UNIVERSITY OF MUMBAI

Revised syllabus (Rev- 2016) from Academic Year 2016 -17
Under

FACULTY OF TECHNOLOGY

Automobile Engineering

Second Year with Effect from AY 2017-18
Third Year with Effect from AY 2018-19
Final Year with Effect from AY 2019-20

As per **Choice Based Credit and Grading System**
with effect from the AY 2016–17

Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	Pract	Total
AEC701	Automotive Design	04	--	04	--	04
AEC702	CAD/CAM/CAE*	04	--	04	--	04
AEC703	Autotronics	04	--	04	--	04
AEDLO 703X	Department Level Optional Course III	04	--	04	--	04
ILO701X	Institute Level Optional Course I#	03	--	03	--	03
AEL701	Automotive Design	--	02	--	01	01
AEL702	CAD/CAM/CAE*	--	02	--	01	01
AEL703	Autotronics	--	02	--	01	01
AEP701	Project I	--	06	--	03	03
Total		**19**	**12**	**19**	**06**	**25**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		Test1	Test 2	Avg					
AEC701	Automotive Design	20	20	20	80	03	--	--	100
AEC702	CAD/CAM/CAE*	20	20	20	80	03	--	--	100
AEC703	Autotronics	20	20	20	80	03	--	--	100
AEDLO 703X	Department Level Optional Course III	20	20	20	80	03	--	--	100
ILO701X	Institute Level Optional Course I#	20	20	20	80	03	--	--	100
AEL701	Automotive Design	--	--	--	--	--	25	25	50
AEL702	CAD/CAM/CAE*	--	--	--	--	--	25	25	50
AEL703	Autotronics	--	--	--	--	--	25	25	50
AEP701	Project I	--	--	--	--	--	50	--	50
Total				**100**	**400**		**125**	**75**	**700**

Course Code	Department Level Optional Course III	Course Code	Institute Level Optional Course I#
AEDLO7031	Automotive NVH	ILO7011	Product Lifecycle Management
AEDLO7032	Automotive Embedded Systems	ILO7012	Reliability Engineering
AEDLO7033	Automotive Aerodynamics and Aesthetics	ILO7013	Management Information System
AEDLO7034	Computational Fluid Dynamics*	ILO7014	Design of Experiments
		ILO7015	Operation Research
		ILO7016	Cyber Security and Laws
		ILO7017	Disaster Management and Mitigation Measures
		ILO7018	Energy Audit and Management
		ILO7019	Development Engineering

***Common with Mechanical Engineering**

 # Common with all branches

Course Code	Course Name	Credits
AEC 701	Automotive Design	4

Objectives

1. To familiarize with the fundamental knowledge in the field of automotive design.
2. To acquaint with required analytical abilities to provide solutions to design problems.

Outcomes: Learner will be able to…

1. Select and design specific gear pairs for given conditions.
2. Design Gearbox
3. Design various Engine components.
4. Design clutch/brakes with drive lines.
5. Select standard components such as Bearings/belts.
6. Design Cam and follower for given requirement.

Module	Detailed content	Hrs
1	**Design of Gears** Spur, Helical, Bevel and Worm with strength, wear and thermal consideration **Single stage gear box design** consisting of - Spur, Helical, Bevel gear pairs, Housing design	12
2	**Engine design- (Petrol and diesel)** 1. Cylinder and cylinder liner 2. Piston, piston rings and piston pin or gudgeon pin 3. Connecting rod with small and big end bearing 4. Crankshaft and Selection of Bearing.	10
3	**Design of Clutches:** single plate, multiple plates, centrifugal clutch Design of propeller shaft and Axles	08
4	**Design of Brakes:** Energy Absorbed by a Brake, Heat to be dissipated during Braking, Materials for Brake Lining, Single Block or Shoe Brake, Pivoted Block or Shoe Brake, Double Blockor Shoe Brake, Internal expanding Brake.	06
5	**Design of Cam and Follower:** Roller follower mechanism with spring and shaft Design of valves and valve operating mechanism	06
6	**Design and selection of belts**- Flat - belt and V- belt with pulley construction and Roller chain	06

Theory Examinations:

Internal Assessment for 20 marks:

Consisting **two compulsory class tests**

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

End Semester Examination:

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

i. Question paper will comprise of total six questions.
ii. All questions carry equal marks.

iii. Questions will be mixed in nature (for example Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
iv. Only four questions need to be solved.

NOTE

Use of standard design data books like PSG Data Book, Design Data by Mahadevan, and Design data by Kale Khandhare is permitted at the examination and shall be supplied by the institute.

ReferenceBooks:

1. Machine Design Exercises - S.N. Trikha, Khanna Publications, Delhi
2. Design of machine elements - V. B. Bhandari Tata McGraw Hill Pub.
3. Machine Design - An Integrated Approach - Robert L. Norton - Pearson Education Asia.
4. Mechanical Engineering Design - J. E. Shigley - McGraw Hill
5. Machine Design Exercises - S.N. Trikha, Khanna Publications, Delhi
6. Recommended Data Books – PSG and K. Mahadevan
7. Gear Design Handbook - GitinMaitra
8. Material handling equipments - N. Rudenko , Peace Publication
9. Material handling equipments - Alexandrov, MIR Publication
10. Machine Design - Reshetov - Mir Publication
11. Machine Design - Patel, Pandya, Sikh Vol – I & II, C. Jamnadas& Co. Educational & Law Publishers
12. Design of Machine Elements - V.M. Faires.
13. Design of Machine Elements - Spotts.

Course Code	Course Name	Credits
AEC702	CAD/CAM/CAE*	04

Objectives

1. To introduce new and exciting field of Intelligent CAD/CAM/CAE with particular focus on engineering product design and manufacturing.
2. To develop a holistic view of initial competency in engineering design by modern computational methods.
3. To develop New API for CAD

Outcome: A learner will be able to….

1. Identify proper computer graphics techniques for geometric modeling.
2. Transform, manipulate objects and store and manage data.
3. CAM Toolpath Creation and NC- G code output.
4. Use rapid prototyping and tooling concepts in any real life applications.
5. Identify the tools for Analysis of a complex engineering component.

