Introduction to Automotive Ergonomics** Ergonomics in Vehicle Design, Importance of Ergonomics, Overview of Human Characteristics and Capabilities, Implementing Ergonomics **Occupant Packaging** Vehicle packaging, Occupant Package or Seating Package Layout, Design Considerations, Sequence in Development of Vehicle Package, Package Dimensions, Reference Points, and Seat-Track-Related Dimensions	06

5.	**Controls, Displays, and Interior Layouts** Controls and Displays Interface, Types of Controls and Displays, Design Considerations, Issues, and Location Principles, Methods to Evaluate Controls and Displays, Examples/Case studies of Control and Display Design Issues	06
6.	**Field of View** from Automotive Vehicles, Introduction, Types of Fields of View, Forward-Field-of-View Evaluations, Mirror Design Issues, Methods to Measure Fields of View **Visibility Issues** Light Transmissivity, Other Visibility-Degradation Causes, Shade Bands, Plane and Convex Combination Mirrors, Heavy-Truck Driver Issues, Cameras and Display Screens	06

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. Automotive ergonomics by Nikolas Gkikas, CRC press, Taylor Francis Group
2. Ergonomics in Automotive Design Process by Vivek Bhise, CRC press, Taylor Francis Group
3. M. S. Sanders and Ernest J. McCormick: Human Factors in Engineering and Design, Sixth Edi., McGraw Hill International Editions, 1987.
4. P.O. Astrand and K. Rodahl, Textbook of work physiology, McGraw Hill, New York, 1970.
5. Wickens, C.D., Lee, J.D., Liu, Y., Gordon Becker, S.E. (2004). An Introduction to Human Factors in Engineering (2nd Ed.). Upper Saddle River, New Jersey: Pearson Prentice-Hall

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Course Code	Course Name	Credits
AE 412	**Image and Video Processing**	3

Course Objectives:

1. To know the basic components of an image processing system.
2. To understand the basics of the human visual system as they relate to image processing; including spatial frequency resolution and brightness adaption.
3. To understand how images and videos are represented; including optical images, analog images, and digital images.

Course Outcomes: Learner will be able to

1. Review the fundamental concepts of a digital image processing system
2. Distinguish between image processing applications: restoration, enhancement and compression
3. Make use of filters, both spatial and frequency, to mitigate the effects of noise in images.
4. Interpret Image and video compression standards
5. provide practical solutions for the image and video processing problems

Theory Syllabus:

Module	Details	Hrs.
1	**Image Fundamentals**-Image Definition, Steps and Components of Image Processing, Image Sensing and Acquisition, Image Sampling and Quantization, Relationship Between Pixels	5
2	**Image Enhancement** Point Processing Techniques: Image Negative, Bit Plane Slicing, Gray Level Slicing, Contrast Stretching, Clipping, Thresholding, Dynamic Range Compression, Histogram Equalization. Mask Processing Techniques: Discrete Fourier Transform: Transform Pair, Transform Matrix, Properties. Filtering in Frequency Domain: Average Filter, Weighted Average Filter, Order Statistic Filter: Min, Max, Median Filter.	6
3	**Image Segmentation, Representation and Morphological Operations** Image Segmentation:Point, Line and Edge Detections Methods, Hough Transform, Graph Theoretic Method, Region Based Segmentation. Image Representation: Chain Codes, Shape Number, Polygon Approximation, Statistical Moments. Basic Image Morphological Operations: Erosion, Dilation, Opening, Closing, Hit-or-Miss Transformation.	6
4	**Video Capture and Display** Principles of Color Video, Video Cameras, Video Display. Composite versus Component Models. Spatial and Temporal Frequencies. Video file formats.	8
5	**Two-Dimensional Motion Estimation** Optical Flow, Two-Dimensional Motion versus OpticalFlow, Methodologies: Motion Representation, Motion Estimation Criteria. Optimization Methods, Pixel-Based Motion Estimation, Block-Matching Algorithm	6

6	**Compression** Lossy and Lossless compression techniques, JPEG JPEG2000 and Variants, Introduction to video processing, Compression standards and formats (MPEG & H.XXX), Video Streaming.	7

Laboratory:
6-8 assignments and/or experiments based on the modules mentioned in the theory 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: 25 marks
Term Work consists of assignments as decided by the Instructor. Students can also avail NPTEL or equivalent Certification for this course, which shall be considered in place of the assignment.

