

University of Mumbai



No. AAMS(UG)/ 131 of 2022-23

CIRCULAR:-

Attention of the Principals of the Affiliated Colleges and Directors of the Recognized Institutions in Faculty of Science & Technology is invited to this office circular No. UG/169 of 2017-18 dated 8th August, 2017, relating to the revised syllabus as per (CBCS) for Bachelor of Engineering (Automobile Engineering) (Sem. III & VIII) be revised for S.E. (Sem. III & IV) from Academic Year 2017-18, Third Year (Sem. V & VI) from Academic Year 2018-19 and Bachelor of Engineering (Sem. VII & VIII) from Academic Year 2019-20.

You are hereby informed that the recommendations made by the Board of Studies in **Mechanical Engineering** at its meeting held on 31st May, 2022 and subsequently passed in the Faculty and then by the Board of Deans at its meeting held on 5th July, 2022 vide item No. 6.46 (R) have been accepted by the Academic Council at its meeting held on 11th July, 2022 vide item No. 6.46 (R) and that in accordance therewith, the revised syllabus of **B.E. (Automobile Engineering) (Sem.- VII & VIII) (CBCS) (REV – 2019 'C' Scheme)**, has been brought into force with effect from the academic year 2022-23. (The circular is available on the University's website www.mu.ac.in).

MUMBAI – 400 032

20th October, 2022

To

The Principals of the Affiliated Colleges and Directors of the Recognized Institutions in Faculty of Science & Technology.

A.C/6.46 (R)/11/07/2022

No. AAMS(UG)/ 131-A of 2022-23

20th October, 2022

Copy forwarded with Compliments for information to:-

- 1) The Dean, Faculty of Science & Technology,
- 2) The Chairman, Board of Studies in Mechanical Engineering,
- 3) The Director, Board of Examinations and Evaluation,
- 4) The Director, Board of Students Development,
- 5) The Director, Department of Information & Communication Technology,
- 6) The Co-ordinator, MKCL.

(Dr. Shailendra Deolankar)
I/c Registrar

Copy to :-

- 1. The Deputy Registrar, Academic Authorities Meetings and Services (AAMS),**
- 2. The Deputy Registrar, College Affiliations & Development Department (CAD),**
- 3. The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Department (AEM),**
- 4. The Deputy Registrar, Research Administration & Promotion Cell (RAPC),**
- 5. The Deputy Registrar, Executive Authorities Section (EA),**
- 6. The Deputy Registrar, PRO, Fort, (Publication Section),**
- 7. The Deputy Registrar, (Special Cell),**
- 8. The Deputy Registrar, Fort/ Vidyanagari Administration Department (FAD) (VAD), Record Section,**
- 9. The Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari,**

They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above circular and that on separate Action Taken Report will be sent in this connection.

- 1. P.A to Hon'ble Vice-Chancellor,**
- 2. P.A Pro-Vice-Chancellor,**
- 3. P.A to Registrar,**
- 4. All Deans of all Faculties,**
- 5. P.A to Finance & Account Officers, (F.& A.O),**
- 6. P.A to Director, Board of Examinations and Evaluation,**
- 7. P.A to Director, Innovation, Incubation and Linkages,**
- 8. P.A to Director, Board of Lifelong Learning and Extension (BLLE),**
- 9. The Director, Dept. of Information and Communication Technology (DICT) (CCF & UCC), Vidyanagari,**
- 10. The Director of Board of Student Development,**
- 11. The Director, Department of Students Welfare (DSD),**
- 12. All Deputy Registrar, Examination House,**
- 13. The Deputy Registrars, Finance & Accounts Section,**
- 14. The Assistant Registrar, Administrative sub-Campus Thane,**
- 15. The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan,**
- 16. The Assistant Registrar, Ratnagiri sub-centre, Ratnagiri,**
- 17. The Assistant Registrar, Constituent Colleges Unit,**
- 18. BUCTU,**
- 19. The Receptionist,**
- 20. The Telephone Operator,**
- 21. The Secretary MUASA**

for information.

AC – 11 July, 2022

Item No. – 6.46 (R)

University of Mumbai



**Revised Syllabus for
B.E. (Automobile Engineering)
Semester – (VII & VIII)
(Choice Based Credit System)**

(With effect from the academic year 2022-23)

University of Mumbai



O: _____	Title of Course	B.E. (Automobile Engineering)
O: _____	Eligibility	After Passing Third Year Engineering as per the Ordinance 0.6243
R: _____	Passing Marks	40%
No. of years/Semesters:		8 semesters
Level:		P.G. / U.G. / Diploma / Certificate
Pattern:		Yearly / Semester
Status:		New / Revised 2019 'C' Scheme
To be implemented from Academic Year :		With effect from Academic Year : 2022-23

Signature:

Dr. Vivek Sunnapwar
Chairman
of Board of Studies in
Mechanical Engineering

Signature:

Dr. Suresh K. Ukarande
Associate Dean,
Faculty of Science and
Technology

Dr Anuradha Majumdar
Dean,
Faculty of Science and
Technology

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.

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

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.

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

Preface

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

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

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

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

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

Board of Studies in Mechanical Engineering

Dr. Vivek K. Sunnapwar	: Chairman
Dr. S. M. Khot	: Member
Dr. V. M. Phalle	: Member
Dr. Siddappa Bhusnoor	: Member
Dr. S.S. Pawar	: Member
Dr. Sanjay U. Bokade	: Member
Dr. Dhanraj Tambuskar	: Member
Dr. V. B. Tungikar	: Member
Dr. K.P. Karunakaran	: Member
Dr. S. S. Thipse	: Member
Dr. Milind Deshmukh	: Member

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							Total
		Theory					Term Work	Prac/ Oral	
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
		Test1	Test2	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

Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract./Tut.	Theory	Pract.	Total
AEC801	Hybrid and Electric Vehicles	3	--	3	--	3
AEDLO805X	Department Level Optional Course – 5	3	--	3	--	3
AEDLO806X	Department Level Optional Course – 6*	3	--	3	--	3
ILO802X	Institute Level Optional Course – 2	3	--	3	--	3
AEL801	Hybrid and Electric Vehicles	--	2	--	1	1
AEL802	Laboratory based on IoT*	--	2	--	1	1
AEP801	Major Project II	--	12 [#]	--	6	6
Total		12	16	12	8	20

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Prac./Oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (Hrs)			
		Test1	Test2	Avg					
AEC801	Hybrid and Electric Vehicles	20	20	20	80	3	--	--	100
AEDLO805X	Department Level Optional Course – 5	20	20	20	80	3	--	--	100
AEDLO806X	Department Level Optional Course – 6*	20	20	20	80	3	--	--	100
ILO802X	Institute Level Optional Course – 2	20	20	20	80	3	--	--	100
AEL801	Hybrid and Electric Vehicles	--	--	--	--	--	25	25	50
AEL802	Laboratory based on IoT*	--	--	--	--	--	25	25	50
AEP801	Major Project II	--	--	--	--	--	100	50	150
Total		--	--	80	320	--	150	100	650

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

* Common with Mechanical Engineering

Major Project 1 and 2:

Students can form groups with minimum 2 (Two) members and not more than 4 (Four) members

Faculty Load: In Semester VII – ½ hour per week per project group

In Semester VIII – 1 hour per week per project group

Department Optional Courses

CourseCode	Sem.VII:DepartmentOptional Course-3	CourseCode	Sem.VII:DepartmentOptional 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

CourseCode	Sem.VIII:DepartmentOptional Course-5	CourseCode	Sem.VIII:DepartmentOptional Course -6*
AEDLO8051	Automotive Materials	AEDLO8061	Product Design and Development
AEDLO8052	Automotive Embedded Systems	AEDLO8062	Design for X
AEDLO8053	Engine and Battery Management Systems	AEDLO8063	Total Quality Management