Modules	Details	Hrs.
01	**Computer Graphics and Techniques for Geometric Modeling** Computer Graphics: Two dimensional computer graphics, vector generation, the windowing transformation, Three dimensional Computer graphics, viewing transformation, Homogeneous coordinates, Perspective projection, Hidden line removal & hidden surface removal algorithm, light & shade ray tracing. The parametric representation of geometry, Bezier curves, Cubic Spline curve, B-Spline curve, parametric representation of line, circle, ellipse & parabola. Constructive solid geometry (CSG), Boundary Representation (B-Rep), Wire Frame Modeling, Solid Modeling, Surface Modeling, Parametric Modeling, feature based modeling, Feature recognition, Design by feature.	08
02	**Transformation, Manipulation & Data Storage** 2D & 3D Transformations (Translation, Rotation, & Scaling & Magnification), Concatenations, Matrix representation, Problems & object oriented programming on Transformations. Object transformation, mirror transformation, Artificial Intelligence in Design & Manufacturing, Representation of Knowledge, and Knowledge base Engineering. **Application Programming Interface (API)** Concept of customizing applications by writing programs, Fusion Object Model, Creating Scripts and Add-Ins, Document and assembly structure, Attributes, Creating Programs for Assemblies, Joint, B- Rep & Geometry.	08
03	**Design to Manufacturing (CAM)** 2D Machining Strategies, 3D Machining Strategies, Fixture Component Terminology, Work Coordinate System Terminology, Create setups, Apply 2D operations, Facing, 2D adaptive clearing, 2D contour. Chamfer milling, Bore ,Tool simulation and stock material removal , Produce setup sheets , Product NC code via post processing,	08
04	**Computer Aided Engineering (CAE)** Fundamentals of computer aided engineering, CAE includes mass property calculations, kinematic analysis and animation (movement, visualization, simulation and FEA). Case study based on modeling and analysis of structural, thermal/fluid, and dynamic (vibration analysis) system. Parameter optimization.	08
05	**Computer Integrated Manufacturing & Technology Driven Practices** Introduction, Evolution, Objectives, CIM Hardware and Software, CIM Benefits, Nature and role of the elements of CIM, Identifying CIM needs, Data base requirements of CIM, Role of CAD/CAM in CIM, Obstacles to Computer Integrated Manufacturing, Concept of the future CIM systems, Socio -techno- economic aspects of CIM.	08

06	**Rapid Prototyping and Tooling** Introduction to RP, Technology Description, Overview of RP, Benefits and Application. RP Processes: Process overviews, STL file Generation, Classes of RP systems: Stereo-lithography Approach (SLA), SLA with photo-polymerization (mathematical modelling of the process), SLA with liquid thermal polymerization, Selective Laser Sintering (SLS), Fused deposition modelling, Laminated object manufacturing, Laser powder forming. Prototype properties: Material properties, colour, dimensional accuracy, stability, surface finish, machinability, environmental resistance, operational properties. RP Applications: Design, Concept Models, Form & fit checking, Functional testing, CAD data verification, Rapid Tooling, Rapid manufacturing, Science & Medicine, RP processes for MEMS, Photolithography, Direct Laser Writer, Bulk Lithography for 3D micro fabrication (Modelling of beam propagation and curing in resin system).	08

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

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

End Semester Examination:

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

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

References:

1. "CAD/CAM Computer Aided and Manufacturing" by Mikell P. Groover and Emory W. Zimmers, Jr., *Eastern Economy Edition*
2. "CAD/ CAM , Theory & Practice" by Ibrahim Zeid, R. Sivasubramanian, *Tata McGraw Hill Publications*
3. "Computer Graphics" by Donald Hearn and M. Pauline Baker, *Eastern Economy Edition*
4. "CAD/CAM Principles, Practice and Manufacturing Management" by Chris McMahon, Jimmie Browne, *Pearson Education*
5. "CAD/CAM/CIM" by P. Radhakrishan, S. Subramanyan, V. Raju, *New Age International Publishers*
6. "CAD/CAM Principles and Applications" by P.N. Rao, *Tata McGraw Hill Publications*
7. "Principle of Computer Graphics" by William .M. Neumann and Robert .F. Sproul, *McGraw Hill Book Co. Singapore.*
8. David L. Goetsch, Fundamental of CIM technology ,Delmar publication
9. David Bedworth, Computer Integrated Design and Manufacturing, *McGraw Hill.*
10. "CNC Machines" by B.S. Pabla and M. Adithan, *New Age International Publishers.*
11. "Numerical Control and Computer Aided Manufacturing" , T.K. Kundra, P.N. Rao, N.K. Tiwari, *Tata McGraw Hill*
12. "CNC Technology and Programming", Krar, S., and Gill, A., *McGraw Hill publishers*
13. "Computer Integrated Manufacturing- An Introduction with Case Studies" by Paul G. Ranky, *Prentice Hall International*
14. "Flexible Manufacturing Systems" by H.K. Shivanand, M.M. Benal, V.Koti, *New Age International Publishers*

15. "Automation, Production Systems and Computer Integrated Manufacturing ", Groover M.P., *Prentice-Hall of India Pvt. Ltd*
16. “Mathematical Elements for Computer Graphics”, Rogers D F I and Adams J A, McGraw-Hill.
17. “Computer Integrated Manufacturing Hand Book” by Eric Teicholz, Joel N. Orr, McGraw Hill International Editions
18. “Rapid Prototyping” Chee Kai ChuaWorld Scientific Publishing
19. “Rapid Prototyping:Principles and Applications” RafiqNoorani, Wiley
20. “Rapid Prototyping:Principles and Applications” C.K. Chua,K.F.Leong, C.S. Lim World Scientific Publishing
21. “Rapid Prototyping and Manufacturing” P. F. Jacobs, Society of Manufacturing Engineers.

Course Code	Course Name	Credits
AEC 703	Autotronics	4

Objectives

1. To study basic and advance Automotive Electronics systems.
2. To acquaint with working of different Automotive Electronics systems and subsystems.
3. To familiarize basic and advance electronics technologies like Battery, Fuel Cell, ECM etc.