Text Books:

1. Digital Image Processing (3rd Edition) by Willam K. Pratt, John Willey & Sons

Reference Books:

1. "Multimedia Communication Technology", J. R. Ohm, Springer Publication.
2. "Video Coding for Mobile Communications" David Bull et al, Academic Press.
3. "Handbook on Image and Video Processing", A. I. Bovik, Academic Press.
4. "Digital Video", Tekalp, Prentice Hall.

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Course Code	Course Name	Credits
AE413	**Multi Object Tracking in Self Driving Cars**	3

Course Objectives:

1. To Implement Algorithms for parameter estimation for position of a target in a sensor, estimation in linear and nion linear models and navigation applications.
2. To apply kalman filters to linear state space models with a multitude of sensors.

Course Outcomes: Learner will be able to

1. Implement algorithms for parameter estimation in linear and non-linear models
2. Implement algorithms for detection and estimation of the position of a target in a sensor network
3. Apply the Kalman filter to linear state space models with a multitude of sensors
4. Implement basic algorithms for simultaneous localization and mapping (SLAM)
5. Describe and model the most common sensors used in sensor fusion applications
6. Implement the most common motion models in target tracking and navigation applications

Module	Details	Hours
1	**Sensor Fusion and Perception** Sensors, Sensors and sensor-near signal processing, Key Concepts of the Perception-Planning-Control Pipeline for Self-Driving, Key Concepts of Machine Learning, Reinforcement Learning (RL), Deep Reinforcement Learning (DRL)	6
2	**Lidar Sensor** Introduction to Lidar and Cloud, Point Cloud Segmentation, Clustering Obstacles, Working with Real Point Cloud Data, Radar Calibration, Radar Detection, Pose Estimation from Lidar Data	5
3	**Object Detection** Object Localization, Landmark Detection, Convolutional Implementation of Sliding Windows, Bounding Box Prediction, Intersection Over Union, Non-max Suppression, Anchor Boxes, YOLO Algorithm, Semantic Segmentation with U-Net, U-Net Architecture, Self-Driving Algorithms for Simultaneous Localization and Mapping (SLMA)	7
4	**Kalman Filters** Linear Kalman Filter, Lidar and Radar Fusion with Kalman Filters, Extended Kalman Filters (EKF), Error State EKF, Limitations of EKF, An Alternative to the EKF – The Unscented Kalman Filters,	5
5	**Object-Tracking and Action Recognition** Introduction to Video Analysis, Optical Flow, Optical Flow Estimation, Visual Object tracking, Visual Object tracking Methods, Introduction to Action recognition, Action Classification, Action Classification with Neural Networks, Action localization	6
6	**C++ Checkpoint** Basic concepts of procedure-oriented and object-oriented programming, Structure of C++ program with simple C++ program, Function in C++, the main function, Function prototyping, C++ Code to Capture Images and Videos, Calculate Frames Per Second (FPS),	7

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. Autonomous Vehicles: Opportunities, Strategies, and Disruptions, Michael E. McGrath
2. Autonomous Vehicle Lidar: A Tutorial, Kai Zhou, Andrew Baab and Ronald Calhoun
3. Applied Deep Learning and Computer Vision for Self-Driving Cars, Sumit Ranjan and Dr. S. Senthamilarasu, Packt Publishing Limited
4. Kalman Filtering and Information Fusion, Hongbin Ma, Liping yan, Yuanqing Xia and Mengyin Fu, Springer Publications
5. Sensing and Control for Autonomous Vehicles, Thor I Fossen, Kristin Y. Pettersen and Henk Nijmeijer, Springer International Publication
6. Object Oriented Programming with C++, Fifth edition, E. Balagurusamy, Tata McGraw Education Hill
7. Object oriented Programming with ANSI & Turbo C++, First Edition, Ashok N. Kamthane, Pearson India

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Course Code	Course Name	Credits
AE491	**Major Project II**	4

Course Objectives:

1. To acquaint with the process of undertaking literature survey or market survey or feasibility study /industrial visit and identifying the problem
2. To familiarize the process of problem solving in a group
3. To acquaint with the process of applying basic engineering fundamental in the domain of practical applications
4. To inculcate the process of research

Course Outcomes: Learner will be able to

1. Do literature survey based on market or feasibility study/industrial visit and identify the problem.
2. Apply basic engineering fundamentals in the domain of practical applications, cultivate the habits of working in a team.
3. Cultivate the habit of working in a team
4. Attempt a problem solution in a right approach.
5. Correlate the theoretical and experimental/simulations results and draw the proper inferences
6. Prepare project report as per guidelines and with proper references/citations.
7. Exhibit and explain project ideas/models at various platforms.

