UNIVERSITY OF MUMBAI

Bachelor of Engineering

in

Automobile Engineering

Final Year with effect from AY 2022-23

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

Under

FACULTY OF SCIENCE & TECHNOLOGY

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

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	**Final Year B.E. in Automobile Engineering**
2	Eligibility for Admission	**After Passing Third Year Engineering as per the Ordinance 0.6243**
3	Passing Marks	**40%**
4	Ordinances / Regulations (if any)	**Ordinance 0.6243**
5	No. of Years / Semesters	**8 semesters**
6	Level	**Under Graduate**
7	Pattern	**Semester**
8	Status	**Revised**
9	To be implemented from Academic Year	**2022-2023**

Date

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

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

Preamble

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

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

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

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

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Incorporation and implementation of Online Contents from NPTEL/ Swayam Platform

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

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

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

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Preface

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

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

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

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

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

Board of Studies in Mechanical Engineering

Dr. Vivek K. Sunnapwar : Chairman
Dr. S. M. Khot : Member
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Program Structure for Final Year Engineering
Semester VII &VIII
UNIVERSITY OF MUMBAI
(With Effect from 2022-2023)

Semester VII

	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. Tut.	Theory	Pract.	Total
AEC701	Autotronics	3	--	3	--	3
AEC702	Vehicle Dynamics	3	--	3		3
AEDLO703X	Department Level Optional Course – 3	3	--	3	--	3
AEDLO704X	Department Level Optional Course – 4	3	--	3	--	3
ILO701X	Institute Level Optional Course – I	3	--	3	--	3
AEL701	Vehicle Maintenance	--	2	--	1	1
AEL702	Vehicle Dynamics	--	2	--	1	1
AEL703	Industrial Skills*	--	2	--	1	1
AEP701	Major Project I	--	6#	--	3	3
Total		**15**	**12**	**15**	**6**	**21**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Prac/ Oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg					
AEC701	Autotronics	20	20	20	80	3	--	--	100
AEC702	Vehicle Dynamics	20	20	20	80	3	--	--	100
AEDLO703X	Department Level Optional Course – 3	20	20	20	80	3	--	--	100
AEDLO704X	Department Level Optional Course – 4	20	20	20	80	3	--	--	100
ILO701X	Institute Level Optional Course – I	20	20	20	80	3	--	--	100
AEL701	Vehicle Maintenance	--	--	--	--	--	25	25	50
AEL702	Vehicle Dynamics	--	--	--	--	--	25	25	50
AEL703	Industrial Skills*	--	--	--	--	--	25	25	50
AEP701	Major Project I	--	--	--	--	--	50	--	50
Total		**--**	**--**	**100**	**400**	--	**125**	**75**	**700**

# indicates work load of Learner (Not Faculty), for Major Project

* Common with Mechanical Engineering

Department Optional Courses

Course Code	Sem. VII: Department Optional Course- 3		Course Code	Sem. VII: Department Optional Course - 4
AEDLO7031	Vehicle Performance and Testing		AEDLO7041	Transport Management Systems
AEDLO7032	Alternate Fuels and Emission Control		AEDLO7042	Tire Technology
AEDLO7033	Automotive Aerodynamics and Aesthetics		AEDLO7043	Automotive Sensors and Control Systems

Institute Optional Courses

Course Code	Institute Optional Course-I #
ILO7011	Product Lifecycle Management
ILO7012	Reliability Engineering
ILO7013	Management Information System
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 all branches

Course Code	Course Name	Credits
AEC701	**Autotronics**	**03**

Course 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, Modern Energy storage methods, 48-volt technology etc.

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

1. Illustrate working of different batteries and modern Energy storage methods 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 Automotive & Communication Protocols and actuators used in automobiles.
6. Elaborate working of Automotive Diagnostics with its procedure and equipment used.

Module	Content	Hrs.
1	**1.1 Battery** 1.1.1 Requirement, 1.1.2 Construction, 1.1.3 Principle of operation, 1.1.4 Working of Lead acid, alkaline, Zebra, Sodium Sulphur, Swing, batteries, 1.1.5 Ratings, 1.1.6 Charging. 1.1.7 Maintenance & testing of Lead acid battery. **1.2 Modern Energy storage methods:** 1.2.1 Ultra Capacitor 1.2.2 Super Capacitor 1.2.3 Ultra high-speed flywheels. **1.3 Layouts of 48-volt technology** 1.3.1 Mild hybrids, 1.3.2 Micro- hybrids 1.3.3 Plug-in hybrids. 1.3.4 Range extended EVs	08
2	**2.1 Charging System** 2.1.1 Requirements of charging system 2.1.2 Dynamo 2.1.2.1 Principle of operation 2.1.2.2 Construction 2.1.2.3 Working 2.1.2.4 Regulators, Combined current & voltage regulator etc. 2.1.3 Alternator 2.1.3.1 Principle of operation 2.1.3.2 Construction 2.1.3.3 Working 2.1.3.4 Rectification from AC to DC **2.2 Starting system**	06