*Common with Mechanical Engineering

Institute Optional Courses

CourseCode	InstituteOptionalCourse-I [#]	CourseCode	InstituteElectiveCourse-II [#]
ILO7011	ProductLifecycleManagement	ILO8021	ProjectManagement
ILO7012	ReliabilityEngineering	ILO8022	FinanceManagement
ILO7013	ManagementInformationSystem	ILO8023	EntrepreneurshipDevelopmentand Management
ILO7014	DesignofExperiments	ILO8024	HumanResource Management
ILO7015	OperationResearch	ILO8025	ProfessionalEthicsandCSR
ILO7016	CyberSecurityandLaws	ILO8026	ResearchMethodology
ILO7017	DisasterManagement and MitigationMeasures	ILO8027	IPR andPatenting
ILO7018	EnergyAuditandManagement	ILO8028	DigitalBusinessManagement
ILO7019	DevelopmentEngineering	ILO8029	EnvironmentalManagement

#Commonwithallbranches

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	<p>1.1 Battery</p> <p>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.</p> <p>1.2 Modern Energy storage methods:</p> <p>1.2.1 Ultra Capacitor 1.2.2 Super Capacitor 1.2.3 Ultra high-speed flywheels.</p> <p>1.3 Layouts of 48-volt technology</p> <p>1.3.1 Mild hybrids, 1.3.2 Micro- hybrids 1.3.3 Plug-in hybrids. 1.3.4 Range extended EVs</p>	08
2	<p>2.1 Charging System</p> <p>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.</p> <p>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</p> <p>2.2 Starting system</p> <p>2.2.1 Requirements of starting system 2.2.2 Various torque terms used</p>	06

	<p>2.2.3 Starter motors drives</p> <p>2.2.3.1 Bendix</p> <p>2.2.3.2 Folo through Barrel</p> <p>2.2.3.3 Rubber compression</p> <p>2.2.3.4 Compression spring</p> <p>2.2.3.5 Friction clutch</p> <p>2.2.3.6 Overrunning clutch</p> <p>2.2.3.7 Dyer</p> <p>2.2.4 Starter motor solenoids & switches</p> <p>2.2.5 Glow plugs</p> <p>2.3 Integrated Starter and Alternator</p>	
3	<p>3.1 Electronic Ignition System</p> <p>3.1.1 Capacitor Discharge Ignition system</p> <p>3.1.2 Distributer less Ignition System</p> <p>3.1.3 Direct Ignition System,</p> <p>3.1.4 Hall Effect pulse generator</p> <p>3.1.5 Inductive pulse generator</p> <p>3.2 Automotive Protocols: LIN, CAN, KWP2000 & J1939, Flex Ray</p> <p>3.2.1 Communication Protocols: USART, I2C, SPI, CAN Bus</p> <p>3.2.2 Use of CAN Protocol in automobiles.</p>	04
4	<p>4.1 Automotive Actuators and Controllers</p> <p>4.1.1 Introduction,</p> <p>4.1.2 Function & operating principle</p> <p>4.1.3 Construction & working of solenoid actuators,</p> <p>4.1.4 Relays</p> <p>4.1.5 Motorized actuators,</p> <p>4.1.6 Thermal Actuators</p> <p>4.1.7 Electro hydraulic & Electrochemical Valve actuators,</p> <p>4.1.8 Application & new developments in the actuators technology.</p> <p>4.1.9 Stepper motors.</p> <p>4.1.10 DC Motors</p> <p>4.1.11 PID Control</p> <p>4.1.12 Introduction to Fuzzy logic and Adaptive control.</p>	06
5	<p>5.1 Automotive Lighting and wiring harness systems.</p> <p>5.1.1 Lighting</p> <p>5.1.1.1 Energy demand of lighting system</p> <p>5.1.1.2 Types of Lamps</p> <p>i. Head lamp: Construction & types. Setting & control</p> <p>ii. Fog Lamp</p> <p>iii. Side Lamp</p> <p>iv. Tail lamp</p> <p>v. Parking lamp</p> <p>vi. Brake warning light</p> <p>vii. Trafficators</p> <p>viii. Blinkers</p> <p>ix. Flashers</p> <p>x. Electronic flasher circuit</p> <p>xi. Instrument panel lights</p> <p>xii. Body interior illumination</p> <p>xiii. Adaptive lighting system.</p> <p>5.1.1.3 Reflectors: Parabolic, Bifocal, Homifocal, poly-ellipsoidal</p> <p>5.1.1.4 Gauges: Fuel, Temperature, Oil pressure etc.</p> <p>5.1.1.5 Accessories: Electric horn, wipers, Fuel pump, Power operated windows, Vehicle Immobilizers, Central locking circuit.</p>	06

	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 two 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	06
	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.	
2	Engine Tests	08
	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.	
3	Vehicle Level Tests	08
	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.	
4	Component Level Tests	06
	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.	
5	Vehicle Crash Tests	06
	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)	
6	xEV Test	06
	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.	

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 Heinmann, 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, CO ₂ , NO _x & 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
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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 Danniell, 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 trailer 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 zerodepreciation 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 5.1 Scheduling of goods transport 5.2 Management Information System (MIS) in passenger / goods transport operation 5.3 Storage & 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 - Government 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

muquestionpapers.com

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 RoadSurface -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:	06
	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.	
2	Introduction to control systems: Classification of the control system. Open-loop and closed-loop systems.	08
	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	
3	Stability analysis: Introduction to concepts of stability, Concept of S-plane, The Routh criteria for stability	12
	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	
4	Powertrain Control Systems:	04
	Air-Fuel Ratio Control	
	Control of Spark Timing	
	Idle-Speed Control	
	Transmission Control	
5	Vehicle Control Systems:	06
	Cruise and Headway Control	
	Antilock Brake and Traction-Control Systems	
	Vehicle Stability Control	
	Four-Wheel Steering	
	Active Suspensions	

6	<p>Intelligent Transportation Systems:</p> <p>Overview of Intelligent Transportation Systems:</p> <p>Advanced Traffic Management Systems Advanced Traveler Information Systems Commercial Vehicle Operations Advanced Vehicle-Control Systems</p> <p>Longitudinal Motion Control:</p> <p>Site-Specific Information Platooning String Stability</p> <p>Automated Steering and Lateral Control:</p> <p>Lane Sensing Automated Lane-Following Control Automated Lane-Change Control</p>	06
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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 Cakmakçı 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	
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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, Fault 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-West Press (P) Ltd., 1985.
2. Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill.
3. B.S. Dhillon, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980.
4. P.D.T. Connor, "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

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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	<p>Introduction to Operations Research: Introduction, Structure of the Mathematical Model, Limitations of Operations Research</p> <p>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</p> <p>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.</p> <p>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</p> <p>Integer Programming Problem: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.</p>	14
02	<p>Queuing models: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population</p>	05
03	<p>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</p>	05
04	<p>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.</p>	05
05	<p>Game Theory. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games</p>	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. Kenneth 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. Yongg – 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 and Practice, 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

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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	Basics of Computers- Desktop/Laptop operations	
1.2	Microsoft Office	
1.2.1	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.)	
1.2.2	MS Excel- Assignment to Create and tabulate a spreadsheet (Excel-data analysis, charts, pivot tables, VBA, etc.)	
1.2.3	MS- Power point- Assignment to design and use a Presentation Software (MSPPT, Prezi, etc. – Presentation design, templates, custom slides, animation, graphs, charts, troubleshooting etc.)	
1.2.4	MS Outlook (Navigation, archiving, tasks distribution, filters, scheduling etc.)	
1.3	G-Suite (Gmail, G-Meet, Calendar, Sheets, Docs, Slides etc.)	
1.4	An introduction to the typesetting package LATEX.	
2	Aptitude and Logical Reasoning	2
2.1	Aptitude – Aptitude training, types of questions, mock tests	
2.2	Logical Reasoning – Verbal and Non-verbal reasoning, Types of questions, Mock tests	
3	Developing Metacognitive skills	2
3.1	Task orientation and Goal setting (can be based on Final year Project):	
3.2	Creativity and Problem-solving	
4	Collaborative Techniques:Team building skills	1
4.1	Activities on Team building	
4.2	Case studies on Leadership, Decision making and Team building	

5	GD – PI	2
5.1	Group Discussion – Factual, Strategic, Abstract, Case study, Picture based	
5.2	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.