Guidelines for Project

- Students should do literature survey/Market survey/ feasibility study/visit industry/analyze current trends and identify the problem for Project and finalize the project title in consultation with Guide/Supervisor.
- Students should use multiple literatures and understand the problem.
- Students should attempt a solution to the problem by experimental/simulation methods.
- The solution to be validated with proper justification and report to be compiled in standard format.

Assessment:

Project II should be assessed based on following points

1. Quality of problem selected
2. Clarity of Problem definition and Feasibility of problem solution
3. Relevance to the specialization / Industrial trends
4. Clarity of objectives and scope
5. Quality of work attempted
6. Validation of results using numerical/experimental & simulation techniques
7. Quality of Written, Oral Presentation & Question answer session.

Project Report has to be prepared strictly as per report writing guidelines.
Project II should be assessed through a presentation by the student project group to a panel of Internal and External Examiner approved by the BoS of the Department.

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Course Code	Course Name	Credits
AE 414	**Personal Financial Management**	3

Course Objectives: The course is aimed

1. To introduce the basic concepts of finance and their practical application.
2. To demonstrate the process of drafting a financial budget.
3. To explain investment avenues and planning of personal finance.
4. To develop portfolio strategies for individual and institutional investor
5. To discuss various components of insurance and tax management.
6. To introduce financial frauds, measures to avoid frauds and resources of frauds.

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

1. To know the basic concepts of finance and interpret current business positions by reading books of accounts.
2. To analyze investment avenues and plan personal finance to develop portfolio strategies for individuals.
3. To Develop skills to interpret current market position.
4. To Create analytical approach for financial decisions.
5. To learn and understand Tax and Insurance management.
6. To identify financial frauds and understand the level of financial aspects.

Detailed Theory Syllabus:

Module No	Module	Detailed Contents of Module	Hrs.
1	Introduction to PersonalFinancial Planning	Financial Planning Process: Goal, Vision and mission , Components of Personal Financial Plan, Advantages and developing personal financial plan	3
2	Financial Budget	Meaning and Process of Drafting Financial Budget,Components of Financial Budget,Drafting Financial Budget	3
3	Investment Management	Meaning of Investment,Concept of Risk and Return and Time Value of Money,Investment Avenues,Portfolio Creation and Management	6
4	Insurance and Spending Management	Components of Insurance: Life Insurance, Health Insurance, PropertyInsurance, Spending Management	3
5	Tax Management	Introduction to Tax Regime and Tax Returns,Introduction to Income Tax and its impact on Incomes,Tax on property: Revenue and Capital Incomes,Tax Management, Tax Saving, Tax Avoidance	3
6	Financial Frauds	Meaning and Types of Fraud,Investment Frauds, Online Payment Frauds, Identity Theft, Mass Marketing Fraud,Measures to avoid frauds,Recourse	6

		from frauds,Cases of Frauds	

Theory Assessment:

Internal Assessment: 20 marks

Consisting of Two compulsory internal assessments 20 Marks each. The final marks will be the average score of both the assessments.

End Semester Examination: 40 Marks

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

Books and References:

1. Financial Management: I. M. Pandey, Vikas Publishing House.
2. Financial Management: M.Y. Khan, P.K. Jain, Tata McGraw Hill.
3. Financial Management: Prassana Chandra, Prentice Hall.
4. Investment Analysis & Portfolio Management- Prasanna Chandra, Tata McGrawHill
5. Wealth Management- Dun & Bradstreet, Tata McGrawHill
6. Wealth Management- S.K.Bagachi, Jaico publishing house

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Course Code	Course Name	Credits
AE415	**Refrigeration and Air Conditioning**	3

Course Objectives:

1. To present a problem oriented in depth knowledge of automotive air conditioning.
2. To address the underlying concepts and methods behind automotive air conditioning.