	2.2.1 Requirements of starting system 2.2.2 Various torque terms used 2.2.3 Starter motors drives 2.2.3.1 Bendix 2.2.3.2 Folo through Barrel 2.2.3.3 Rubber compression 2.2.3.4 Compression spring 2.2.3.5 Friction clutch 2.2.3.6 Overrunning clutch 2.2.3.7 Dyer 2.2.4 Starter motor solenoids & switches 2.2.5 Glow plugs **2.3 Integrated Starter and Alternator**	
3	**3.1 Electronic Ignition System** 3.1.1 Capacitor Discharge Ignition system 3.1.2 Distributer less Ignition System 3.1.3 Direct Ignition System, 3.1.4 Hall Effect pulse generator 3.1.5 Inductive pulse generator **3.2 Automotive Protocols:** LIN, CAN, KWP2000 & J1939, Flex Ray 3.2.1 Communication Protocols: USART, I2C, SPI, CAN Bus 3.2.2 Use of CAN Protocol in automobiles.	04
4	**4.1 Automotive Actuators and Controllers** 4.1.1 Introduction, 4.1.2 Function & operating principle 4.1.3 Construction & working of solenoid actuators, 4.1.4 Relays 4.1.5 Motorized actuators, 4.1.6 Thermal Actuators 4.1.7 Electro hydraulic & Electrochemical Valve actuators, 4.1.8 Application & new developments in the actuators technology. 4.1.9 Stepper motors. 4.1.10 DC Motors 4.1.11 PID Control 4.1.12 Introduction to Fuzzy logic and Adaptive control.	06
5	**5.1 Automotive Lighting and wiring harness systems.** 5.1.1 Lighting 5.1.1.1 Energy demand of lighting system 5.1.1.2 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. 5.1.1.3 Reflectors: Parabolic, Bifocal, Homifocal, poly-ellipsoidal 5.1.1.4 Gauges: Fuel, Temperature, Oil pressure etc.	06

	5.1.1.5 Accessories: Electric horn, wipers, Fuel pump, Power operated windows, Vehicle Immobilizers, Central locking circuit. **5.2 Wiring** 5.2.1 Cables 5.2.2 Sizes 5.2.3 Colors & color codes 5.2.4 Connectors 5.2.3 Multiplex wiring system **5.3 Electromagnetic Interference and Compatibility** (EMI/EMC)	
6	**6.1 Automotive Diagnostics:** Testing Sensors, Testing Actuators, Scanners/ Fault code readers & Analysers, Auto-TAP OBD scanner, Diagnostics Procedure and Diagnostic equipment. 6.2 Introduction to Automotive embedded system, Intelligent vehicle system. Telematics, X by wire, GPS ,OBD-II, V2V & V2I Communication, Scope of AI & ML in automobile.	06

Text Books/References:

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 Equipment 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.

Link for NPTEL Courses:

https://nptel.ac.in/courses/107106088 - Fundamentals of Automotive Systems, IIT Madras
https://nptel.ac.in/courses/113105102 - Electrochemical Energy Storage, IIT Kharagpur
https://nptel.ac.in/courses/108102121 - Electric Vehicles - Part 1, IIT Delhi

Course Code	Course Name	Credits
AEC702	**Vehicle Dynamics**	**03**

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	Content	Hrs.
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	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	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	6
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

Assessment:

Internal Assessment for 20 marks:

Consisting of **Two Compulsory Class Tests**

First test based on approximately 40% of content and second test based on remaining contents (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 syllabus.

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 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 any module other than module 3)
3. **Only three out of the remaining questions to be solved.**

Text 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. Road and Off Road Vehicle system Dynamics. Hand Book
6. Mechanics of Road Vehicle, Steeds
7. Car Suspension : Bastow

Links for online NPTEL/SWAYAM courses:

https://nptel.ac.in/courses/107/106/107106080/

Course Code	Course Name	Credits
AEDLO7031	**Vehicle Performance and Testing**	**03**

Course Objectives:

1. To understand the vehicle regulation requirements
2. To understand and learn the automotive engine testing requirement
3. To understand and learn the automotive vehicle testing requirement
4. To understand the automotive crash test and safety requirements.
5. To understand and learn the automotive components testing requirement
6. To understand and learn the automotive xEV testing requirement

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

1. Identify vehicle categories and their regulations requirements
2. Explain automotive engine test requirements
3. Explain automotive vehicle test requirements
4. Explain automotive crash test and safety requirements
5. Explain automotive component testing requirements
6. Explain the automotive xEV testing requirement

Module	Content	Hrs.
1	**Introduction** Technical Specification of Vehicles, Classification of Vehicles, Homologation, Vehicle Rules and Regulations (CMVR), Standards, Overview of the Type Approval process, Vehicle Testing Instruments and Lab Setups, Test Tracks.	06
2	**Engine Tests** Engine Testing set up Requirement and Installations, Chassis Dynamometer, Driving Cycles, Power Test, Emission Measurement Devices and Lab Setup, Mass & Evaporative Emission, Testing of CNG & LPG vehicles, Requirement of CNG & LPG retro-fitment kit.	08
3	**Vehicle Level Tests** CMVR Requirements, Photographs, Angle & Dimensions Measurement of Vehicle, Arrangement of Foot Controls, Requirement of Temporary Cabin Tyre Tread Depth Test, Vehicle Weightment, Gradeability Test, Steering Test, Vehicle Noise Measurement, Fuel Consumption Test, Brake Test, Velocity and Acceleration Measurement Test.	08
4	**Component Level Tests** Requirement, Installations and Testing of Various Vehicle Components such as Tyre, Windscreen, Horn, Rear View Mirror, Fuel Tank, Bumper, Lighting devices, Signaling devices and Reflectors.	06
5	**Vehicle Crash Tests** Requirements of the Restrained System (seat belt and airbag), Vehicle Crashworthiness, Crash Test Setup/Instruments, Dummies, Injury Evaluation, Frontal Impact Test, Lateral Impact Test, Rear Impact Test, Pedestrian Safety Requirement and New Car Assessment Programme (NCAP)	06
6	**xEV Test** Constructional and Functional Safety Requirements of Electric, Hybrid and Fuel Cell Vehicles, Requirement and Testing of Battery, Motor and e-retro fitment kit and chargers (AC & DC), EMI and EMC.	06