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

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

Books recommended/References/ Resources:

- Meenakshi Raman, Prakash Singh. *Business Communication*, Oxford University Press, 2012
- Claudyne Wilder. *The Presentations Kit: 10 steps for Selling Your Ideas*, John Wiley & Sons, 1994.
- Lesikar, Flatley. *Basic Business Communication: Skills for Empowering the Internet Generation*, Tata McGraw Hill, 2008.
- Flavell, J. H. *Cognitive development: Past, present, and future*. 1992.
- Thorpe, Edgar and Showick Thorpe. *Objective English*, Pearson, 2013. (7th edition Amazon)
- Thorpe, Edgar. *Test of Reasoning: for All Competitive Examination*. 7th edition., Amazon
- Sinha, Nishit K., *Reasoning*, Pearson.
- Aggarwal, R.S., *A Modern Approach to Logical Reasoning*, S. Chand.
- Weblinks - <https://cambridge-community.org.uk/professional-development/gswmeta/index.html>
- [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](https://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. Term work evaluation:

Term work evaluation for Project 1 should be conducted by Internal examiner on continuous basis throughout 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

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Course Code	Course Name	Credits
AEC 801	Hybrid and Electric Vehicles	03

Course Objectives:

1. To familiarize with the different sustainable transportations available.
2. To familiarize with the basic concepts of hybrid, electric and fuel cell vehicles.
3. To acquaint with various aspects of hybrid and electric drivetrain.
4. To study various challenges associated with fuel cell technology.

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

1. Explain the need and evolution of electric & hybrid electric vehicles.
2. Identify and Demonstrate the working principle of different EV/HEV's configurations.
3. Compare various energy sources for EV's and HEV's.
4. Design drivetrain parameters for EV's and HEV's.
5. Elaborate the use of fuel cells in vehicular applications.
6. Understand the need of BMS and chargers in EV's.

Module	Content	Hrs.
1	<p>Introduction</p> <ul style="list-style-type: none"> • Environmental Impact • Air pollution • Global Warming • Petroleum Resources • Need for different transportation systems • History of Electric Vehicles, Hybrid Vehicles and Fuel Cell Vehicles • Well to Wheel Analysis • Initiatives by Government of India • Current scenario in EV/HEV • Need for Softwares related to EV modeling and testing 	03
2	<p>Electric Vehicles</p> <ul style="list-style-type: none"> • Drivetrain Configurations • Traction Motor characteristics • Tractive effort • Transmission requirement and • Vehicle Performance (Acceleration and Range) <p>EV Parameters</p> <ul style="list-style-type: none"> • Weight • Size • Force • Energy Consumed • Power 	10
3	<p>Hybrid Electric Vehicles Configurations</p> <ul style="list-style-type: none"> • Series • Parallel • Series-Parallel • Complex • Power flow control for above configurations <p>Couplings</p> <ul style="list-style-type: none"> • Torque Coupling • Speed coupling 	10

	<ul style="list-style-type: none"> • Combined Torque and speed coupling Design of Series and Parallel Hybrid drivetrain <ul style="list-style-type: none"> • Control strategies for series drivetrain • Control strategies for parallel hybrid drivetrain • Sizing of drivetrain parameters 	
4	Energy storage devices and Electric Motors <ul style="list-style-type: none"> • Batteries for EV's and HEV's-Lead Acid, Nickel Based and Lithium Ion Battery Chemistries • Ultra capacitors • Flywheels • Hybridization of Energy storage devices Concepts of Energy and Power <ul style="list-style-type: none"> • Specific Energy • Specific power • State of Charge, Depth of Discharge • Energy Efficiency • Electrochemical reactions • Voltages Motors for Electric Vehicles <ul style="list-style-type: none"> • DC Motors • Induction Motors • Switched Reluctance Motors(SRM) Regeneration <ul style="list-style-type: none"> • Energy consumption in braking • Brake systems for EV's and HEV's 	08
5	Fuel Cell Electric Vehicles Fundamentals <ul style="list-style-type: none"> • Operating principle • Electrode potential • Current voltage curve Fuel Cell Technologies <ul style="list-style-type: none"> • PEMFC • AFC • PAFC • MCFC • SOFC • DMFC • Hydrogen storage and Production • Fuel cell hybrid electric drive train-Configuration, control strategy 	06
6	Battery Management System and Chargers for EV's <ul style="list-style-type: none"> • Need of Battery management systems(BMS) in Electric Vehicles • Basics of Electric Vehicles Chargers-AC and DC Chargers • Battery Swapping Technologies • V2G and G2V concepts 	05

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 based on content covered in Theory and Laboratory Classes.
- 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) based on content covered in Theory and Laboratory Classes.
- iv. Only four questions need to be solved.

Text Books:

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

References:

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

Links for NPTEL/Swayam Courses:

1. <https://nptel.ac.in/courses/108/103/108103009/>

Course Code	Name of the Course	Credits
AEDLO8051	Automotive Materials	03

Course Objectives:

1. To comprehend the need to make automobiles lighter
2. To improve efficiency of automobiles through proper selection of materials and processing methods
3. To understand the importance of crashworthiness through advanced materials
4. To know the recent trends in materials and related technologies for various automotive parts and components

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

1. Identify the need for new alternative materials that are lighter to improve efficiency of automobiles.
2. Apply different processing routes for composites and plastics for making exterior and interior parts of automobiles.
3. Estimate the role of different classes of materials for various automotive systems
4. Suggest technologies to make automotive glasses lighter and tougher.
5. Develop advanced materials/biocomposites for specific automobile applications
6. To Comprehend and use Ashby charts for material selection

Module	Content	Hrs.
1	<p>Conventional Materials, their processing and the need for new materials</p> <ul style="list-style-type: none"> • Body design concepts with a focus on light weighting • Considerations in the use of Steel-Shift towards Aluminium and magnesium alloys for car bodies. • Evolution of casting technology, extrusion and sheet forming for making of car bodies. • Light weighting of vehicles with emphasis on material selection. • Need to shift to new materials and risks in adopting new materials 	7
2	<p>Materials for Interior</p> <ul style="list-style-type: none"> • Various plastics and composites used in making dashboards and their processing. • Materials used in Flooring, dashboard silencer, headliner, door trim, baffles, rear shelf and their functionality • Airbag materials used and their property requirements • Seat belt requirements and materials 	6
3	<p>Materials for Exterior</p> <ul style="list-style-type: none"> • Application of various new materials including various types of composites in making of car bodies, and the processing method/s used to shape these parts. • Reinforcement of fibres in composites - Woven fabrics - Non woven random mats - Various types of fibres in PMC processes - Hand lay-up processes - Spray up processes - • Compression moulding - Resin transfer moulding-pultrusion- Filament winding - Injection moulding-Vacuum Infusion Processing. Fibre reinforced plastics(FRP), Glass Fibre reinforced plastics (GFRP) and Trends for biocomposites in automobiles 	9