Outcomes: Learner will be able to…

1.Illustrate working of different batteries and fuel cells used in automobiles.
2. Demonstrate working of Charging system used in automobiles.
3. Illustrate working of starting system and drives used in automobiles.
4. Draw and Interpret lighting and wiring systems in automobile.
5. Comprehend working of different sensors and actuators used in automobiles.
6.Elaborate working of Electronic control module (ECM) with its importance in vehicle operation.

Module	Detailed Contents	Hrs.
01	**1. Battery** 1.1 Requirement, 1.2 Construction, 1.3 Principle of operation, 1.4 Working of Lead acid, alkaline, Zebra, Sodium Sulphur, Swing, batteries, 1.5 Ratings, 1.6 Charging. 1.7 Maintenance & testing of Lead acid battery. **2. Fuel Cells** 2.1 Introduction of Fuel Cells & fuel used 2.2 Constructions and Operation of proton Exchange membrane 2.3 Alkaline Fuel Cell. 2.4 Medium & high temperature fuel cells, 2.5 Reformers. **3. 42-volt technology** 3.1 Introduction, 3.2 Transition from 12V to 42V electrical system, 3.3 Need of 42V automotive electrical system. 3.4 42V automotive power system, 3.5 Method of controlling 12V system in 42V architecture, 3.6 Present developments in 42 volt technology.	08
02	**1. Charging System** 1.1 Requirements of charging system 1.2 Dynamo 1.2.1 Principle of operation 1.2.2 Construction 1.2.3 Working 1.2.4 Regulators, Combined current & voltage regulator etc. 1.3 Alternator 1.3.1 Principle of operation 1.3.2 Construction 1.3.3 Working 1.3.4 Rectification from AC to DC **2. Starting system**	08

	2.1 Requirements of starting system 2.2 Various torque terms used 2.3 Starter motors drives 2.3.1 Bendix 2.3.2 Folo through Barrel 2.3.3 Rubber compression 2.3.4 Compression spring 2.3.5 Friction clutch 2.3.6 Overrunning clutch 2.3.7 Dyer 2.4 Starter motor solenoids & switches 2.5 Glow plugs **3. Integrated Starter and Alternator**	
03	**1. Electronic Ignition System** 1.1 Capacitor Discharge Ignition system 1.2 Distributer less Ignition System 1.3 Direct Ignition System, 1.4 Hall Effect pulse generator 1.5 Inductive pulse generator 1.6 Multi Point Fuel Injection (from electronic view point 1.7 Common Rail Diesel Injection (from electronic view point **2. Electronic Engine controls** 2.1 Electronic control module (ECM) 2.2 Operating modes of ECM (closed loop & open loop) 2.3 Inputs required & output signals from ECM 2.4 Electronic spark timing 2.5 Electronic spark control 2.6 Air management system 2.7 idle speed control	08
04	**1. Sensors & Actuators** **1.1 Automotive Sensors,** 1.1.1 Thermisters, 1.1.2 Inductive Sensors, 1.1.3 Position Sensors (Rotary, Linear) 1.1.4 Pressure Sensors, 1.1.5 Knock Sensor, 1.1.6 Optical Sensor 1.1.7 Hot wire & thin film air flow sensor, 1.1.8 Turbine fluid flow sensors 1.1.9 Light sensor, 1.1.10 Methanol sensor 1.1.11 Rain sensor operating principles 1.1.12 Oxygen sensor 1.1.13 Application & new developments in sensor technology 1**.2 Automotive Actuators** 1.2.1 Introduction, 1.2.2 Function & operating principle 1.2.3 Construction & working of solenoid actuators, 1.2.4 Relays 1.2.5 Motorized actuators, 1.2.6 Thermal Actuators 1.2.7 Electro hydraulic & Electrochemical Valve actuators, 1.2.8 Application & new developments in the actuators technology.	08

	1.2.9 Stepper motors.	
05	**1. Automotive Lighting and wiring harness systems.** **1.1 Lighting** 1.1.1 Energy demand of lighting system 1.1.2 Types of Lamps i. Head lamp: Construction & types. Setting & control ii. Fog Lamp iii. Side Lamp iv. Tail lamp v. Parking lamp vi. Brake warning light vii. Trafficators viii. Blinkers ix. Flashers x. Electronic flasher circuit xi. Instrument panel lights xii. Body interior illumination xiii. Adaptive lighting system. 1.1.3 Reflectors: Parabolic, Bifocal, Homifocal, poly-ellipsoidal 1.1.4 Gauges: Fuel, Temperature, Oil pressure etc. 1.1.5 Accessories: Electric horn, wipers, Fuel pump, Power operated windows. **1.2 Wiring** 1.2.1 Cables 1.2.2 Sizes 1.2.3 Colors & color codes 1.2.4 Connectors 1.2.3 Multiplex wiring system	08
06	**Introduction to Automotive embedded system and Intelligent vehicle system. Telematics, X by wire, GPS ,OBD-II etc.**	08

Theory Examinations:

Internal Assessment for 20 marks:
Consisting **two compulsory class tests**
First test based on initial 40% of the content and second test based on remaining content (but excluding contents covered in Test I).

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

i. Question paper will comprise of total six questions.
ii. All questions carry equal marks.
iii. Questions will be mixed in nature (for example Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
iv. Only four questions need to be solved.

Reference Books:

1. Understanding Automotive Electronics by William B. Ribbens
2. Automobile Electrical & Electronics by Tom Denton.
3. Intelligent Vehicle Technologies by Michel Parent
4. Light weight Electric/Hybrid vehicle design by John Fenton & Ron Hodkinson
5. Computerized engine control by Dick King
6. Automotive electrical equipments by P.L.Kohli
7. Automotive Mechanics by William Crouse and Anglin.
8. Automotive Electronic Hand book by Ronald K. Jurgen
9. Car electronics (Second edition) edited by Shuji Mizutani.

Course Code	Course Name	Credits
AEDLO7031	Automotive NVH	4

Objectives:

1. To acquaint with concept of Noise, Vibration and Harshness in automotive industry.
2. Study various types of noise and measurement techniques.
3. To familiarize with various sources of noise from automobiles.
4. To acquaint with automotive noise controlling techniques.