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

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

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

Text Books/References:

1. Central Motor Vehicle Rules (CMVR), 2020
2. Michael Plint & Anthony Martyr, "Engine Testing & Practice", Butterworth Heinmenn, 3rd edition, 2007
3. Vehicle Inspection Handbook by American Association of Motor Vehicle Administrators
4. Automotive crash and safety Test book
5. Bureau of Indian Standards (BIS)
6. Automotive Industry Standards (AIS)
7. International automotive Regulations/Standards
8. Federal Motor Vehicle Safety Standards (FMVSS)
9. NCAP Regulations and Standards

Course Code	Course Name	Credits
AEDLO7032	**Alternate Fuels and Emission Control**	**03**

Course Objectives:

1. To broaden the knowledge of alternate fuels,
2. To understand the manufacturing and performance characteristics of alternate fuels
3. To broaden the understanding of performance of single and multi cylinder diesel and petrol engines
4. To introduce emission tests procedure

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

1. To Identify different alternate automotive fuels
2. Understand gaseous fuel technology in internal combustion applications.
3. Identify the advantage and disadvantages of Alternative Fuels
4. Understand various emission source in SI and CI Engine
5. Understand different emission control technique

Module	Content	Hrs.
1	**Introduction** Overview of Alternative Fuel, History of Fuel, Need for alternate fuels, availability and comparative properties of alternate fuels, classification of alternative fuels.	4
2	**Gaseous Fuels** - CNG, LPG, BIOGAS, LNG & HCNG: Availability, properties, modifications required in SI engines, performance and emission characteristics, storage, handling & dispensing, safety aspects. **Synthetic fuels:** Di-Methyl Ether (DME), Diethyl Ether (DEE), and Gas to Liquid (GTL): Availability, properties, modifications required in CI engines, performance and emission characteristics, storage, handling and dispensing, safety aspects. **Hydrogen and Fuel cells** - Production methods, properties, performance and emission characteristics, storage and handling, safety aspects, classification, description of fuel cell systems, fuel cell components, properties of fuel cells,	7
3	**Liquid Fuels** Sustainable mobility, emission scenario & norms, emission sources & effects, greenhouse gases & control, petroleum reserves & refining, fuel properties & their effects on performance & emission characteristics **Bio fuels:** Biodiesel, Ethanol and straight vegetable oils (SVO), Manufacturing process of alcohol, blending of methanol and ethanol, types of vegetable oils for engine application, their effects on performance & emission characteristics.	7
4	**Emissions From SI Engines** Emission formation in S.I. engines, hydrocarbons, carbon monoxide, nitric oxide & lead, effects of design & operating variables on emission formation, controlling of emission formation in engines, thermal reactors, catalytic converters, charcoal canister control for evaporative emission, positive crank case ventilation system	8
5	**Emissions From CI Engines** Diesel combustion, stages, direct & indirect combustion, emission formation, particulate matter & smoke, effect of operating variables on emission formation, PM & NOx trade-off,Exhaust Gas Recirculation (EGR), air injection, cetane number effect, emission after-treatment devices like DOC, DPF, SCR & NOx Adsorber.	8

6	**Emission Measurement And Test Procedure** Measurement & instrumentation for HC, CO, CO2, NOx & PM, smoke meters, and calibration checks on emission equipment's, dilution tunnel technique for particulate measurement, emission test procedures on engine & chassis dynamometers, constant volume sampling procedure.	6

Assessment:

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

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

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

Text Books:

1. ALTERNATIVE FUELS - Concepts, Technologies and Developments by S.S. Thipse, Jaico Publications.
2. Ganesan.V, Internal Combustion Engines, Tata McGraw Hill, 1994.
3. Crouse.W.M, Anglin.A.L., Automotive Emission Control, McGraw Hill 1995.
4. Samir Sarkar (2009) Fuels and Combustion: Third Edition, Universities Press, India.

References:

1. Springer.G.S, Patterson.D.J, Engine Emissions, pollutant formation, Plenum Press, 1986
2. Patterson, D.J, Henin.N.A, Emissions from Combustion engines and their Control, Anna Arbor Science, 1985. Linden.D, Handbook of Batteries and Fuel Cells, McGraw Hill, 1995.
3. Maxwell et al, Alternative Fuel: Emission, Economic and Performance, SAE, 1995
4. Watson, E.B., Alternative fuels for the combustion engine, ASME, 1990
5. Bechtold, R., Alternative fuels guidebook, 1998.
6. Joseph, N., Hydrogen fuel for structure transportation, SAE, 1996.
7. Holt and Danniel, Fuel cell powered vehicles: Automotive technology for the future, SAE, 2001.
8. Vora K C & Ghosh B, Monograph on Automotive Catalytic Converter, ARAI Publication, 1995.