4	Glasses and Paints in Automobiles <ul style="list-style-type: none"> • Introduction to Automotive glasses, properties and composition. Various approaches in tempering of glass for improved toughness and shatter resistance. Trends in windshield glass with Gorilla glass. • Paint technology: basic concepts and sequences of application and current trends Use of nanoparticles in paints to make self cleaning, scratch resistant paints, nano coatings for corrosion resistance 	6
5	Smart material and systems in Automobiles <ul style="list-style-type: none"> • Relevance of smart materials in the automobile industry, • Use of shape memory alloys, Solid state SMA engine, Electro or magnetorheological engine mounts, Electrorheological (ER) and magnetorheological (MR) fluids in dampers, Shape Memory tumble flaps, Semi-active vibration damping systems, Electrochromic rear-view mirrors • Fuel Injector materials: high melting point materials-Use of ceramics as fuel injectors, Sintered Friction materials for making disc brake pads 	6
6	Selection of Materials <ul style="list-style-type: none"> • Introduction to Ashby charts for making a good selection of materials for different systems in automobiles. • Case studies on materials developments by Original Equipment Manufacturers (OEMs) of Automobiles 	5

Theory Examinations:

Internal Assessment for 20 marks:

Consisting of 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.

- Question paper will comprise of total six questions.
- All questions carry equal marks.
- 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)
- Only four questions need to be solved.

Text Books:

- Mathews F.L. and Rawlings R.D., "Composite materials: Engineering and Science", Chapman and Hall, London, England, 1st edition, 1994
- Budinski and Budinski," Engineering Materials Properties and Selection", Prentice Hall India,2009

References:

1. Automotive Engineering: Lightweight, Functional, and Novel Materials-Brian Cantor, P. Grant, C. Johnston, CRC Press, Taylor and Francis Group,2008
2. Advanced Materials in Automotive Engineering, Jason Rowe, Woodhead Publishing,2012
3. The Science and Technology of Materials in Automotive Engines - Hiroshi Yamagata, Woodhead Publishing,2012.
4. Lightweight and Sustainable Materials for Automotive Applications-Omar Faruk, Jimi Tjong, Mohini Sain, CRC press,2017
5. Analysis and Performance of fiber composites- Bhagwan D Agarwal, Lawrence J Broutman, K Chandrashekhara, Wiley, 3rd edition, 2006

NPTEL Links:

<https://nptel.ac.in/courses/112/107/112107221/>

<https://nptel.ac.in/courses/112/104/112104122/>

<https://nptel.ac.in/courses/112/107/112107083/>

<https://www.youtube.com/watch?v=iNVmoSDoufk>

Course Code	Course Name	Credits
AEDLO8052	Automotive Embedded Systems	03

Course Objectives:

1. To provide broad introduction to automotive embedded systems.
2. To understand communication techniques.
3. To understand fundamentals of real time operating system.
4. To study concepts involved in embedded hardware for systems realization.
5. To apply hardware and software knowledge to develop automotive embedded system applications according to requirement and constraints.
6. To provide a comprehensive overview about existing and future automotive electronic systems.

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

1. Illustrate basic concepts of embedded systems.
2. Interpret the various types of communication protocols used in Automobiles.
3. Interpret features of Real Time Operating System.
4. Identify various hardware modules used in embedded systems.
5. Recognize Tools for software development from Automobile viewpoint.
6. Comprehend embedded systems used in Automobiles using different case studies.

Module	Content	Hrs.
1	Introduction to Embedded Systems: - Definition of Embedded System, Embedded Systems Vs General Computing Systems, Overview of Embedded System Architecture with function of each block in brief, Memory, Sensors (resistive, optical, position, thermal) and Actuators (solenoid valves, relay/switch, opto-couplers), Harvard and Von Neumann architecture, RISC and CISC processors, Categories of embedded systems, Quality attributes (Design Metric) of embedded system and Major Application Areas.	06
2	Embedded Communication: Modes of data communication: serial, parallel, synchronous and asynchronous communication. Serial communication protocols: I2C, CAN, USB, Parallel communication protocols: ISA, PCI. A Review of Embedded Automotive Protocols, CAN Protocol: Introduction, Features, Networks Organization, CAN Frame Types (Standard CAN Frame and Extended CAN Frame), Bus Arbitration and Different message types in CAN. Flex Ray Protocol: Introduction, Features, Bus Level, Networks Organization, Flex Ray Frame.	12
3	Real Time Operating Systems: Basics concepts and its types i.e general and real time operating system, Function of RTOS: Task management and various scheduling algorithms, Features of RTOS: watchdog timer and semaphore, Deadlock.	06
4	Hardware Modules: MC9S12XD family features, Modes of operation, Functional block diagram overview, Programming model Map Overview, Pulse width Modulator (PWM) and on chip ADC serial communication protocol: SCI, SPI, I2C, CAN.	08
5	Software Developments Tools: Introduction to HCS12XDT512 Student learning kit & PBMCU (Project board), Introduction to code warrior IDE: editing, debugging simulating simple programs. Flashing code into HCS12XDT512 SLK board and testing.	04

6	Integration of Software and Hardware: Downloading the software from Host Machine to target Machine, Implementing Application Prototype: Power windows and automotive lighting system. Case Study on Adaptive Cruise Control, Anti-lock brake system and Air Bag system in Automobiles.	04
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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.

- i. Question paper will comprise of total six questions, each carrying 20 marks.
- ii. Question 1 will be compulsory, based on the entire syllabus.
- iii. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 4 then part (b) will be from any module other than module 4) covering contents of the curriculum covered in Theory.
- iv. Only Four questions need to be solved.

Text Books:

1. Shibu. K.V,” Introduction to Embedded Systems”, Mc Graw Hill, 2nd edition.
2. K.V.K.K. Prasad, “Embedded Real Time Systems: Concepts, Design & Programming”, Dreamtech Publication.
3. Raj Kamal,” Embedded Systems Architecture, Programming and design”, Tata MCgraw-Hill Publication.
4. Frank Vahid, and Tony Givargis, “Embedded System Design: A unified Hardware/Software Introduction”, Wiley Publication.

Reference Books:

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

Links for Online NPTEL/SWAYAM Courses:

- <https://nptel.ac.in/courses/108/105/108105057/>
<https://nptel.ac.in/courses/106/105/106105193/>

Course Code	Course Name	Credits
AEDLO 8053	Engine and Battery Management Systems	03

Course Objectives:

1. To introduce the importance of the Engine Management system in controlling exhaust emissions.
2. To introduce students to the role of Battery Management Systems in Hybrid and Electric vehicles.
3. To introduce students to different requirements, architectures, and Fault detection parameters of BMS.

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

1. Understand importance of Engine Management systems in SI Engines Exhaust emissions
2. Understand importance of Engine Management systems in CI Engines Exhaust emissions
3. Explain Battery fundamentals and Draw various BMS Architectures
4. Identify the requirements of BMS
5. Interpret the concept associated with battery charging / discharging process
6. Comprehend various Fault occurrences in Batteries.