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Outcomes: Learner should be able to ….

1. Comprehend the basic concepts of noise and vibration.
2. Demonstrate noise measurements and analyze sound for automotive applications.
3. Apply the concept of design of interiors to maintain NVH levels.
4. Apply noise control techniques to reduce noise.
5. Demonstrate vibration measurements for automobile.
6. Apply vibration isolation and control techniques to automobiles.

Module	Details	Hrs
01	**1.1 Introduction to NVH** Noise, Vibration and Harshness (NVH)—general meaning, and its role in automotive design and development. Physiological effects of noise and vibration. **1.2Review of Basic Concepts of Vibration Analysis**	06
02	**2.1 Noise Fundamentals** Fundamentals of Acoustics—general sound propagation—structure borne and air borne sounds, plane wave propagation—acoustic near and far fields, reference quantities, the decibel scale, relationship among sound power, sound intensity and sound pressure level, summation of pure tones, decibel addition, subtraction and averaging (numerical treatment), effects of reflecting surfaces on sound propagation, octave band analysis, anatomy of human ear, mechanism of hearing, loudness, weighting networks, equivalent sound level.	12
03	**3.1Automotive Noise Sources** Noise characteristics of engines, Engine overall noise levels, Assessment of the noise sources viz.—Engine noise, Intake and Exhaust noise, Tyre/Road noise, Aerodynamic sound sources in vehicles, Transmission and Gearbox noise, Brake noise. Acoustical Design of Mufflers. **3.2 AutomotiveNoise Control Techniques** Noise control strategies, Noise control at source—along the path—isolation, damping, balancing, resonators, sound energy absorption, sound transmission through barriers, enclosures.	12
04	**4.1 Vibration Control and Measurement Techniques** Review of Vibration Control Techniques: Dampers—various types, Vibration Isolation, Frequency and Seismic measuring instruments. Vibration Absorber, Tuned and Untuned viscous dampers, Centrifugal Pendulum.	06
05	**5.1Case Studies** Vibration Control and Measurement Techniques—for e.g., Isolation of engine from vehicle structure and Control of torsional oscillation amplitudes in engine crankshaft, etc.	04
06	**6.1 NVH Measurements** Vibration and Noise Standards – Pass/Drive by noise, noise from stationary vehicles, interior noise in vehicles, NVH measurement tools and techniques, Modal parameter (natural frequency, mode shape and damping) estimation techniques, signal and system analysis.	08

Theory Examinations:

Internal Assessment for 20 marks:

Consisting **two compulsory class tests**

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

End Semester Examination:

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

i. Question paper will comprise of total six questions.
ii. All questions carry equal marks.
iii. Questions will be mixed in nature (for example Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
iv. Only four questions need to be solved.

Text and Reference Books:

1. Norton M. P., Fundamental of Noise and Vibration, Cambridge University Press, 1989.
2. Clarence W. de Silva ―Vibration Monitoring, Testing, and Instrumentation, CRC Press, 2007.
3. Munjal M.L., Acoustic Ducts and Mufflers, John Wiley, 1987.
4. Baxa, Noise Control of Internal Combustion Engine, John Wiley, 1984.
5. Ewins D. J., Model Testing: Theory and Practice, John Wiley, 1995.
6. McConnell K, "Vibration Testing Theory and Practice", John Wiley, 1995.
7. Allan G. Piersol, Thomas L. Paez ―Harris' shock and vibration hand book, McGraw-Hill, New Delhi, 2010.
8. David A. Bies and Colin H.Hansen ―Engineering Noise Control: Theory and Practice, Spon Press, London 2009.
9. Colin H Hansen ―Understanding Active Noise Cancellation, Spon Press, London. 2003
10. Matthew Harrison ―Vehicle Refinement: Controlling Noise and Vibration in Road Vehicles, Elsevier Butterworth-Heinemann, Burlington, 2004.
11. Xu Wang ―Vehicle Noise and Vibration Refinement, CRC Press, 2010.
12. Bell, L. H. and Bell, D. H., "Industrial Noise Control – Fundamentals and Applications", Marcel Dekker Inc, New York, 1994.
13. Ambekar, A. G., "Mechanical Vibrations and Noise Engineering", Prentice Hall of India, New Delhi, 2006.
14. Beranek, L. L. and Ver. I. L., "Noise and Vibration Control Engineering – Principles and Application", John Wiley & Sons Inc., 1992.
15. Wilson, C. E., "Noise Control – Measurement, Analysis, and Control of Sound and Vibration", Harper & Row Publishers, New York, 1989.
16. Thomson, W. T., "Theory of Vibrations with Applications", CBS Publishers, Delhi
17. Singiresu S.Rao - "Mechanical Vibrations" - Pearson Education,2004.
18. Kewal Pujara "Vibrations and Noise for Engineers", Dhanpat Rai & Sons, 1992.

Course Code	Course Name	Credits
AEDLO7032	Automotive Embedded Systems	4

Objectives

1. To provide broad introduction to automotive embedded systems
2. To provide a comprehensive overview about existing and future automotive electronic systems.

Outcomes: Learner will be able to…

1. Illustrate basic concepts of embedded systems
2. Comprehend 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 system.
5. Recognize Tools for software development from Automobile viewpoint.
6. Comprehend embedded systems used in automobiles using different case studies.

Module	Detailed Contents	Hrs.
01	**Introduction** Introduction to functional building blocks of embedded systems – Register, memory devices,ports, timer, interrupt controllers using circuit block diagram representation for each categories –Devices & buses for devices network - serial communication using I2C, CAN, USB buses – parallelcommunication using ISA, PCI - device drivers in a system – Serial port & parallel port.	08
02	**Embedded Communications** A Review of Embedded Automotive Protocols, Dependable Automotive CAN Networks, Flex Ray Protocol	08
03	**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	08
04	**Hardware Modules** MC9S12XD family features Modes of operation: functional block diagram overview, Programming model Map Overview Pulse width Modulator(PWM) On chip ADC serial communication protocol: SCI,SPI,IIC,CAN	08
05	**Software Developments Tools** Introduction to HCS12XDT512 Student learning kit & PBMCU (Project board), Introduction to code warrior IDE: editing, debugging simulating simple programs. Flashing code into HCS12XDT512 SLK board and testing	08
06	**Integration of Software and Hardware** Downloading the software from Host Machine to target Machine, Implementing Application Prototype: Power windows and automotive lighting system	08

Theory Examinations:

Internal Assessment for 20 marks:

Consisting **two compulsory class tests**

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

End Semester Examination:

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

i. Question paper will comprise of total six questions.
ii. All questions carry equal marks.
iii. Questions will be mixed in nature (for example Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
iv. Only four questions need to be solved.