NPTEL Links:

https://nptel.ac.in/courses/112/103/112103262/

Course Code	Course Name	Credits
AEDLO7033	**Automotive Aerodynamics and Aesthetics**	**03**

Course Objectives

1. To familiarize the fundamentals of fluid mechanics related to vehicles.
2. To acquaint with concepts of the aerodynamics drag of vehicles.
3. To understand aerodynamic of racing car
4. To familiarize with the basic principles of wind tunnel technology.
5. To understand the importance of aesthetics with respect to aerodynamics

Course 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	Content	Hrs.
01	**Fundamental of Aerodynamic** Scope, historical developments, fundamental of fluid mechanics, flow phenomenon related to vehicles, Wake around vehicle body, Flow separation and reattachment , Streamlining of Automobile Calculation of Drag and Drag force Effect of aerodynamic on Light Cars and Trucks - Fuel Consumption	6
02	**Car Aerodynamic** The origin of forces and moments on a car, Flow field around a car, Study of aerodynamic on different types of car(Hatch back, Fast back, Notch back etc.), Various devices used for improving performance of car(Like air dams, spoilers etc.)	7
03	**Aerodynamics of High Performance Vehicles and Simulation** High performance vehicles – very low drag cars , Race Car Aerodynamics , Formula 1 : study of external Aerodynamics, High Efficiency Radiators **Simulation** Development and simulation methods for cars, Aerodynamic Studies of Flows Around Bluff Bodies, Introduction to software used for simulation	8
04	**Aerodynamics of Commercial Vehicle and Bus** Study of aerodynamic on different types of trucks (forward control, Normal Control, tanker etc.), Various modification of the cabin and trailor to reduce drag, Aerodynamic of Buses.	7
05	**Wind Tunnel Technology** Principles of wind tunnel technology – Limitations of simulation – Scale models – Existing automobile wind tunnels – Climatic wind tunnels – Measuring equipment and transducers – Pressure measurements- Velocity measurements – Flow visualization techniques – Road testing methods – Wind noise measurements.	8
06	**Automobile Aesthetics** Importance of aesthetics , Optimization of vehicle bodies (car, Truck , Bus) for low drag with external fittings , Study of surface finish on aerodynamic of car	5

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. T. Yomi Obidi, 'Theory and Applications of Aerodynamics for Ground Vehicles', SAE Publications, 2014.
3. A. Pope - "Wind Tunnel Testing"- John Wiley & sons - 2nd Editions, New York - 1974.
4. R. McCallen, Ross Browand, 'The Aerodynamics of Heavy Vehicles', Springer, 2014.
5. Smits, Lim, 'Flow Visualization: Techniques and Examples', 2nd edition, Imperial College, 2012.
6. Vehicle Aerodynamics – SP-1145 - SAE _ 1996

Course Code	Course Name	Credits
AEDLO7041	**Transport Management Systems**	**03**

Course Objectives:

1. To familiarise with the Motor Vehicle Acts in India
2. To understand the basic of Motor Vehicle taxation
3. To understand the basic of Motor Vehicle Insurance
4. To understand the Passenger & goods transportation system operations
5. To understand the overview of Traffic Navigation & Global Positioning System

Course Outcomes:

After completion of this course, Learner will be able to…

1. Explain the basics of Motor Vehicle Act
2. Know the way of applying tax on Motor Vehicle
3. Apply the basic knowledge of Motor Vehicle Insurance
4. Apply the basic knowledge of Passenger & goods transportation system operations
5. Implement advance techniques in traffic management

Module	Content	Hrs.
1	**1. Motor Vehicle Act** 1.1 Short titles & definitions 1.2 Laws governing to use of motor vehicle & vehicle transport 1.3 Licensing of drivers & conductors 1.4 Registration of vehicle 1.5 State & interstate permits 1.6 Traffic rules, Signals & controls 1.7 Accidents, Causes & analysis 1.8 Liabilities & preventive measures 1.9 Rules & regulations 1.10 Responsibility of driver 1.11 Public & public authorities 1.12 Offences, penalties & procedures 1.13 Different types of forms 1.14 Personnel, Authorities & duties 1.15 Rules regarding construction of motor vehicles 1.16 Tourist and National Permits 1.17 Fitness of a Motor Vehicle 1.18 Rules for Special Purpose Vehicle(Off Road vehicle, Specially designed vehicle ,Government Department Vehicle)	10
2	**2. Taxation** 2.1 Objectives 2.2 Structure & methods of laving taxation 2.3 One-time tax 2.4 Tax exemption & tax renewal 2.5 Types of Tax 2.6 Different types of Tax at Vehicle Registration Renewal	04
3	**3. Insurance** 3.1 Insurance types & significance 3.1.1 Comprehensive plus zero depreciation 3.1.2 Third party insurance 3.2 Furnishing of particulars of vehicles involved in accident 3.3 MACT (Motor Accident Claims Tribunal)	08

	3.4 Solatium Fund 3.5 Hit & Run case 3.6 Duty of driver in case of accident 3.7 Surveyor & Loss Assessor, Surveyor's report 3.8 Role of Surveyor 3.9 Settlement of Insurance and Procedure of Investigation	
4	**4. Passenger Transport Operation** 4.1 Structure of passenger transport organizations 4.2 Typical depot layouts 4.3 Requirements and Problems on fleet management 4.4 Fleet maintenance 4.5 Planning - Scheduling operation & control 4.6 Personal & training-training for drivers & conductors 4.7 Public relations, Propaganda, publicity and passenger amenities 4.8 Parcel traffic. 4.9 Theory of fares-Basic principles of fare charging 4.10 Differential rates for different types of services 4.11 Depreciation & debt charges 4.12 Operation cost and Revenues 4.13 Economics & records 4.14 Maintenance management of State Transport Undertaking (STU) 4.15 Bus Rapid Transport system (BRTS) 4.16 Indian Railways Passenger Transport Operation	08
5	**5. Goods Transport Operation** 5.1Scheduling of goods transport 5.2 Management Information System (MIS) in passenger / goods transport operation 5.3Storage & transportation of petroleum products 5.4 Intelligent Transport System (ITS) 5.5 RO-RO Service for transportation of goods 5.6 Dedicated Freight Corridor (DFC) of Indian Railways	04
6	**6. Advance Techniques in Traffic Management** 6.1 Traffic navigation 6.2 Global positioning system	02

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.