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

1. Calculate different air properties using Psychrometric principle
2. Calculate different cooling load on given Air conditioning system
3. The student can identify different areas of Automobile air conditioning
4. Can find the applications of all the areas in day to day life.

Module	Details	Hours
1	**Introduction to Air conditioning & Refrigeration:** Methods of refrigeration. Vapour compression refrigeration system, vapour absorption refrigeration system, applications of refrigeration & air conditioning, Automobile air conditioning, air conditioning for passengers, isolated vehicles, Refrigerated transport vehicles, applications related with very low temperatures, layout of a system, compressor components, condenser and high pressure service ports, thermostatic expansion valve, expansion valve calibration, controlling evaporator temperature, evaporator pressure regulator, evaporator temperature regulator.	10
2	**Heating system:** Automotive heaters, manually controlled air conditioner, heater system, automatically controlled air conditioner and heater systems, automatic temperature control, air conditioning protection, engine protection.	06
3	Classification, properties, selection criteria, commonly used refrigerants, alternative refrigerants, eco-friendly refrigerants, applications of refrigerants, refrigerants used in automobile air conditioning, Containers handling refrigerants, tapping into the refrigerant container, refrigeration system diagnosis, diagnostic procedure, ambient conditions affecting system pressures.	08
4	**Psychrometry:** Psychometric properties, psychometric tables/charts, psychometric processes, comfort charts, factors affecting comfort, effective temperature, ventilation requirements. Design considerations for achieving desired inside/room conditions with respect to prevailing outside/environment conditions. Factors affecting/contributing towards the load on refrigeration & air conditioning systems. Cooling & heating load calculations. Load calculations for automobiles. Effect of air conditioning load on engine performance in terms of loss of available Peak Torque/Power and Fuel consumption.	10
5	**Air Conditioning Systems:** Classification, layouts, central / unitary air conditioning systems. System components like compressor, evaporator, condenser, expansion devices, Receiver dryer, fan blowers, heating system etc. Switch and electrical wiring circuit. **Air Distribution Systems:** Distribution ducting, sizing, supply / return ducts, type of grills, diffusers, ventilation, air noise level, layout of duct systems for automobiles and their impact on load calculations. Air conditioning and temperature control:Objectives, evaporator airflow through the recirculating unit, automatic temperature control, duct system, controlling flow, vacuum reserve, testing the air control and handling	10

	systems.	
6	**Air Conditioning Service**: Air conditioner maintenance & service - removing & replacing Components. Compressor service. Testing, Diagnosis & trouble shooting of air conditioning system. Refrigerant gas charging procedure &. Servicing of heater system. Air Conditioning Control: Common controls such as thermostats, humidistat, control dampers, pressure cutouts, relays.	06

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. Refrigeration and Air conditioning R S Khurmi S Chand publication, ISBN-10: 8121927811
2. Refrigeration and Air conditioning C P Arora Tata McGraw Hill Publication, ISBN-13-978-07-008390-5
3. Basic Refrigeration and Air conditioning Dr P M Ananthnarayan Tata McGraw Hill Publication, edition 2005 ISBN- 9780070495005
4. Refrigeration and Air conditioning S N Sapali PHI publication, ISBN – 9788120333604
5. Refrigeration and Air conditioning Manohar Prasad New Age International, ISBN-9788122414295
6. Refrigeration and Air conditioning Ahdul Ameen PHI Publication, ISBN – 9788120326712
7. Mitchell information Services, Inc - "Mitchell Automatic Heating and Air Conditioning Systems" - Prentice Hall Ind. - 1989.
8. Paul Weiser - "Automotive Air Conditioning" - Reston Publishing Co., Inc., - 1990.
9. MacDonald, K.I., - "Automotive Air Conditioning" - Theodore Audel series - 1978
10. Goings. L. F. – "Automotive Air Conditioning" - American Technical services - 1974. Boyce H. Dwiggins,"Automotive Air Conditioning" - Delmar – 2002.
11. Principles of refrigeration R J Dossat John Wiley and sons Ltd ISBN 978-0130272706
12. "Automotive Air-Conditioning", by Crouse & Anglin – McGraw Hill Pub.
13. "Automotive Air-Conditioning", by Paul Weiser – Reston Publishing Co.
14. "Automatic Heating & Air Conditioning Systems" – Mitchell Information Services.
15. "Air Conditioning", by Paul Lang, C.B.S. Publisher & Distributor, Delhi.
16. "Modern Air Conditioning", by Harris.
17. "Automobile Engg", by Anil Chikara - Satya Prakashan.
18. "American Society of Heating, Refrigeration & Air Conditioning – Fundamentals",ASHRAE Handbook – 1985.