Reference Books:

1. Automotive Electronics By Tom H.Denton
2. Automotive Electrical and Electronic Systems by John F. Kershaw, James D. Halderman / Pearson Education
3. Automotive Embedded System Handbook by Nicolas Navet/CRC PRESS
4. Distributed Automotive Embedded System
5. Embedded System Handbook by Richard Zurawski

Course Code	Course Name	Credits
AEDLO7033	Automotive Aerodynamics and Aesthetics	4

Objectives

1. To familiarize the fundamentals of fluid mechanics related to vehicles.
2. To acquaint with concepts of the aerodynamics drag of cars.
3. To familiarize with the basic principles of wind tunnel technology.

Outcomes: Learner will be able to…

1. Illustrate various flow phenomenon related to vehicles.
2. Demonstrate and analyze different types of drag forces.
3. Optimize various shape configurations in automobiles.
4. Illustrate the principle of wind tunnel technology.
5. Comprehend stability of vehicle under aerodynamics forces.
6. Demonstrate various techniques used for drag reduction.

Module	Detailed Contents	Hrs.
01	**Introduction**-Scope, historical developments, fundamental of fluid mechanics, flow phenomenon related to vehicles, external and Internal flow problem, resistance to vehicle motion, performance, fuel consumption and performance potential of vehicle aerodynamics, engine cooling requirement, air flow to passenger compartment, duct for air conditioning, cooling of transverse engine and rear engine.	08
02	**AERODYNAMIC DRAG OF CARS**-Cars as a bluff body, flow field around car, drag force, types of drag force, analysis of aerodynamic drag, drag coefficient of cars, strategies for aerodynamic development, low drag profiles.	08
03	**Shape Optimization of Cars**--Front end modification, front and rear wind shield angle, boat tailing, hatch back, fast back and square back, dust flow patterns at the rear, effects of gap configuration, effect of fasteners.	08
04	**Vehicle Handling**--The origin of forces and moments on a vehicle, lateral stability problems, methods to calculate forces and moments – vehicle dynamics under side winds, the effects of forces and moments, characteristics of forces and moments, dirt accumulation on the vehicle, wind noise, drag reduction in commercial vehicles.	08
05	**Wind Tunnel for Automotive Aerodynamics**--Introduction, principle of wind tunnel technology, limitation of simulation, stress with scale models, full scale wind tunnels, measurement techniques, equipment and transducers, road testing methods, numerical methods.	08
06	**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.	08

Theory Examinations:

Internal Assessment for 20 marks:

Consisting **two compulsory class tests**

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

End Semester Examination:

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

i. Question paper will comprise of total six questions.
ii. All questions carry equal marks.
iii. Questions will be mixed in nature (for example Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
iv. Only four questions need to be solved.

Reference Books:

1. Hucho.W.H. - "Aerodynamic of Road Vehicles" - Butterworth's Co., Ltd., - 1997.
2. A. Pope - "Wind Tunnel Testing"- John Wiley & Sons - 2nd Edition, New York - 1974.
3. Automotive Aerodynamic: Update SP-706 - SAE - 1987
4. Vehicle Aerodynamics - SP-1145 - SAE – 1996.
5. Product Design and Development by AK Chitale and Gupta

Course Code	Course Name	Credits
AEDLO7034	Computational Fluid Dynamics*	4

Objectives

1. To study basic principles of Computational Fluid Dynamics
2. To study grid generation and discretization methods

Outcomes: Learner will be able to…

1. Demonstrate methodology to work with CFD
2. Illustrate principles of grid generation and discritisation methods
3. Identify and apply specific boundary conditions relevant to specific application
4. Decide solution parameters relevant to specific application
5. Analyze the results and draw the appropriate inferences
6. Demonstrate basic principles of FVM

Module	Detailed Contents	Hrs.
01	**Introduction:** What is CFD, Scope and Application of CFD, Methods of Predictions like Experimental and theoretical, Working of Commercial CFD Software, Solution methodology-Preprocessing, Solver, Post processing.	04
02	**Mathematical description of Physical Phenomenon:** Governing Differential Equations, Meaning of Differential equation, The Continuity Equation, A Momentum equation, The Energy Equation, The General Differential Equation, Boundary Conditions, Initial and Boundary Conditions, Initial and Boundary Value problems.	06
03	**Grid Generation and Discretization Methods:** Structured and unstructured Grids: O-type, H-type, C-type of Structured Grid Generation, Mesh Adaptation. The Nature of Numerical Methods: The Discritization Concept, The Structure of the Discritization Equation. Basic discretization techniques applied to model equations and systems of equations: finite difference, finite volume and finite element methods. Methods of Deriving the Discretization Equations, Taylor-Series Formulation, Variational Formulation, Method of Weighted Residuals, Control Volume Formulation	08
04	**Heat Conduction, Convection and Diffusion:** Steady One-dimensional Conduction, Unsteady One-dimensional Conduction, Two and Three-dimensional Situations, Over relaxation and Under relaxation, Steady One-dimensional and Two Dimensional Convection-Diffusion, Unsteady One-dimensional Convection.	
05	**Incompressible Fluid Flow:** Governing Equations, Stream Function-Vorticity Method, Determination of Pressure for Viscous Flow, The SIMPLE, SIMPLER Algorithm, Introduction to Turbulence Modeling, Basic Theories of Turbulence, The Time-Averaged Equations for Turbulent Flow.	
06	**Finite Volume Methods**: FVM solutions to steady one, two and three dimensional diffusion problems and unsteady one and two dimensional diffusion problems, FVM solutions to convection-diffusion problems - one and two dimensional, steady and unsteady; Advection schemes; Pressure velocity coupling	08