Module	Content	Hrs.
1	<p>Introduction to Engine Management System and Battery Management System</p> <ul style="list-style-type: none"> • ECU and VCU- Function and Components <p>Emission Controls in SI Engine</p> <ul style="list-style-type: none"> • Exhaust Emissions • Catalytic emission control, • Emission control legislation • Exhaust gas measuring techniques, • On board Emission Diagnosis. • ECU development: Hardware, Function and Software development 	07
2	<p>Emission Control in CI Engine</p> <ul style="list-style-type: none"> • Minimizing Emissions inside Engine • Exhaust Gas treatments • Electronic Diesel Control(EDC)-inline fuel injection pumps • Unit Injector system for Passenger systems • Common rail system for Passenger systems • Fuel Injection control, Lamda sensor, Torque control systems for Passengers cars. 	06
3	<p>Battery Fundamentals</p> <ul style="list-style-type: none"> • Battery Operation • Construction • Chemistry <p>BMS Architectures</p> <ul style="list-style-type: none"> • Monolithic • Distributed • Semi Distributed 	06
4	<p>BMS Requirements</p> <ul style="list-style-type: none"> • Battery pack topology • BMS design requirements 	

	<p>Battery pack sensing</p> <ul style="list-style-type: none"> • Voltage • Temperature • Current, • High Voltage contactor control • Isolation sensing • Thermal control • Protection, Charge Control <p>Communication to CAN</p> <ul style="list-style-type: none"> • State of charge estimation • Energy estimation • Power estimation • Diagnostics <p>Battery Models</p> <ul style="list-style-type: none"> • Thevenin Equivalent Circuit, • Hysteresis • Coulombic efficiency, • Self discharge modeling 	10
5	<p>Battery state of charge estimation (SOC)</p> <ul style="list-style-type: none"> • Voltage-based methods to estimate SOC • Model-based state estimation <p>Battery Health Estimation</p> <ul style="list-style-type: none"> • Lithium-ion aging • Negative electrode and Positive electrode <p>Cell Balancing</p> <ul style="list-style-type: none"> • Causes of imbalance • Circuits for balancing 	08
6	<p>Fault Detection</p> <ul style="list-style-type: none"> • Over voltage, • Over temperature • Over current • Battery imbalance • Excessive Self discharge • Internal Short circuit detection • Lithium plating detection • Venting detection • Excessive capacity loss 	05

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. Gasoline Engine Management:Systems and Components.Konrad Reif
Ed.Bosch,SpringerVieweg,ISBN 978-3-658-03963-9
2. Diesel Engine Management:Systems and Components.Konrad Reif
Ed.Bosch,SpringerVieweg,ISBN 978-3-658-03980-6
3. A systems Approach to Lithium Ion Battery Management,PhillipWeicker,ISBN 13: 978-1-60807-659-8

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Course Code	Course Name	Credits
AEDLO8061	Product Design and Development	03

Course Objectives:

1. To understand the basic concepts of engineering design and product design & development, focusing on the front-end processes.
2. To demonstrate an understanding of the overview of all the product design & development processes.
3. To demonstrate knowledge of concept generation and the selection of tools.
4. To study the applicability of product design & development in industrial applications.

Course Outcomes: Upon satisfactory completion of this course, the student will be able to:

1. Describe the process of product design & development.
2. Employ engineering, scientific, and mathematical principles to develop and execute a design project from a concept to a finished product.
3. Create 3D solid models of mechanical components using CAD software.
4. Demonstrate individual skills using selected manufacturing techniques such as rapid prototyping.
5. Fabricate an electromechanical assembly of a product from engineering drawings.
6. Work collaboratively in a team to complete a design project.
7. Effectively communicate the results of projects and other assignments both in a written and oral format.

Module	Details	Hours
01	Need for developing products, The importance of Engineering and Industrial design, The design process, Relevance of product lifecycle issues in design, Societal considerations in Engineering and Industrial Design, Generic product development process, Various phases of product development, Planning for products, Establishing markets-market segments-relevance of market research.	7
02	The design processes, Descriptive and prescriptive design models, Concept development & evaluation, Pugh's total design activity model, Concept generation and selection method, Embodiment design, Product architecture, and Steps in developing product architecture.	7
03	Identifying customer needs, Voice of Customer (VoC), Customer populations, Hierarchy of human needs, Need gathering methods, Establishing engineering characteristics, Competitive benchmarking, Quality Function Deployment (QFD), House of Quality (HoQ), Product design specification, Development of product design with specifications using QFD, Relevant case studies.	7
04	Creative thinking, Creativity and problem-solving methods, Creative thinking methods, Brainstorming technique, Gordon technique, Check listing technique, Synectic technique, Morphological Analysis, and Attribute Listing technique. Generating design concepts, Systematic methods of designing.	7

05	Industrial design, Basic forms & elements, Integrating basic forms & elements such as balance, rhythm, proportion, The golden rule of proportions, human factors, and design, User-friendly design, Design for serviceability, Design for environment.	7
06	Concept of Design for Manufacturing and Assembly (DFMA). Role of computers in product design and manufacturing process, Prototyping techniques such as Stereolithography (SLA), Selective laser sintering (SLS), Fused disposition Modelling (FDM), Laminated object manufacturing (LOM), 3-D printing, and Ballistic Particle Manufacturing (BPM).	7

Assessment:

Internal Assessment for 20 marks: Consisting of **Two Compulsory Class Tests**

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

End Semester Examination:

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

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

Text Books:

1. Anita Goyal, Karl T Ulrich, Steven D Eppinger, "Product Design and Development," 4th Edition, 2009, Tata McGraw-Hill Education, ISBN-10-007-14679-9.
2. Kevin Otto, Kristin Wood, "Product Design," Indian Reprint 2004, Pearson Education, ISBN9788177588217.

Reference Books:

1. Clive L.Dym, Patrick Little, "Engineering Design: A Project-based Introduction," 3rd Edition, John Wiley & Sons, 2009, ISBN978-0-470-22596-7.
2. George E. Dieter, Linda C.Schmidt, "Engineering Design," 4th Edition, McGraw-Hill International Edition, 2009, ISBN978-007-127189-9.
3. Yousef Haik, T. M. M. Shahin, "Engineering Design Process," 2nd Edition Reprint, Cengage Learning, 2010, ISBN 0495668141

Course Code	Course Name	Credits
AEDLO8062	Design for X	03

Course Objectives:

1. To acquaint the learners with the concept of design for manufacturing and assembly
2. To acquaint the learners with the concept of design for reliability and maintainability
3. To study the product development economics

Course Outcomes: learner will able to...

1. Apply design concepts and guidelines for manufacturing and assembly.
2. Demonstrate the concept of value analysis and its relevance.
3. Understand the economics of product development
4. Apply design concepts for reliability and maintainability

Module	Details	Hours
1.	DESIGN FOR MANUFACTURE: General design principles for manufacturability-strength and mechanical factors, mechanisms selection, evaluation method, Process capability-Feature tolerances-Geometric tolerances-Assembly limits—Datum features-Tolerance stacks	5
2.	DESIGN FOR ASSEMBLY: Assembly processes-Handling and insertion process-Manual, automatic and robotic assembly-Cost of Assembly-Number of Parts-DFA guidelines	8
3.	VALUE ENGINEERING: Introduction to Value Engineering and Value Analysis, Value types-functional—operational—aesthetic, Value engineering in product design; Advantages, Applications in product design, Problem identification and selection, Analysis of functions, Anatomy of function. Primary versus secondary versus tertiary/unnecessary functions, Functional analysis: Functional Analysis System Technique (FAST), Case studies.	8
4.	PRODUCT DEVELOPMENT ECONOMICS: Elements of Economics Analysis-Quantitative and qualitative analysis-Economic Analysis Process-Estimating magnitude and time of future cash inflows and outflows-Sensitivityanalysis-Projecttrade-offs-Trade-offsrules-Limitationofquantitativeanalysis-Influenceofqualitativefactorsonprojectsuccess	8
5.	CONCEPT OF RELIABILITY: Introduction: The study of Reliability and Maintainability, Concepts, Terms and Definitions, Applications, The Failure Distribution: The reliability Function, Mean Time to Failure, Hazard Rate Function, Bathtub Curve, Conditional Reliability	5
6.	MAINTAINABILITY: Analysis of down time, Report Time Distribution, Stochastic Point Processes, Reliability under Preventive Maintenance, State-Dependent System with Repair, Design for Maintainability.	5

Assessment:

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests

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

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

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

References:

1. HarryPeck, DesigningforManufacture, PitmanPublications,1983.
2. GeorgeEDieter, EngineeringDesign, McGraw-HillInt Editions,2000
3. S.S.Iyer, ValueEngineering, NewAgeInternational, 2000
4. CharlesE.Ebeling, An Introduction to Reliability and Maintainability Engineering, TMH2000.