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Course Code	Course Name	Credits
AE416	**Quality Management**	3

Course Objectives:

1. To understand the concepts of Quality.
2. To demonstrate the approaches and techniques to assess and improve process and/or product quality and reliability
3. To introduce the principles and techniques of Statistical Quality Control

Course Outcomes:

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

1. Realize the importance of significance of quality
2. Illustrate basic concepts and statistical methods in quality control
3. Illustrate the different sampling techniques in quality control
4. Able to make use of control charts and analyze it for improving the process quality
5. Acquire basic knowledge of total quality management

Module	Details	Hours
1.	**Introduction** Different Definitions and Dimensions of Quality, Historical Perspective (From Evolution of Quality Control, Assurance and Management to Quality as Business Winning Strategy), Contribution of Renowned Quality Gurus (Their Philosophies and Impact on Quality).Introduction to Quality, Classification of Quality Tools, Quality of Design, Quality of Conformance, Compromise between Quality and Cost	5
2.	**Quality Engineering and Management Tools, Techniques & Standards** 7 QC tools, 7 New Quality Management Tools, 5S Technique, Kaizen, Poka-Yoke, Quality Circle, Cost of Quality Technique, Introduction to Quality Management Standards – ISO: 9000, ISO:14000, QS:9000 (Concept, Scope, Implementation Requirements & Barriers, and Benefits), Introduction to National and International Quality Awards (Malcolm Baldrige National Quality Award – MBNQA, The Deming Prize Rajiv Gandhi National Quality Award)	8
3.	**Total Quality Management** Basic Philosophy, Approach, Implementation Requirements & Barriers **Designing for Quality** Introduction to Concurrent Engineering, Quality Function Deployment (QFD) and Failure Mode and Effect Analysis FMEA) – Concept, Methodology and Application (with case studies).	8
4.	**Process Quality Management methods** Introduction, Methods, Taguchi approach, Achieving robust design, Steps in experimental design **SQC & SQC tools** Statistics in Quality control, Variables and Attributes data, Process Capability, Control charts for variables and for attribute data($\bar{X}$ and R-Chart, p-chart np-chart, c-chart, U chart), Applications of SQC in engineering – case studies **Sampling Techniques** Advantages of Sampling Inspection, operating characteristic (OC) curve. Choosing OC curve for appropriate sampling plan, acceptance sampling	8

5.	**Contemporary Trends in Quality Engineering & Management** Just in time (JIT) Concept, Lean Manufacturing, Agile Manufacturing, World Class Manufacturing, Total Productive Maintenance (TPM), Benchmarking, Business Process Re-engineering (BPR), Six Sigma - Basic Concept, Principle, Methodology, Implementation, Scope, Advantages and Limitation of all as applicable.	8
6.	**Quality in Service Sectors** Characteristics of Service Sectors, Quality Dimensions in Service Sectors, Measuring Quality in Different Service Sectors.	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. Quality Assurance and Total Quality Management (ISO 9000, QS 9000 ISO 14000) by K C Jain and A K Chitale, Khanna Publishers
2. Quality Control & Application by B. L. Hanson & P. M. Ghare, Prentice Hall of India
3. Total Quality Management by Dale H. Besterfield, Carol Besterfield - Michna, Glen H. Besterfield and Mary Besterfield - Sacre, Pearson Educaiton
4. Quality Management by Kanishka Bedi
5. Total Quality Management – Dr. S. Kumar, Laxmi Publication Pvt. Ltd.
6. Total Quality Management by K C Arora, S K Kataria & Sons
7. Statistical Quality Control by M. Mahajan, Dhanpat Rai & Co. (P) Ltd.