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

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

End Semester Examination:

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

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

References:

1. An introduction to computational fluid dynamics-The finite volume method, Versteeg.H.K. , Malalasekera.W., Prentice Hall
2. Computational Fluid Mechanics and Heat Transfer, Anderson, D.A., Tannehill, I.I., and Pletcher, R.H., Hemishphere Publishing Corporation, New York, USA, 1984
3. Introduction to Computational Fluid Dynamics, Niyogi P. ,Laha M.K., Chakrabarty S.K., Pearson Education, India
4. Computational Fluid Flow and Heat Transfer, Muralidhar, K.,andSundararajan,T., Narosa Publishing House ,New Delhi
5. Computer Simulation of flow and heat transfer, Ghoshdasdidar, P. S., Tata McGraw-Hill Publishing Company Ltd
6. Finite Element Programming of the Navier Stock Equation, Taylor, C and Hughes J.B., Pineridge Press Ltd.U.K.
7. Computational Techniques for Fluid Dynamics: Fundamental and General Techniques, Fletcher, C.A.J., Springer-Verlag
8. Numerical Fluid Dynamics, Bose, T. K., Narosa Publishing House
9. T. J. Chung, Computational Fluid Dynamics, Cambridge University Press
10. Anderson, J.D. Computational Fluid Dynamics, McGraw Hill

Course Code	Course Name	Credits
ILO 7011	Product Life Cycle Management	03

Objectives:

1. To familiarize the students with the need, benefits and components of PLM
2. To acquaint students with Product Data Management & PLM strategies
3. To give insights into new product development program and guidelines for designing and developing a product
4. To familiarize the students with Virtual Product Development

Outcomes: Learner will be able to…

1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
2. Illustrate various approaches and techniques for designing and developing products.
3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Module	Detailed Contents	Hrs
01	**Introduction to Product Lifecycle Management (PLM):**Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:** Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	10
02	**Product Design:** Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	09
03	**Product Data Management (PDM):**Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	05
04	**Virtual Product Development Tools:** For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	05
05	**Integration of Environmental Aspects in Product Design:** Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life	05

	Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	
06	**Life Cycle Assessment and Life Cycle Cost Analysis:** Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	05

Assessment:

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

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

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

REFERENCES:

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, Antonino Risitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3. Saaksvuori Antti, ImmonenAnselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265

Course Code	Course Name	Credits
ILO 7012	Reliability Engineering	03

Objectives:

1. To familiarize the students with various aspects of probability theory
2. To acquaint the students with reliability and its concepts
3. To introduce the students to methods of estimating the system reliability of simple and complex systems
4. To understand the various aspects of Maintainability, Availability and FMEA procedure

Outcomes: Learner will be able to…

1. Understand and apply the concept of Probability to engineering problems
2. Apply various reliability concepts to calculate different reliability parameters
3. Estimate the system reliability of simple and complex systems
4. Carry out a Failure Mode Effect and Criticality Analysis

Module	Detailed Contents	Hrs
01	**Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. **Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. **Measures of Dispersion:**Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	08
02	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	08
03	**System Reliability:** System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
04	**Reliability Improvement:** Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	08
05	**Maintainability and Availability:** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	05
06	**Failure Mode, Effects and Criticality Analysis:** Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	05

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

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

End Semester Examination:

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

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

REFERENCES:

1. L.S. Srinath, "Reliability Engineering", Affiliated East-Wast Press (P) Ltd., 1985.
2. Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980.
4. P.D.T. Conor, "Practical Reliability Engg.", John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, "Reliability in Engineering Design", John Wiley & Sons.
6. Murray R. Spiegel, "Probability and Statistics", Tata McGraw-Hill Publishing Co. Ltd.

Course Code	Course Name	Credits
ILO 7013	Management Information System	03

Objectives:

1. The course is blend of Management and Technical field.
2. Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
4. Identify the basic steps in systems development

Outcomes: Learner will be able to…

1. Explain how information systems Transform Business
2. Identify the impact information systems have on an organization
3. Describe IT infrastructure and its components and its current trends
4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Module	Detailed Contents	Hrs
01	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS	4
02	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	7
03	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	7
04	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
05	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model.	6
06	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	8

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

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

End Semester Examination:

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

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

REFERENCES:

1. Kelly Rainer, Brad Prince, Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

Course Code	Course Name	Credits
ILO 7014	Design of Experiments	03

Objectives:

1. To understand the issues and principles of Design of Experiments (DOE)
2. To list the guidelines for designing experiments
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Outcomes: Learner will be able to…

1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action
2. Apply the methods taught to real life situations
3. Plan, analyze, and interpret the results of experiments

Module	Detailed Contents	Hrs
01	**Introduction** 1.1 Strategy of Experimentation 1.2 Typical Applications of Experimental Design 1.3 Guidelines for Designing Experiments 1.4 Response Surface Methodology	06
02	**Fitting Regression Models** 2.1 Linear Regression Models 2.2 Estimation of the Parameters in Linear Regression Models 2.3 Hypothesis Testing in Multiple Regression 2.4 Confidence Intervals in Multiple Regression 2.5 Prediction of new response observation 2.6 Regression model diagnostics 2.7 Testing for lack of fit	08
03	**Two-Level Factorial Designs** 3.1 The 2^2 Design 3.2 The 2^3 Design 3.3 The General2^k Design 3.4 A Single Replicate of the 2^k Design 3.5 The Addition of Center Points to the 2^k Design, 3.6 Blocking in the 2^k Factorial Design 3.7 Split-Plot Designs	07
04	**Two-Level Fractional Factorial Designs** 4.1 The One-Half Fraction of the 2^k Design 4.2 The One-Quarter Fraction of the 2^k Design 4.3 The General 2^{k-p} Fractional Factorial Design 4.4 Resolution III Designs 4.5 Resolution IV and V Designs 4.6 Fractional Factorial Split-Plot Designs	07
05	**Response Surface Methods and Designs** 5.1 Introduction to Response Surface Methodology 5.2 The Method of Steepest Ascent	07

	5.3 Analysis of a Second-Order Response Surface 5.4 Experimental Designs for Fitting Response Surfaces	
06	**Taguchi Approach** 6.1 Crossed Array Designs and Signal-to-Noise Ratios 6.2 Analysis Methods 6.3 Robust design examples	04

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

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

End Semester Examination:

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

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

REFERENCES:

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition,John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss

Course Code	Course Name	Credits
ILO 7015	Operations Research	03

Objectives:

1. Formulate a real-world problem as a mathematical programming model.
2. Understand the mathematical tools that are needed to solve optimization problems.
3. Use mathematical software to solve the proposed models.