References:

1. Motor Vehicle Act - Governmment of India Publications
2. Economics of Transport, S.K. Shrivastava
3. Transport Development in India, S. Chand & Co. Pvt. Ltd., New Delhi.
4. CMVR-1989
5. Peter R. White: Public Transport: Its Planning, Management and operation (Natural and Built Environment Series, Kindle Edition, September 2008.)
6. John Doke-Fleet Management
7. Kitchin L.D. - Bus Operation, Illiffe and sons Co. London, III edition
8. Websites of different transport organizations like Indian Railways, Konkan Railways, Ministry of Road Transport & Highways and Motor Vehicle Department Maharashtra

Course Code	Course Name	Credits
AEDLO 7042	**Tire Technology**	**03**

Course Objectives:

1. To understand Tire Materials and Tire Manufacturing processes in detail.
2. To study effect of effect of Tire on Grip and Rolling resistance
3. To understand Future tire technologies in Passenger and Commercial vehicles.

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

1. Understand basics of Tire construction and factors influencing tire design
2. Explain tread design and tread wear mechanisms.
3. Describe the Tire casing construction
4. Understand use of Natural Rubber as Tire Material and Describe Tire Manufacturing Process
5. Interpret how Tire Grip works on Dry and Wet surfaces.
6. Understand the effect of Tire on Rolling resistance and Fuel savings.

Module	Content	Hrs.
1	**Introduction to Tyres** - The Global Tire Industry, Tire Technology, Tire Construction, Mission Profile and Design Envelopes, Dimensions and Nomenclature, Tire Speed and Load Rating, Trends in Tire Sizes, Secondary Factors Influencing Tire Design. ,Off-Road Tires , Farm Tires	**06**
2	**Tire Tread Technology** -Introduction, Tread Compounds, Radial Tire Tread Design Parameters, Tire Footprint Pressure, Tread Extrusion Contour, Tread Radius, Tread Wear Mechanisms	**06**
3	**Tire Casing Construction** -Introduction, Casing Components, Belt Design, Casing Construction, Inner Liner and Barrier, Ply ,Sidewall, Bead,Apex (Bead Filler), Chafer (Toe Guard), Shoulder Wedge, Model Compound Line-up.	**06**
4	**Radial Tire Materials**-Polymers used in tires, Natural Rubber and Grades(TSL-L,5,10,20,50), properties of natural rubber compounds, synthetic elastomers used in tires, Carbon black and its properties, Vulcanization systems, Pressing aids. **Tire Manufacturing**- Component Preparation, Electron beam radiation process, Tire building, Tire curing, Final Finish, Impact on Environment due to Tire Manufacturing.	**06**
5	**Tire grip on Road Surface**-How Road Surface affects Grips, Generation of grip forces in contact patch, Grip on wet surfaces, Grip and Vehicle Handling, Testing tire grip.	**08**
6	**Rolling resistance and Fuel Saving**-Tires Contribution to fuel efficiency, Fuel saving and reduction of exhaust emission, Viscoelastic material and energy dissipation, Measurement of Tire rolling resistance-As per standard ISO8767 and 9948 and Laboratory Measurement **Future trends-** In Passenger Car Tires and Commercial Vehicle Tires.	**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 a total of 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 Books:

1. Rubber Products Manufacturing Technology By: Anil K. Bhowmick
2. Tyre Technology By: Tom French.
3. Tyre Manufacturing & Engineering By: F. J. Kovac.

References:

1. Tire Engineering: An Introduction by Rodgers,Brendan

Course Code	Course Name	Credits
AEDLO7043	**Automotive Sensors and Control Systems**	**03**

Course Objectives:

1. To study the working and role of sensors and actuators in automotive.
2. To study the basic concepts of control systems
3. To acquaint with the concepts of advanced control systems for vehicles.

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

1. Understand the working of automotive sensors and actuators
2. Differentiate various types of control systems classification and time domain specifications
3. Apply concepts of stability
4. Understand the concepts of Powertrain Control Systems
5. Understand the concepts of Vehicle Control Systems
6. Understand the concepts of Intelligent Transportation Systems

Module	Content	Hrs.
1	**Automotive Sensors:** MAP sensor; Crankshaft Angular Position and Engine Speed; mass airflow sensor (MAS); TPS sensor; EGO sensor; Engine knock sensor; vehicle-speed sensor; displacement sensor (such as LVDT); Accelerometers; **Automotive Actuators:** Important actuation devices needed for engine and vehicle-control systems such as Fuel Metering; Spark Ignition; Exhaust Gas; Throttle Actuator; Brake-Pressure Modulators; Suspension Actuator etc.	06
2	**Introduction to control systems:** Classification of the control system. Open-loop and closed-loop systems. Transient and steady-state analysis of first and second-order systems. Time Domain specifications. Step response of the second-order system Steady-state error, error coefficients, steady-state analysis of the different type of systems using step, ramp and parabolic inputs	08
3	**Stability analysis**: Introduction to concepts of stability, Concept of S-plane, The Routh criteria for stability Experimental determination of frequency response, Stability analysis using Root locus, Bode plot and Nyquist Plots Introduction to state-space analysis Process control systems, ON-OFF control. P, PD, PI, P-I-D Controls	12
4	**Powertrain Control Systems:** Air–Fuel Ratio Control Control of Spark Timing Idle-Speed Control Transmission Control	04
5	**Vehicle Control Systems:** Cruise and Headway Control Antilock Brake and Traction-Control Systems Vehicle Stability Control Four-Wheel Steering Active Suspensions	06