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Course Code	Course Name	Credits
AE417	**ARVR in Automobiles**	3

Course Objectives:

1. To acquire knowledge of ARVR technology.
2. To analyse hardware & software technologies used in VR
3. To study Principles of Augmented Reality
4. To study applications of ARVR in various engineering fields.

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

1. Understand basic principles of Virtual reality
2. Learn about hardware and 3D User interface technology in VR.
3. Learn about software technologies used in VR.
4. Understand concept of 3D Interaction Techniques in VR
5. Understand basic principles of Augmented reality.
6. Understand application of AR/VR for various engineering fields.

Module	Details	Hours
1	**Virtual Reality and Virtual Environments** The historical development of VR: Scientific landmarks Computer Graphics, Real-time computer graphics, Flight simulation, Virtual environments, Requirements for VR, benefits of Virtual reality. Visual Displays Auditory Displays, Haptic Displays, Choosing Output Devices for 3D User Interfaces.	06
2	**3D User Interface Input Hardware** Input device characteristics, Desktop input devices, Tracking Devices, 3D Mice, Special Purpose Input Devices, Direct Human Input, Home - Brewed Input Devices, Choosing Input Devices for 3D Interfaces.	06
3	**Software Technologies in VR** Database - World Space, World Coordinate, World Environment, Objects - Geometry, Position / Orientation, Hierarchy, Bounding Volume, Scripts and other attributes, VR Environment - VR Database, Tessellated Data, LODs, Cullers and Occluders, Lights and Cameras, Scripts, Interaction - Simple, Feedback, Graphical User Interface, Control Panel, 2D Controls, Hardware Controls, Room / Stage / Area Descriptions, World Authoring and Playback, VR toolkits, Available software in the market	08
4	**3D Interaction Techniques** 3D Manipulation tasks, Manipulation Techniques and Input Devices, Interaction Techniques for 3D Manipulation, Design Guidelines - 3D Travel Tasks, Travel Techniques, Design Guidelines - Theoretical Foundations of Wayfinding, User Centered Wayfinding Support, Environment Centered Wayfinding Support, Evaluating Wayfinding Aids, Design Guidelines - System Control, Classification, Graphical Menus, Voice Commands, Gestural Commands, Tools, Multimodal System Control Techniques, Design Guidelines	08
5	**Augmented Reality** Taxonomy, technology and features of augmented reality, difference between AR and VR, Challenges with AR, AR systems and functionality, Augmented reality methods, visualization techniques for augmented reality, wireless displays in educational augmented reality	08

	applications, mobile projection interfaces, marker-less tracking for augmented reality, enhancing interactivity in AR environments, evaluating AR systems.	
6	**Applications & Case study projects** for Engineering, Architecture, Education, Medicine, Entertainment, Science, Training. Programming through VRML/X3D: Defining and Using Nodes and Shapes, VRML Browsers, Java 3D, OpenCV for virtual / augmented reality	04

Laboratory:
6-8 experiments based on the modules mentioned in the theory to be performed

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: 25 marks
Term Work consists of experiments and/or assignments as decided by the instructor. Students can also avail NPTEL or equivalent Certification for this course, which shall be considered in place of the assignment work.

Books/References:

1. R. K Maurya, "Computer Graphics with Virtual Reality", Wiley India
2. Grigore Burdea, Philippe Coiffet, "Virtual Reality Technology", Wiley.

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Course Code	Course Name	Credits
AE418	**Visual Communication & Digital Publishing**	3

Course Objectives:

1. To train the students with the latest tools in digital communication
2. To prepare students for the future by making them aware about the digital publishing and its implications

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

1. Communicate effectively with digital expression
2. Differentiate between visual and sensory perceptions
3. Apply fundamentals of Design for creating digital content
4. Execute design based on specific requirements and present them effectively