Outcomes: Learner will be able to…

1. Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
2. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
3. Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
4. Understand the applications of integer programming and a queuing model and compute important performance measures

Module	Detailed Contents	Hrs
01	**Introduction to Operations Research**: Introduction, , Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis **Transportation Problem**: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem**: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem **Integer Programming Problem**: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	14
02	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05
03	**Simulation**: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	05

04	**Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05
05	**Game Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	05
06	**Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

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

End Semester Examination:

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

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

REFERENCES:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons

Course Code	Course Name	Credits
ILO 7016	Cyber Security and Laws	03

Objectives:

1. To understand and identify different types cybercrime and cyber law
2. To recognized Indian IT Act 2008 and its latest amendments
3. To learn various types of security standards compliances

Outcomes: Learner will be able to…

1. Understand the concept of cybercrime and its effect on outside world
2. Interpret and apply IT law in various legal issues
3. Distinguish different aspects of cyber law
4. Apply Information Security Standards compliance during software design and development

Module	Detailed Contents	Hrs
01	**Introduction to Cybercrime:** Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
02	**Cyber offenses & Cybercrime:** How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	9
03	**Tools and Methods Used in Cyberline** Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
04	**The Concept of Cyberspace** E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	8
05	**Indian IT Act.** Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
06	**Information Security Standard compliances** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

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

End Semester Examination:

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

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

REFERENCES:

1. Nina Godbole, SunitBelapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security,* Wiley India, New Delhi
6. Kennetch J. Knapp, *Cyber Security &Global Information Assurance* Information Science Publishing.
7. William Stallings, *Cryptography and Network Security*, Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
9. Website for more information , A Compliance Primer for IT professional : https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538

Course Code	Course Name	Credits
ILO 7017	Disaster Management and Mitigation Measures	03

Objectives:

1. To understand physics and various types of disaster occurring around the world
2. To identify extent and damaging capacity of a disaster
3. To study and understand the means of losses and methods to overcome /minimize it.
4. To understand role of individual and various organization during and after disaster
5. To understand application of GIS in the field of disaster management
6. To understand the emergency government response structures before, during and after disaster

Outcomes: Learner will be able to…

1. Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
2. Plan of national importance structures based upon the previous history.
3. Get acquainted with government policies, acts and various organizational structure associated with an emergency.
4. Get to know the simple do's and don'ts in such extreme events and act accordingly.

Module	Detailed Contents	Hrs
01	Introduction ***1.1*** Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
02	Natural Disaster and Manmade disasters: 2.1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion **2.2** Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	09
03	Disaster Management, Policy and Administration 3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. 3.2 Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	06
04	Institutional Framework for Disaster Management in India: 4.1 Importance of public awareness, Preparation and execution of emergency management program. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. 4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	06
05	Financing Relief Measures: 5.1 Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management	09

	of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. 5.2 International relief aid agencies and their role in extreme events.	
06	**Preventive and Mitigation Measures:** 6.1 Pre-disaster, during disaster and post-disaster measures in some events in general 6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication 6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. 6.4 Do's and don'ts in case of disasters and effective implementation of relief aids.	06

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

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

End Semester Examination:

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

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

REFERENCES:

1. 'Disaster Management' by Harsh K.Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elsevier Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by RajdeepDasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.

(Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

Course Code	Course Name	Credits
ILO 7018	Energy Audit and Management	03

Objectives:

1. To understand the importance energy security for sustainable development and the fundamentals of energy conservation
2. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
3. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Outcomes: Learner will be able to…

1. To identify and describe present state of energy security and its importance.
2. To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
5. To analyze the data collected during performance evaluation and recommend energy saving measures

Module	Detailed Contents	Hrs
01	**Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
02	**Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08
03	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	10
04	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	10

05	**Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
06	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

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

End Semester Examination:

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

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

REFERENCES:

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Course Code	Course Name	Credits
ILO7019	Development Engineering	03

Objectives:

1. To understand the characteristics of rural Society and the Scope, Nature and Constraints of rural Development
2. To study Implications of 73rdCAA on Planning, Development and Governance of Rural Areas
3. An exploration of human values, which go into making a 'good' human being, a 'good' professional, a 'good' society and a 'good life' in the context of work life and the personal life of modern Indian professionals
4. To understand the Nature and Type of Human Values relevant to Planning Institutions

Outcomes: Learner will be able to…

1. Apply knowledge for Rural Development.
2. Apply knowledge for Management Issues.
3. Apply knowledge for Initiatives and Strategies
4. Develop acumen for higher education and research.
5. Master the art of working in group of different nature.
6. Develop confidence to take up rural project activities independently

Module	Contents	Hrs
1	Introduction to Rural Development Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services.	08
2	Post-Independence rural Development Balwant Rai Mehta Committee - three tier system of rural local Government; Need and scope for people's participation and Panchayati Raj; Ashok Mehta Committee - linkage between Panchayati Raj, participation and rural development.	04
3	Rural Development Initiatives in Five Year Plans Five Year Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring organizations and agencies; Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub-plan for the weaker section; Micro-eco zones; Data base for local planning; Need for decentralized planning; Sustainable rural development.	06
4	Post 73rd Amendment Scenario 73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology and rural planning; Need for further amendments.	04
5	Values and Science and Technology Material development and its values; the challenge of science and technology; Values in planning profession, research and education. Types of Values Psychological values — integrated personality; mental health; Societal values — the modern search for a good society; justice, democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; human values as freedom, creativity, love and wisdom.	10

6	Ethics Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	**04**

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

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

End Semester Examination:

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

0. Question paper will comprise of total **six questions**, **each carrying 20 marks**
1. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
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 any module other than module 3)
3. Only **Four questions need to be solved**

