

UNIVERSITY OF MUMBAI



Bachelor of Engineering

in

Automobile Engineering

Final Year with effect from AY 2022-23

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

Under

**FACULTY OF SCIENCE &
TECHNOLOGY**

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



Syllabus for Approval

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

Date

Dr. S. K. Ukarande
Associate Dean
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Preamble

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

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

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

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

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Incorporation and implementation of Online Contents from NPTEL/ Swayam Platform

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

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

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

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Preface

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

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

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

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

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

Board of Studies in Mechanical Engineering

Dr. Vivek K. Sunnapwar	: Chairman
Dr. S. M. Khot	: Member
Dr. V. M. Phalle	: Member
Dr. Siddappa Bhusnoor	: Member
Dr. S.S. Pawar	: Member
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Dr. Dhanraj Tambuskar	: Member

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					End Sem Exam	Exam. Duration (Hrs)	Term Work	Prac./ Oral	Total
		Internal Assessment			Avg	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

Course Code	Sem. VIII: Department Optional Course- 5	Course Code	Sem. VIII: Department Optional 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

Course Code	Institute Elective Course-II #
ILO8021	Project Management
ILO8022	Finance Management
ILO8023	Entrepreneurship Development and Management
ILO8024	Human Resource Management
ILO8025	Professional Ethics and CSR
ILO8026	Research Methodology
ILO8027	IPR and Patenting
ILO8028	Digital Business Management
ILO8029	Environmental Management

Common with all branches

8. Individual as well as team work

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>	10

	<ul style="list-style-type: none"> • Torque Coupling • Speed coupling • Combined Torque and speed coupling <p>Design of Series and Parallel Hybrid drivetrain</p> <ul style="list-style-type: none"> • Control strategies for series drivetrain • Control strategies for parallel hybrid drivetrain • Sizing of drivetrain parameters 	
4	<p>Energy storage devices and Electric Motors</p> <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 <p>Concepts of Energy and Power</p> <ul style="list-style-type: none"> • Specific Energy • Specific power • State of Charge, Depth of Discharge • Energy Efficiency • Electrochemical reactions • Voltages <p>Motors for Electric Vehicles</p> <ul style="list-style-type: none"> • DC Motors • Induction Motors • Switched Reluctance Motors(SRM) <p>Regeneration</p> <ul style="list-style-type: none"> • Energy consumption in braking • Brake systems for EV's and HEV's 	08
5	<p>Fuel Cell Electric Vehicles Fundamentals</p> <ul style="list-style-type: none"> • Operating principle • Electrode potential • Current voltage curve <p>Fuel Cell Technologies</p> <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	<p>Battery Management System and Chargers for EV's</p> <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>

Draft Syllabus

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,	04

	debugging simulating simple programs. Flashing code into HCS12XDT512 SLK board and testing.	
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

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.

- Question paper will comprise a total of 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)

iv. Only four questions need to be solved.

Text Books:

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

Draft Syllabus

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, ISBN 9788177588217.

Reference Books:

1. Clive L.Dym, Patrick Little, "Engineering Design: A Project-based Introduction," 3rd Edition, John Wiley & Sons, 2009, ISBN 978-0-470-22596-7.
2. George E. Dieter, Linda C.Schmidt, "Engineering Design," 4th Edition, McGraw-Hill International Edition, 2009, ISBN 978-007-127189-9.
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.

Draft Syllabus

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. 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>	06
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,	8

	<p>engaging with all stakeholders of the projects, Team management, 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 	6

	<ul style="list-style-type: none"> & conflicts: Concept of roles; role dynamics; role conflicts and stress. • Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. • 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	08

	j. Preparation of Research Report	
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 Intellectual 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-</p> <p>Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts</p> <p>Difference between physical economy and digital economy,</p> <p>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</p> <p>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	Managing E-Business -Managing Knowledge, Management skills for e-business, Managing Risks in e –business 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	06
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

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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

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