6	**Intelligent Transportation Systems:** **Overview of Intelligent Transportation Systems:** Advanced Traffic Management Systems Advanced Traveler Information Systems Commercial Vehicle Operations Advanced Vehicle-Control Systems **Longitudinal Motion Control:** Site-Specific Information Platooning String Stability **Automated Steering and Lateral Control:** Lane Sensing Automated Lane-Following Control Automated Lane-Change Control	06

N.B.:

1. Software such as LabView, MATLAB/Simulink and Scilab can be used to demonstrate the basics of the control system and its application in automotive.
2. Research papers may be referred to study the latest trends in the automotive control systems

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

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

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

Text Books:

1. Bosch Automotive Electrics and Automotive Electronics: Systems and Components, Networking and Hybrid Drive, 5th Edition, Published by Robert Bosch GmbH, 2007
2. Control Systems by A. Anand Kumar by PHI Learning Private Limited
3. Automotive control systems by A. Galip Ulsoy, Huei Peng & Melih Cakmakcı Cambridge University Press

References:

1. Bosch Automotive Handbook, 10th Edition
2. Automotive Control Systems for Engine, Driveline, and Vehicle, Second Edition by Uwe Kiencke, Lars Nielsen., Published by Springer.
3. Control system by Norman Nise , Wiley india Pvt. Ltd
4. Control System Engineering by Nagnath J and Gopal M, Wiley Eastern Ltd

Course Code	Course Name	Credits
ILO7011	**Product Life Cycle Management**	**03**

Course 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

Course 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	Content	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 Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	05
06	**Life Cycle Assessment and Life Cycle Cost Analysis:** Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of	05

	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	

Assessment:

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

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

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

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, Immonen Anselmie, "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
ILO7012	**Reliability Engineering**	**03**

Course 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

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

End Semester Examination:

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

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

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
ILO7013	**Management Information System**	**03**

Course 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

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

End Semester Examination:

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

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

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
ILO7014	**Design of Experiments**	**03**

Course 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

Course 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	Content	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 General 2^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 5.3 Analysis of a Second-Order Response Surface 5.4 Experimental Designs for Fitting Response Surfaces	07
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 on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

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

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

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
ILO7015	**Operations Research**	**03**

Course 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.

Course 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	Content	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	05

	with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	
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 on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

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

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

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
ILO7016	**Cyber Security and Laws**	**03**

Course 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

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

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

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

References:

1. Nina Godbole, Sunit Belapure, *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
ILO7017	**Disaster Management and Mitigation Measures**	**03**

Course 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

Course 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	Content	Hrs.
01	Introduction 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 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.	09
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 on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

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

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

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 Rajdeep Dasgupta, 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
ILO7018	**Energy Audit and Management**	**03**

Course 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.

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

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

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

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**

Course Objectives:

1. To understand the characteristics of rural Society and the Scope, Nature and Constraints of rural
   Development.
1. To study Implications of 73rd CAA on Planning, Development and Governance of Rural Areas
2. 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
3. To understand the Nature and Type of Human Values relevant to Planning Institutions

Course 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	Content	Hrs.
01	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
02	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
03	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
04	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
05	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	10

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

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

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

References:

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

1. Planning Guide to Beginners
2. Weaver, R.C., The Urban Complex, Doubleday.
3. Farmer, W.P. et al, Ethics in Planning, American Planning Association, Washington.
4. How, E., Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp. 123-150.
5. Watson, V. , Conflicting Rationalities: -- Implications for Planning Theory and Ethics, Planning Theory andPractice, Vol. 4, No.4, pp.395 – 407

Course Code	Name of the Course	Credit
AEL701	**Vehicle Maintenance Lab**	**01**

Course Objectives:

1. To identify and layout the physical facilities necessary for an automotive service and maintenance workshop
2. To identify the equipment and tools necessary for the operation of an automotive service and maintenance workshop
3. To define the different job positions that are needed in the automotive service and maintenance workshop
4. To identify some of the fundamental traits of human behaviour in the automotive service industry.
5. To familiarize with fault diagnosis techniques used in automobiles.
6. To acquaint with the procedure to operate machine and equipment of a modern automotive service and maintenance workshop.

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

1. Draw layout of automobile workshop and its usefulness.
2. Identify the various equipment and tools necessary for the operation of an automotive repair shop
3. Identify the various faults in the engine system on an actual vehicle in the workshop.
4. Perform Computerized Wheel alignment operation.
5. Perform Wheel Balancing operation.
6. Perform removal and re-fitting of the tyre using an automatic tyre changer.

Term Work:

A) List of Experiments: The laboratory Experiments should be based on the following:

1. Prepare a layout of an automobile service and maintenance workshop.
2. Prepare the list of different types of tools & instruments and statements/records required for the repair and maintenance works.
3. Detect faults using fault diagnosis techniques/equipment such as scanners in Engine/ electrical/electronic ignition systems.
4. Identify and rectify faults in the electrical systems such as Starting system and charging system.
5. Identify and rectify faults in the electrical systems such as Headlights, Side lamps or Parking lights, Electric horns.
6. Perform wheel balancing on a computerized wheel balancer.
7. Perform wheel alignment activity to set proper steering geometry
8. Perform removal and refitting of the tyre using an automatic tyre changer

B) Mini Project/Case Study: The students are expected to carry out a mini project/case study in a group of 2-3 to acquire soft skills as well as diagnostics expertise as required in a modern automotive workshop.