Reference

1. ITPI, Village Planning and Rural Development, ITPI, New Delhi
2. Thooyavan, K.R. Human Settlements: A 2005 MA Publication, Chennai
3. GoI, Constitution (73rd GoI, New Delhi Amendment) Act, GoI, New Delhi
4. Planning Commission, Five Year Plans, Planning Commission
5. Planning Commission, Manual of Integrated District Planning, 2006, Planning Commission New Delhi
6. Planning Guide to Beginners
7. Weaver, R.C., The Urban Complex, Doubleday.
8. Farmer, W.P. et al, Ethics in Planning, AmericanPlanningAssociation, Washington.
9. How, E., Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp. 123-150.
10. Watson, V. , Conflicting Rationalities: -- Implications for Planning Theory and Ethics, Planning Theory and Practice, Vol. 4, No.4, pp.395 – 407

Subject Code	Course Name	Credits
AEL 701	Automotive Design Lab	01

Objectives:

1. To familiarize with basic concept of design for designing the automotive components
2. To acquaint with preparation of working drawings based on designs.

Outcomes: Learner will be able to...

1. Demonstrate understanding of various design consideration
2. Apply basic design concepts for safe working of parts in automotive system.
3. Prepare production drawings pertaining to various designs.
4. Select appropriate materials for various components of the mechanical systems.
5. Demonstratedesign calculations for various automotive components.
6. Analyze various automotivesystems using standard analysis software's.

Laboratory shall comprise of:

1. Minimum six exercises on the following in the form ofdesign calculations.
    a. Single stage gear box design including gear box housing.
    b. Single cylinder petrol engine.
    c. Single cylinder diesel engine.
    d. Design of single-plate clutch
    e. Design of multi-plate clutch
    f. Design of Brake.
    g. Design of cam and follower
    h. Design of Flat - belt and V- belt with pulley construction
    i. Design of Roller chain

2. Design and detailed assembly drawing of minimum two design problems, from the following. (Computer aided drawing on **A- 3 size sheets).**
    a. Single stage gear box design including gear box housing
    b. Single cylinder petrol engine.
    c. Single cylinder diesel engine.
    d. Design of single-plate clutch
    e. Design of multi-plate clutch
3. **Course project**: Students in a group of two to four will be able to design and prepare working drawings of any automotive component by applying the knowledge gained during the course.

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

1. Exercises &CAD Drawing Sheets : 15 Marks
2. Course Project : 05 Marks
3. Attendance (Theory & Practical) : 05 Marks

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

NOTE

Use of standard design data books like PSG Data Book, Design Data by Mahadevan, and Design data by Kale Khandhare is permitted at the examination and shall be supplied by the institute.

End Semester Practical/Oral Examination:

1. 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 performance	15 marks
Oral	10 marks

2. 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

Course Code	Course Name	Credits
AEL702	CAD/CAM/CAE*	01

Objectives

1. To introduce new and exciting field of Intelligent CAD/CAM/CAE with particular focus on engineering product design and manufacturing.
2. To develop a holistic view of initial competency in engineering design by modern computational methods.
3. To develop New API for CAD

Outcome: A learner will be able to….

1. Identify proper computer graphics techniques for geometric modelling.
2. Transform, manipulate objects and store and manage data.
3. CAM Toolpath Creation and NC- G code output.
4. Use rapid prototyping and tooling concepts in any real life applications.
5. Identify the tools for Analysis of a complex engineering component.

List of Exercises

1. Programming for transformations,
2. API on Creating As built joints, Slider Joint Motion
3. Get the physical Properties API
4. Get the circle and arc data from the edge
5. Sketch spline through points creation : API
6. Solid modeling using any 3D modeling software
7. Part programming and part fabrication on CNC trainer (Turning / Milling)
8. Geometrical optimization of any mechanical component using computer aided engineering concepts. (Shape optimization)
9. Development of physical 3D mechanical structure using any one of the rapid prototyping processes.

Term Work

Term work shall consist of

a) Any fourexercises from 1 to 6 of the above list
b) Part programming and part fabrication on CNC trainer.
c) A course project in a group of not more than four students on 8 and 9 of above list.

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

- Exercises : 15 Marks
- Course Project : 05 Marks
- Attendance : 05 Marks

Practical/Oral examination

1. Each student will be given a small task of design based on syllabus, which will be assessed by examiners during the oral examination.
2. The distribution of marks for oral-practical examination shall be as follows:
   Design Task: 15 marks
   Oral: 10 marks
3. Evaluation of practical/oral examination to be done based on the performance of design task
4. Students work along with evaluation report to be preserved till the next examination

Subject Code	Course Name	Credits
AEL 703	Autotronics	01

Objectives:

1. To acquaint with working of Automotive Batteries
2. To acquaint with working principle of Charging ,Starting system
3. To familiarize the function and location of various Sensors and Actuators
4. To acquaint with wiring and Lighting system in Automobiles.

Outcomes: Learner should be able to…

1. Illustrate working of Automotive batteries and its types
2. Dismantle and Assemble A.C Generator/Dynamo
3. Dismantle and Assemble starter motor
4. Measure temperature using sensor
5. Measure pressure using sensor
6. Measure Oxygen using sensor.

The laboratory assignments should be based on the following:

List of Experiments

1. Study of Lead Acid Battery.
2. Battery testing: Voltagetest, Hydrometer test etc.
3. Dismantling, Inspection & assembly of A. C. Generator/Dynamo.
4. Dismantling, Inspection & assembly of Starter motor.
5. Measurement of Temperature using sensor.
6. Measurement of Pressure using sensor.
7. Measurement of Position using sensor.
8. Measurement of Oxygen using sensor.
9. Study of effect of spark advances on the Engine Emissions.
10. Study of Electro-magnetic fuel Injector.
11. Testing of Spark Plug.

Term Work

Term work shall consist of minimum 8 experiments from the list, 6 assignments covering maximum portion of the syllabus (one on each module).

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

1) Laboratory work (Experiments) **: 10 marks**

2) Assignments : **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.

End Semester Practical/Oral Examination:

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

Oral 25 marks

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