Course Code	Course Name	Credits
AEDLO8063	Total Quality Management	03

Course Objectives:

1. To understand the importance of Quality Management and principles of TQM
2. To understand seven basic QC tools and advanced QM tools
3. To understand the concept of Statistical Quality Control
4. To understand the concept of Continuous Improvement and TQM implementation
5. To understand different Quality Systems and Quality Standards
6. To understand the future trends in TQM and TQM strategies

Course Outcomes: The students will be able to use the tools and techniques of TQM in the manufacturing and service sectors.

1. To apply QM and principles of TQM in organizational development process.
2. To apply the QC & QM tools in process improvement.
3. To apply SQC techniques to improve process quality.
4. To apply Six Sigma project in TQM Implementation
5. To apply QMS and Certification for Quality Accreditation
6. To apply the advanced tools for Quality Sustainability.

Module	Details	Hours
01	<p>Introduction to Quality Management :</p> <p>A) Definitions of Quality, product quality and service quality; the evolution of quality; need for Quality Management, Quality statements and Policy, Customer orientation & satisfaction, Customer complaints, customer retention; Supplier partnership, Supplier rating & selection, CSI, Costs of Quality, Prevention, appraisal and failure aspects, Use of COQ for improving quality and performance, Designing for quality, Quality of design, Quality of conformance.</p> <p>B) Basic concepts of TQM, TQM framework, Contributions of Deming, Juran and Crosby, Juran Trilogy , PDCA Cycle, Barriers to TQM; TQM principles; Strategic Quality Planning; Quality councils; employee involvement, motivation; Empowerment; Team and Teamwork; recognition and reward, performance appraisal.</p>	08
02	<p>QC Tools:</p> <p>A) Seven QC Tools: Check Sheet, Histogram, Pareto Chart, Fishbone Diagram, Run Charts, Scatter Diagram, Process Flow Chart.</p> <p>B) Seven QM Tools: Program Decision Process Chart, Tree Diagram, Affinity Diagram, Prioritization Matrix, etc. Bench Marking Types – Process, Product, Quality Improvement Tools: Why-Why Analysis, Root Cause Analysis, Poka Yoke (Mistake Proofing)</p>	06
03	<p>Statistical Quality Control: 100% Inspection versus Sampling Inspection, Reasons for SQC.</p> <p>A) Acceptance Sampling: Concept of Producer Risk and Consumers Risk.</p>	06

	<p>Operating Characteristics Curve. Sampling Plan – Single Sampling Plan versus Double Sampling Plan. Design Sampling Plan on the basis of MIL, ASQ Standards.</p> <p>B) Statistical Process Control: Variations – Concept, Causes – Random & Assignable, Difference – Process in Control versus Process is Capable, Control Charts, X-Bar, R, P and C Charts, Process Capability (Cp) & Process Capability Index (Cpk), Sigma Limits. Applications of Control Charts in Mass Production, Process Production.</p>	
04	<p>A) Continuous Improvement: Quality Circles, Quality Function Development (QFD), Taguchi quality loss function, Parameter Design, Robust Design; TPM-concepts, 5S, Kaizen, FMEA- stages, Zero Defect.</p> <p>B) TQM Implementation: Manufacturing and Service sectors, Introduction to Six Sigma: Definition, Concept, Methodology. Six Sigma Approaches – Design for Six Sigma (DFSS) Approach & DMAIC Approach, Six Sigma Tools: Applications to manufacturing and service sector including IT, ITeS, and E Com.</p>	08
05	<p>Quality Management System & Certification:</p> <p>A) QMS: Elements and documentation, Quality auditing, Necessity for Certification & Certification Process, Benefits of Certification. Certifying Bodies & Accreditation Agencies, ISO 9000-2015 (5th Edition), Introduction to TS16949: Technical Specifications, QS9000, ISO14000- concepts, requirements and benefits. Case studies of TQM implementation in manufacturing and service sectors including IT and Environmental management systems- ISO 14000 Series Standards, Integration of ISO 14000 with ISO 9000.</p> <p>B) Quality Awards: Malcom Baldrige National Quality Award and Rajiv Gandhi National Quality award.</p>	06
06	<p>Future Trends in TQM: Strategic approach to leadership, Customer centric endeavors, Involvement & empowerment of all employees / stake holders, Decision making based on real time facts, Win-Win policy with suppliers, New paradigms of Green & sustainability, TQM beyond Manufacturing i.e. Healthcare, Education, Finance. Accountability through new tools and technologies, Quality Analytics.</p>	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**

Text Books:

1. Besterfield D.H. et al.: Total quality Management, 3rd Edition, Pearson Education Asia, 2006.
2. Janakiraman B. and Gopal R.K.: Total Quality Management, Prentice Hall India, 2006.
3. Poornima M. Charantimath: Total Quality Management, 2nd Edition, Pearson Education Asia, 2006.
4. N. Logothetis: Managing for Total Quality, 6th Edition, Prentice Hall of India Pvt. Ltd. 2003.
5. Suganthi L. and Samuel A.: Total Quality Management, Prentice Hall India, 2006.
6. Evans J.R. and Lindsay W.M.: The Management and Control of Quality, 8th Edition, 1st Indian Edition, Cengage Learning, 2012.

Reference Books:

1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 6th Edition, South-Western (Thomson Learning), 2005.
2. Oakland, J.S. "TQM – Text with Cases", Butterworth – Heinemann Ltd., Oxford, 3rd Edition, 2003.

Course Code	Course Name	Credits
ILO 8021	Project Management	03

Course Objectives:

1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Course Outcomes: Learner will be able to...

1. Apply selection criteria and select an appropriate project from different options.
2. Write work break down structure for a project and develop a schedule based on it.
3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.
4. Use Earned value technique and determine & predict status of the project.
5. Capture lessons learned during project phases and document them for future reference

Module	Detailed Contents	Hrs
01	Project Management Foundation: Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager, Negotiations and resolving conflicts, Project management in various organization structures, PM knowledge areas as per Project Management Institute (PMI)	5
02	Initiating Projects: How to get a project started, selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	6
03	Project Planning and Scheduling: Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart, Introduction to Project Management Information System (PMIS).	8
04	Planning Projects: Crashing project time, Resource loading and levelling, Goldratt's critical chain, Project Stakeholders and Communication plan Risk Management in projects: Risk management planning, Risk identification and risk register, Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	6
05	5.1 Executing Projects: Planning monitoring and controlling cycle, Information needs and reporting, engaging with all stakeholders of the projects, Team management,	8

	<p>communication and project meetings</p> <p>5.2 Monitoring and Controlling Projects: Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep, Project audit</p> <p>5.3 Project Contracting Project procurement management, contracting and outsourcing,</p>	
06	<p>6.1 Project Leadership and Ethics: Introduction to project leadership, ethics in projects, Multicultural and virtual projects</p> <p>6.2 Closing the Project: Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.</p>	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. Project Management: A managerial approach, Jack Meredith & Samuel Mantel, 7th Edition, Wiley India
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Project Management, Gido Clements, Cengage Learning
4. Project Management, Gopalan, Wiley India
5. Project Management, Dennis Lock, 9th Edition, Gower Publishing England

Course Code	Course Name	Credits
ILO 8022	Finance Management	03

Course Objectives:

1. Overview of Indian financial system, instruments and market
2. Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
3. Knowledge about sources of finance, capital structure, dividend policy

Course Outcomes: Learner will be able to...