Module	Details	Hours
1.	**Need for and the Importance of Human and Visual Communication.** Communication an expression, skill and process, Understanding Communication: SMRC-Model	5
2.	Communication as a process. Message, Meaning, Connotation, Denotation Culture/Codes etc. **Levels of communication**: Technical, Semantic, and Pragmatic. **The semiotic landscape**: language and visual communication, narrative representation	7
3.	**Principles of Visual and other Sensory Perceptions**. Colour psychology and theory (some aspects) Definition, Optical / Visual Illusions etc. **Various stages of design process**- problem identification, search for solution refinement, analysis, decision making, and implementation.	6
4.	**Digital Publishing:** History &Introduction to e-Publishing, Types of e-Publishing, Services required before publishing, Benefits, Advantages & Disadvantages	5
5.	**Fundamentals of Design**: Definition. Approaches to Design, Centrality of Design, Elements of Design: Line, Shape, Space, Colour, Texture. Form Etc. **Principles of Design**: Symmetry. Rhythm, Contrast, Balance Mass/Scale etc. Design and Designers (Need, role, process, methodologies etc.)	7
6.	**Basics of Graphic Design:** Definition, Elements of GD, Design process-research, a source of concept, the process of developing ideas-verbal, visual, combination & thematic, materials, tools (precision instruments etc.) design execution, and presentation.	6

Laboratory:

6-8 experiments and/or assignments based on the modules mentioned in the theory to be conducted

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: 25 marks
Term Work consists of experiments and/or assignments as decided by the Instructor. Students can also avail NPTEL or equivalent Certification for this course, which shall be considered in place of the assignment work.

Books/References:

1. Communication between cultures - Larry A. Samovar, Richard E. Porter, Edwin R. McDaniel & Carolyn Sexton Roy, Monica Eckman, USA, 2012
2. Visual Communication: An Information Theory Approach (The Springer International Series in Engineering and Computer Science Book 409) 1997th Edition, Kindle Edition by Friedrich O. HuckCarl L. Fales , Zia-ur Rahman .
3. Essentials of Visual Communication Paperback – Import, 4 March 2009by Bo Bergström

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Course Code	Course Name	Credits
AE419	**Decision Making in Self Driving Cars**	3

Course Objectives:

1. To Formalize problems as Markov Decision Processes
2. To Understand value functions, as a general-purpose tool for optimal decision-making
3. To Understand basic exploration methods and the exploration / exploitation trade-off
4. To Evaluate the computational performance of search, satisfaction, optimization and learning algorithms.

Course Outcomes: Learner will be able to

1. Formalize problems as Markov Decision Processes
2. Understand value functions, as a general-purpose tool for optimal decision-making
3. Understand basic exploration methods and the exploration / exploitation trade-off
4. Know how to implement dynamic programming as an efficient solution approach to an industrial control problem
5. Evaluate the computational performance of search, satisfaction, optimization and learning algorithms
6. Understand the fundamental concepts for designing a learning method to tackle autonomous system problems such as reasoning, learning and prediction

Module	Details	Hours
1	**Sequential Decision-Making** Introduction, Sequential Decision-Making with Evaluative Feedback, Learning Action Values, Estimating Action Values Incrementally, Trade-off, Optimistic Initial Values, Upper-Confidence Bound (UCB) Action Selection, Contextual Bandits for Real World Reinforcement Learning	6
2	**Markov Decision Process (MDP)** Examples of MDP, The Goal of Reinforcement Learning, Defining RL Framework, Code Standards and Libraries used in RL (Python/Keras/Tensorflow), The Reward Hypothesis, Continuing Tasks, Examples of Episodic and Continuing Tasks	7
3	**Value Functions & Bellman Equations** Specifying Policies, Value Functions, Bellman Equation Derivation, Optimal Policies, Optimal Value Functions, Using Optimal Value Functions to Get Optimal Policies	7
4	**Dynamic Programming** Policy Evaluation vs. Control, Iterative Policy Evaluation, Policy Improvement, Policy Iteration, Flexibility of the Policy Iteration Framework, Efficiency of Dynamic Programming, Approximate Dynamic Programming for Fleet Management	6
5	**Tabular methods and Q-networks** Dynamic Programming and Monte Carlo, Temporal-Difference learning methods (TD, SARSA, Q-Learning), Deep Q-networks (DQN, DDQN, Dueling DQN, Prioritised Experience Replay), Maximization Bias	6
6	**Recent Advances and Applications** Meta-learning, Multi-Agent Reinforcement Learning, Partially Observable Markov Decision Process, Ethics in RL, Applying RL for real-world problems, Temporal Difference Learning	7