Assessment:

Term Work:

Term work shall consist of experiments from the list.

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

Laboratory work (Experiments): 15 marks
Mini Project/Case Study: 05 marks
Attendance: 05 marks

The final certification and acceptance of term work ensure 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 the list of experiments
2. Distribution of marks for practical/viva examination shall be as follows:
   Practical performance: 15 marks
   Oral: 10 marks
1. 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	Name of the Course	Credits
AEL702	**Vehicle Dynamics lab**	**01**

Course Objectives:
1. To familiarize with basic concepts of vehicle dynamics.
2. To acquaint with simulation process using software in domain of vehicle dynamics.

Course Outcomes: After completion of this course, Learner will be able to…
1. Plot performance characteristic curves for shock absorber.
2. Simulate ride behaviour using quarter car model
3. Simulate ride behaviour using half car model
4. Simulate using different road profiles for quarter car and half car model.
5. Calculate drag coefficient for different vehicles
6. Perform test on chassis dynamometer

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 mini project based on topics related to vehicle Dynamics. The case study or mini 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.

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

Term work:

The distribution of marks for term work shall be as follows:
1. Laboratory work (5 Experiments) :**10 marks**
2. Case study/ Mini Project: **10 marks**
3. Attendance: **05 marks**

Practical and oral Examination:

Pair of Internal and External Examiner should conduct practical/Oral based on contents.
Distribution of marks for practical and oral examination shall be as follows:
Practical performance **15 marks**
Oral **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

Course Code	Course Name	Credit
AEL 703	**Industrial Skills**	**01**

Course Rationale: This course has been designed to prepare final year automobile engineering students for placements, as well as to build computer skills and advanced soft skills to make them ready for a career in the industry.

Course Objectives:

1. To familiarize students with basic computer/IT skills in the industry.
2. To practice soft skills and communication to be industry-ready.
3. To inculcate critical thinking and problem-solving abilities for efficient team and project outcomes.
4. To be prepared for campus placements by practicing aptitude, logical reasoning, Group discussion and personal interview rounds.

Course Outcomes: At the end of the course, **the learners will be able to**

1. Skillfully prepare and edit documents and slides on MS Word and MS PowerPoint etc.
2. Execute functions on MS Excel.
3. Learn how to navigate tasks and execute functions in G-suite.
4. Understand and practice metacognitive skills of creativity and problem solving.
5. Hone team building and leadership skills.
6. Perform well in campus placement rounds by practicing Aptitude, Logical reasoning, Group Discussion and Personal Interviews.

Module	**List of Experiments and Activities**	**No. of Lab sessions (*2hrs)**
1	**Computer/IT skills**	6
1.1 1.2 1.2.1 1.2.2 1.2.3 1.2.4 1.3 1.4	Basics of Computers- Desktop/Laptop operations Microsoft Office **MS Word**- Assignment to Create and use various commands in a Word document (Page setup, text formatting, templates, SmartArt, Title and Ribbon bar, Editing etc.) **MS Excel**- Assignment to Create and tabulate a spreadsheet (Excel-data analysis, charts, pivot tables, VBA, etc.) **MS- Power point**- Assignment to design and use a Presentation Software (MSPPT, Prezi, etc. – Presentation design, templates, custom slides, animation, graphs, charts, troubleshooting etc.) **MS Outlook** (Navigation, archiving, tasks distribution, filters, scheduling etc.) G-Suite (Gmail, G-Meet, Calendar, Sheets, Docs, Slides etc.) An introduction to the typesetting package LATEX.	
2	**Aptitude and Logical Reasoning**	2
2.1 2.2	Aptitude – Aptitude training, types of questions, mock tests Logical Reasoning – Verbal and Non-verbal reasoning, Types of questions, Mock tests	
3	**Developing Metacognitive skills**	2
3.1 3.2	Task orientation and Goal setting (can be based on Final year Project): Creativity and Problem-solving	
4	**Collaborative Techniques:Team building skills**	1
4.1 4.2	Activities on Team building Case studies on Leadership, Decision making and Team building	

5	**GD – PI**	2
5.1 5.2	Group Discussion – Factual, Strategic, Abstract, Case study, Picture based Personal Interview–Types of Interview Questions, Strategies, Sample answers, Mock Interviews	

Assignments: Assignments and activities should enable a steady progress in developing the aforementioned skills.A record of the conducted activities can be attached in journal as image printouts, and write up of case studies.

1. Application of MS Office skills (Individual)
   - Create and edit Word documents
   - Create and execute MS Excel functions
   - Create and enhance MS PPT
2. Writing a simple document in LATEX editor and running the typesetter program to produce finished document
3. Aptitude and Logical reasoning tests/practice sheets
4. Team building skills: Activities/Tasks to be performed as a team of 3 or 4 students.
5. Group Discussions
   Case studies on problem-solving to be done as a team activity.
   Personal Interview questionslog book

Assessment: Total – 50 Marks
Marks distribution will be as follows:
FINAL TERM WORK – 25 Marks
Assignments (Journal) – 20 Marks
Attendance - 05 Marks
ORALS/Written – 25 Marks

1. **Aptitude Test (Written) - 15 Marks**
2. **Mock Interview (Orals) – 10 Marks**

Books recommended/References/ Resources:

1. Meenakshi Raman, Prakash Singh. *Business Communication*, Oxford University Press, 2012
2. Claudyne Wilder. *The Presentations Kit*: 10 steps for Selling Your Ideas, John Wiley & Sons, 1994.
3. Lesikar, Flatley. *Basic Business Communication*: Skills for Empowering the Internet Generation, Tata McGraw Hill, 2008.
4. Flavell, J. H. *Cognitive development*: Past, present, and future. 1992.
5. Thorpe, Edgar and Showick Thorpe. *Objective English*, Pearson, 2013. (7th edition Amazon)
6. Thorpe, Edgar. *Test of Reasoning*: for All Competitive Examination. 7th edition., Amazon
7. Sinha, Nishit K., *Reasoning*, Pearson.
8. Aggarwal, R.S., *A Modern Approach to Logical Reasoning*, S. Chand.
9. Weblinks - https://cambridge-community.org.uk/professional-development/gswmeta/index.html
10. Various Quantitative aptitude books and websites listhttps://eduly.in/best-quantitative-aptitude-books/https://prepinsta.com/learn-aptitude/
    https://www.simplilearn.com/learn-ms-excel-free-training-course-skillup

NPTEL
Creativity https://nptel.ac.in/courses/109101017
Course Era
MS Excel https://www.coursera.org/projects/introduction-microsoft-excel
G-suite https://www.coursera.org/projects/collaborating-g-suite-apps
Problem solving https://www.coursera.org/learn/problem-solving
Udemy
G-suite https://www.udemy.com/course/learn-gsuite/

Course Code	Course Name	Credit
AEP701	**Major Project I**	**03**

Course Objectives: The course aims:
The Project work facilitates the students to develop and prove Technical, Professional and Ethical skills and knowledge gained during graduation program by applying them from problem identification, analyzing the problem and designing solutions.

Course Outcomes:

1. Students will be able to develop the understanding of the problem domain through extensive review of literature.
2. Students will be able to identify and analyze the problem in detail to define its scope with problem specific data.
3. Students will be able to identify various techniques to be implemented for the selected problem and related technical skills through feasibility analysis.
4. Students will be able to design solutions for real-time problems that will positively impact society and environment.
5. Students will be able to develop clarity of presentation based on communication, teamwork and leadership skills.
6. Students will be able to inculcate professional and ethical behavior.

Guidelines:

1. **Project Topic Selection and Allocation:**

- Project topic selection Process to be defined and followed:
  - Project orientation can be given at the end of sixth semester.
  - Students should be informed about the domain and domain experts whose guidance can be taken before selecting projects.
  - Student's should be recommended to refer papers from reputed conferences/ journals like IEEE, Elsevier, ACM etc. which are not more than 3 years old for review of literature.
  - Students can certainly take ideas from anywhere, but be sure that they should evolve them in the unique way to suit their project requirements. Students can be informed to refer Digital India portal, SIH portal or any other hackathon portal for problem selection.
- Topics can be finalized with respect to following criterion:
  - **Topic Selection**: The topics selected should be novel in nature (Product based, Application based or Research based) or should work towards removing the lacuna in currently existing systems.
  - **Technology Used:** Use of latest technology or modern tools can be encouraged**.**
  - Students should not repeat work done previously (work done in the last three years).
- Project work must be carried out by the group of at least 2 students and maximum 4.
- The project work can be undertaken in a research institute or organization/Industry/any business establishment. (out-house projects)
- The project proposal presentations can be scheduled according to the domains and should be judged by faculty who are expert in the domain.
- Head of department and senior staff along with project coordinators will take decision regarding final selection of projects.
- Guide allocation should be done and students have to submit weekly progress report to the internal guide.
- Internal guide has to keep track of the progress of the project and also has to maintain attendance report. This progress report can be used for awarding term work marks.

- In case of industry/ out-house projects, visit by internal guide will be preferred and external members can be called during the presentation at various levels

2. **Project Report Format:**
At the end of semester, each group need to prepare a project report as per the guidelines issued by the University of Mumbai.
A project report should preferably contain at least following details:

- Abstract
- Introduction
- Literature Survey
- Survey of Existing systems
- Limitations of Existing systems or research gaps
- Motivation (Challenges that are encouraging to choose the problem)
- Problem Statement and Proposed Solution
- Scope of the system
- Proposed System
    - General Workflow/Block diagram
- Analysis and Modeling (only applicable diagrams)
- Design
    - Architectural View
    - Algorithms/ Methodology
- Experimental Set up
    - Details of Database or details about input to systems or selected data
    - Performance Evaluation Parameters (for Validation)
    - Software and Hardware Set up
- Implementation Plan for Next Semester
    - Timeline Chart for Term1 and Term-II (Project Management tools can be used.)
- Summary
- References

Desirable

- Students can be asked to undergo some Certification course (for the technical skill set that will be useful and applicable for projects.)

3.Term Work:
Distribution of marks for term work shall be done based on following:

a. Weekly Log Report
b. Project Work Contribution
c. Project Report (Spiral Bound) (both side print)
d. Term End Presentation (Internal)

The final certification and acceptance of TW ensures the satisfactory performance on the above aspects.

4. Oral & Practical:
Oral &Practical examination (Final Project Evaluation) of Project 1 should be conducted by Internal and External examiners approved by University of Mumbai at the end of the semester.
Suggested quality evaluation parameters are as follows:

1. Quality of problem selected
2. Clarity of problem definition and feasibility of problem solution
3. Relevance to the specialization / industrial trends
4. Originality
5. Clarity of objective and scope
6. Quality of analysis and design
7. Quality of written and oral presentation
8. Individual as well as team work