1. Understand Indian finance system and corporate finance
2. Take investment, finance as well as dividend decisions

Module	Detailed Contents	Hrs
01	<p>Overview of Indian Financial System: Characteristics, Components and Functions of Financial System.</p> <p>Financial Instruments: Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills.</p> <p>Financial Markets: Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market</p> <p>Financial Institutions: Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges</p>	06
02	<p>Concepts of Returns and Risks: Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio.</p> <p>Time Value of Money: Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.</p>	06
03	<p>Overview of Corporate Finance: Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision.</p> <p>Financial Ratio Analysis: Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.</p>	09
04	<p>Capital Budgeting: Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR)</p>	10

	Working Capital Management: Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	
05	Sources of Finance: Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. Capital Structure: Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	05
06	Dividend Policy: Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	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. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Course Code	Course Name	Credits
ILO8023	Entrepreneurship Development and Management	03

Course Objectives:

1. To acquaint with entrepreneurship and management of business
2. Understand Indian environment for entrepreneurship
3. Idea of EDP, MSME

Course Outcomes: Learner will be able to...

1. Understand the concept of business plan and ownerships
2. Interpret key regulations and legal aspects of entrepreneurship in India
3. Understand government policies for entrepreneurs

Module	Detailed Contents	Hrs
01	Overview Of Entrepreneurship: Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
02	Business Plans And Importance Of Capital To Entrepreneurship: Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur Entrepreneurship And Business Development: Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
03	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	05
04	Indian Environment for Entrepreneurship: key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	08
05	Effective Management of Business: Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	08
06	Achieving Success In The Small Business: Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	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. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Course Code	Course Name	Credits
ILO8024	Human Resource Management	03

Course Objectives:

1. To introduce the students with basic concepts, techniques and practices of the human resource management
2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations
3. To familiarize the students about the latest developments, trends & different aspects of HRM
4. To acquaint the student with the importance of inter-personal & inter-group behavioural skills in an organizational setting required for future stable engineers, leaders and managers

Course Outcomes: Learner will be able to...

1. Understand the concepts, aspects, techniques and practices of the human resource management.
2. Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
3. Gain knowledge about the latest developments and trends in HRM.
4. Apply the knowledge of behavioural skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Module	Detailed Contents	Hrs
01	<p>Introduction to HR</p> <ul style="list-style-type: none"> • Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions • Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues 	5
02	<p>Organizational Behaviour (OB)</p> <ul style="list-style-type: none"> • Introduction to OB Origin, Nature and Scope of Organizational Behaviour, Relevance to Organizational Effectiveness and Contemporary issues • Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness • Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behaviour • Motivation: Theories of Motivation and their Applications for Behavioural Change (Maslow, Herzberg, McGregor); • Group Behaviour and Group Dynamics: Work groups formal and informal groups and stages of group development, Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. • Case study 	7
03	<p>Organizational Structure & Design</p> <ul style="list-style-type: none"> • Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. • Leadership: Concepts and skills of leadership, Leadership and managerial roles, 	6

	<p>Leadership styles and contemporary issues in leadership.</p> <ul style="list-style-type: none"> • Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies. 	
04	<p>Human resource Planning</p> <ul style="list-style-type: none"> • Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale • Performance Appraisal Systems: Traditional & modern methods, Performance Counselling, Career Planning • Training & Development: Identification of Training Needs, Training Methods 	5
05	<p>Emerging Trends in HR</p> <ul style="list-style-type: none"> • Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development, managing processes & transformation in HR. Organizational Change, Culture, Environment • Cross Cultural Leadership and Decision Making: Cross Cultural Communication and diversity at work, Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation 	6
06	<p>HR & MIS: Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries)</p> <p>Strategic HRM: Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals</p> <p>Labor Laws & Industrial Relations: Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act</p>	10

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. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15th edition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Course Code	Course Name	Credits
ILO8025	Professional Ethics and Corporate Social Responsibility	03

Course Objectives:

1. To understand professional ethics in business
2. To recognized corporate social responsibility

Course Outcomes: Learner will be able to...

1. Understand rights and duties of business
2. Distinguish different aspects of corporate social responsibility
3. Demonstrate professional ethics
4. Understand legal aspects of corporate social responsibility

Module	Detailed Contents	Hrs
01	Professional Ethics and Business: The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
02	Professional Ethics in the Marketplace: Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy Professional Ethics and the Environment: Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
03	Professional Ethics of Consumer Protection: Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy Professional Ethics of Job Discrimination: Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
04	Introduction to Corporate Social Responsibility: Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	05
05	Corporate Social Responsibility: Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	08
06	Corporate Social Responsibility in Globalizing India: Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	08

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. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by Bidyut Chakrabarty, Routledge, New Delhi.

Course Code	Course Name	Credits
ILO8026	Research Methodology	03

Course Objectives:

1. To understand Research and Research Process
2. To acquaint students with identifying problems for research and develop research strategies
3. To familiarize students with the techniques of data collection, analysis of data and interpretation

Course Outcomes: Learner will be able to...

1. Prepare a preliminary research design for projects in their subject matter areas
2. Accurately collect, analyze and report data
3. Present complex data or situations clearly
4. Review and analyze research findings

Module	Detailed Contents	Hrs
01	Introduction and Basic Research Concepts 1.1 Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology 1.2 Need of Research in Business and Social Sciences 1.3 Objectives of Research 1.4 Issues and Problems in Research 1.5 Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical	09
02	Types of Research 2.1. Basic Research 2.2. Applied Research 2.3. Descriptive Research 2.4. Analytical Research 2.5. Empirical Research 2.6 Qualitative and Quantitative Approaches	07
03	Research Design and Sample Design 3.1 Research Design – Meaning, Types and Significance 3.2 Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	07
04	Research Methodology 4.1 Meaning of Research Methodology 4.2. Stages in Scientific Research Process: a. Identification and Selection of Research Problem b. Formulation of Research Problem c. Review of Literature d. Formulation of Hypothesis e. Formulation of research Design f. Sample Design g. Data Collection h. Data Analysis i. Hypothesis testing and Interpretation of Data j. Preparation of Research Report	08

05	Formulating Research Problem 5.1 Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	04
06	Outcome of Research 6.1 Preparation of the report on conclusion reached 6.2 Validity Testing & Ethical Issues 6.3 Suggestions and Recommendation	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. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nded), Singapore, Pearson Education

Course Code	Course Name	Credits
ILO8027	IPR and Patenting	03

Course Objectives:

1. To understand intellectual property rights protection system
2. To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
3. To get acquaintance with Patent search and patent filing procedure and applications

Course Outcomes: Learner will be able to...

1. understand Intellectual Property assets
2. assist individuals and organizations in capacity building
3. work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module	Detailed Contents	Hr
01	Introduction to Intellectual Property Rights (IPR): Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. Importance of IPR in Modern Global Economic Environment: Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
02	Enforcement of Intellectual Property Rights: Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement Indian Scenario of IPR: Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
03	Emerging Issues in IPR: Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	05
04	Basics of Patents: Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	07
05	Patent Rules: Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08
06	Procedure for Filing a Patent (National and International): Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication, Time frame and cost, Patent Licensing, Patent Infringement Patent databases: Important websites, Searching international databases	07

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.**

REFERENCE BOOKS:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Duffield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi, IPR: Drafting, Interpretation of Patent Specifications and Claims, New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers, IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press.