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. Decision Making, Planning, and Control Strategies for Intelligent Vehicles, Haotian Cao, Mingjun Li, Song Zhao and Xiaolin Song, Morgan & Claypool Publishers
2. Reinforcement learning: An introduction, Second Edition, Richard S. Sutton and Andrew G. Barto, MIT Press
3. Reinforcement learning. Adaptation, learning, and optimization, Wiering, Marco, and Martijn Van Otterlo.
4. Artificial intelligence: a modern approach, Russell, Stuart J., and Peter Norvig , Pearson Education Limited
5. Introduction to Operations Research, Frederick S. Hillier and Gerald J. Lieberman

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Course Code	Course Name	Credits
AE420	**Artificial Neural Networks**	3

Course Objectives:

1. To Provide the knowledge of neural networks and genetic algorithms, where Artificial Intelligence is the mother branch of all.
2. To learn effective techniques of Supervised, Unsupervised Learning Networks, and Associative Memory Network in building intelligent systems.
3. To learn how to use neural networks for classification and regression problems.

Course Outcomes: Learner will be able to

1. Identify and describe neural networks and their roles in building intelligent machines.
2. Select neural networks to solve a particular problem.
3. Apply Supervised and Unsupervised Learning Networks to solve engineering problems.
4. Apply Associative Memory Network for building intelligent systems.
5. Apply neural networks for classification and regression problems.
6. Evaluate and compare solutions by various Neural Networks for a given problem.

Module	Details	Hours
1	**Introduction** Biological Neuron, Artificial Neural Model, Types of activation functions – Architecture: Feedforward and Feedback, Linear Separability, Non-Linear Separable Problem. XOR Problem, Multilayer Networks.	6
2	**Artificial Neural Network** Fundamental concept, Evolution of Neural Networks, Basic Models, McCulloh-Pitts Neuron, Linear Separability, Hebbian learning rule, perception learning rule, delta learning rule.	7
3	**Supervised Learning Network** Perceptron Networks, Adaptive Linear Neuron, Multiple Adaptive Linear Neurons, Backpropagation Network, Radial Basis Function	7
4	**Unsupervised Learning Networks** Fixed weight competitive nets, Kohonen self-organizing feature maps, learning vector quantization, counter propagation networks, adaptive resonance theory networks.	6
5	**Associative Memory Networks** Training algorithm for pattern Association, Autoassociative memory network, hetroassociative memory network, bi-directional associative memory, Hopfield networks, iterative autoassociative memory networks	7
6	**Third Generation Neural Networks** Spiking Neural networks, convolutional neural networks, deep learning neural networks, applications.	6

Laboratory:

6-8 experiments and/or assignments based on the modules mentioned in the theory to be conducted.

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: 25 marks

Term Work consists of experiments and/or assignments as decided by the Instructor. Students can also avail NPTEL or equivalent Certification for this course, which shall be considered in place of the assignment work.

Books/References:

1. Neural Networks for Pattern Recognition, 1995.
2. Neural Smithing: Supervised Learning in Feedforward Artificial Neural Networks, 1999.
3. Deep Learning, 2016.

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Course Code	Course Name	Credits
AE492	**Major Project III**	6

Course Objectives:

1. To acquaint with the process of undertaking literature survey or market survey or feasibility study /industrial visit and identifying the problem
2. To familiarize the process of problem solving in a group
3. To acquaint with the process of applying basic engineering fundamental in the domain of practical applications
4. To inculcate the process of research

Course Outcomes: Learner will be able to

1. Do literature survey based on market or feasibility study/industrial visit and identify the problem.
2. Apply basic engineering fundamentals in the domain of practical applications, cultivate the habits of working in a team.
3. Cultivate the habit of working in a team
4. Attempt a problem solution in a right approach.
5. Correlate the theoretical and experimental/simulations results and draw the proper inferences
6. Prepare project report as per guidelines and with proper references/citations.
7. Exhibit and explain project ideas/models at various platforms.

Guidelines for Project

Students are expected to have one of the following outcome of the project work done

1. Filing of patent on the innovating work done
2. Presentation of the work done in National/International Conference
3. Publishing the work done in National/International Journal
4. Participation in Project competition at State/National level

Assessment:

Project III should be assessed based on following points

1. Continuous assessment on the progress
2. Quality of platform used to present the project work done

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