Course Code	Course Name	Credits
ILO8028	Digital Business Management	03

Course Objectives:

1. To familiarize with digital business concept
2. To acquaint with E-commerce
3. To give insights into E-business and its strategies

Course Outcomes: The learner will be able to

1. Identify drivers of digital business
2. Illustrate various approaches and techniques for E-business and management
3. Prepare E-business plan

Module	Detailed content	Hours
1	<p>Introduction to Digital Business- Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts</p> <p>Difference between physical economy and digital economy, Drivers of digital business- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services)</p> <p>Opportunities and Challenges in Digital Business,</p>	09
2	<p>Overview of E-Commerce E-Commerce- Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement</p> <p>B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals</p> <p>Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing</p> <p>EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC</p>	06
3	<p>Digital Business Support services: ERP as e –business backbone, knowledge Tope Apps, Information and referral system</p> <p>Application Development: Building Digital business Applications and Infrastructure</p>	06
4	<p>Managing E-Business-Managing Knowledge, Management skills for e-business, Managing Risks in e –business</p>	06

	Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	
5	E-Business Strategy -E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	04
6	Materializing e-business: From Idea to Realization -Business plan preparation Case Studies and presentations	08

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. A textbook on E-commerce, Er Arunrajan Mishra, Dr W K Sarwade, Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, Vinocenzo Morabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in: Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective- DoI:10.1787/9789264221796-enOECD Publishing

Course Code	Course Name	Credits
ILO8029	Environmental Management	03

Course Objectives:

1. Understand and identify environmental issues relevant to India and global concerns
2. Learn concepts of ecology
3. Familiarise environment related legislations

Course Outcomes: Learner will be able to...

1. Understand the concept of environmental management
2. Understand ecosystem and interdependence, food chain etc.
3. Understand and interpret environment related legislations

Module	Detailed Contents	Hrs
01	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities, Environmental issues relevant to India, Sustainable Development, the Energy scenario	10
02	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	06
03	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
04	Scope of Environment Management, Role and functions of Government as a planning and regulating agency Environment Quality Management and Corporate Environmental Responsibility	10
05	Total Quality Environmental Management, ISO-14000, EMS certification.	05
06	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	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. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management V Ramachandra and Vijay Kulkarni, TERI Press
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Macmillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

Course Code	Course Name	Credits
AEL801	Hybrid and Electric Vehicles	01

Course Objectives:

1. To familiarize with Battery Sizing Parameters.
2. To familiarize with Motor Sizing and Selection procedure.
3. To familiarize with EV simulation using software.
4. To improve the understanding with the help of Case Study.

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

1. Perform Battery Sizing calculations.
2. Perform Motor Sizing calculations.
3. Calculate Range and Acceleration Performance of Vehicle.
4. Write a Code to understand Vehicle Performance.
5. Demonstrate Powertrain Sizing for EV and HEV.
6. Understand Technical Specifications from Case Studies.

Term Work:

List of Experiments (any 6 of the following)

1. Battery Sizing calculations for 2W/3W/4W Electric Vehicles.
2. Motor Selection and Sizing Calculations for 2W/3W/4W Electric Vehicles.
3. Vehicle Performance Calculations for HEV and EV's.
4. Simulating Vehicle Performance Calculations in Matlab/Scilab.
5. Modeling Li-Ion Battery in Matlab/Simulink.
6. Modeling BMS in Matlab/Simulink.
7. Case Study on Hybrid Electric Vehicle Model.
8. Case Study on Electric Vehicle Model.

Assessment:

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

- 1) Experiments: **20 marks**
- 2) Attendance (Theory and Practical): **05 marks**

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

End Semester Practical/Oral Examination:

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

Practical performance **15 marks**

Oral **10 marks**

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

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

Course Code	Course Name	Credits
AEL802	Laboratory based on IoT	01

Course Objectives:

1. To learn microcontroller programming using 8051 and Arduino Development Board.
2. To acquaint with interfacing of simple peripheral devices to a microcontroller.
3. To acquaint with exchange of data using wireless communication.
4. To familiarize with logging the data on cloud platform.

Course Outcomes: Learner will able to...

1. Develop simple applications using microcontrollers 8051 and Arduino.
2. Interface simple peripheral devices to a Microcontroller.
3. Use microcontroller based embedded platforms in IoT.
4. Use wireless peripherals for exchange of data.
5. Setup cloud platform and log sensor data.

List of Experiments:

1. Interfacing experiments using 8051 Trainer kit and interfacing modules
 - a. display (LCD/LED/Seven Segment)
 - b. Stepper / DC Motor
2. Introduction to Arduino platform and programming
3. Simple Applications using Arduino Development Board (Any two)
 - a. Simple LED Blinking using development board
 - b. Building IOT Smart Switch using IOT
 - c. Pulse Width Modulation
 - d. Analog to Digital / Digital to Analog Conversion
4. Interfacing Arduino with a Sensor (Any one): Temperature Sensor / PIR/ Ultrasonic sensor/ IR Sensor/ Flame Sensor/ MQ6 Sensor/ Humidity sensor/ Raindrop Sensor, magnetometers, cameras, accelerometers etc.
5. Interfacing Arduino with an Actuator (Any One): Motors / solenoids / Controllers etc.
6. Communication using Wireless Medium (Any One): WiFi / Bluetooth / Zigbee / RFID etc.
7. Setting up and Cloud Platform and logging Sensor Data on the platform.

Assessment:

Term Work

Term work shall consist of the experiments as mentioned above.

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

1. Laboratory work (Experiments): 20 marks
2. Attendance: 05 marks

End Semester Practical/Oral Examination:

Pair of Internal and External Examiner should conduct practical examination followed by Oral.

Course Code	Course Name	Credit
AEP801	Major Project II	06

Course Objectives:

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 to successful completion of the project by implementing the solution.

Course Outcomes: Learner will able to

1. Students will be able to implement solutions for the selected problem by applying technical and professional skills.
2. Students will be able to analyze impact of solutions in societal and environmental context for sustainable development.
3. Students will be able to collaborate best practices along with effective use of modern tools.
4. Students will be able to develop proficiency in oral and written communication with effective leadership and teamwork.
5. Students will be able to nurture professional and ethical behavior.
6. Students will be able to gain expertise that helps in building lifelong learning experience.

Guidelines:

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.

1. 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. Report should be submitted in hardcopy. Also, each group should submit softcopy of the report along with project documentation, implementation code, required utilities, software and user Manuals.

A project report should preferably contain at least following details:

- Abstract
- Introduction
- Literature Survey/ Existing system
- Limitation Existing system or research gap
- Problem Statement and Objective
- Proposed System
 - Analysis/Framework/ Algorithm
 - Design details
 - Methodology (your approach to solve the problem) Proposed System
- 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
- Results and Discussion
- Conclusion and Future Work
- References
- Appendix – List of Publications or certificates

2. Desirable

- Students should be encouraged
 - to participate in various project competition.
 - to write minimum one technical paper & publish in good journal.
 - to participate in national / international conference.

Term Work:

Distribution of marks for term work shall be done based on following:

- a. Weekly Log Report
- b. Completeness of the project and Project Work Contribution
- c. Project Report (Black Book) (both side print)
- d. Term End Presentation (Internal)

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

3. Oral & Practical:

Oral & Practical examination (Final Project Evaluation) of Project 2 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 following:

1. Relevance to the specialization / industrial trends
2. Modern tools used
3. Innovation
4. Quality of work and completeness of the project
5. Validation of results
6. Impact and business value
7. Quality of written and oral presentation
8. Individual as well as team work