Pimpri Chinchwad Education Trust's

PIMPRI CHINCHWAD COLLEGE OF ENGINEERING

SECTOR NO. 26, PRADHIKARAN, NIGDI, PUNE 411044

An Autonomous Institute Approved by AICTE and Affiliated to SPPU, Pune

DEPARTMENT OF MECHANICAL ENGINEERING

Curriculum Structure and Syllabus

of

Honors and Minors in

B. Tech. Mechanical Engineering

(Approved by BoS Mechanical Engineering)

(Course 2020)

Effective from Academic Year 2021-22

Institute Vision

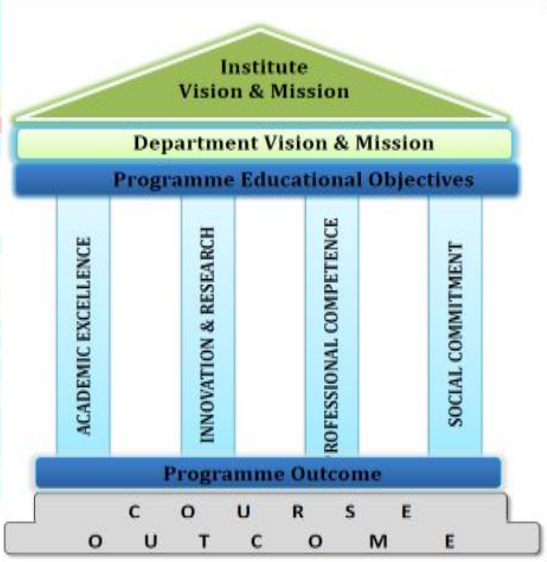
To Serve the Society, Industry and all the Stakeholders through the **Value-Added Quality Education.**

Institute Mission

To serve the needs of society at large by establishing State-of-the-Art Engineering, Management and Research Institute and impart attitude, knowledge and skills with quality education to develop individuals and teams with ability to think and analyze right values and self-reliance.

Quality Policy

We at PCCOE are committed to impart Value Added Quality Education to satisfy the applicable requirements, needs and expectations of the Students and Stakeholders. We shall strive for academic excellence, professional competence and social commitment in fine blend with innovation and research. We shall achieve this by establishing and strengthening state-of- the-art Engineering and Management Institute through continual improvement in effective implementation of Quality Management System.



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Honors in

Systems Engineering

Curriculum structure

Honors in Systems Engineering

Course Code	Semester	Course Name	Teaching Scheme					Evaluation Scheme						
			L	P	T	H	CR	IE1	IE2	ETE	TW	PR	OR	Total
HME5981 / HME5982	V	Foundations of Systems Engineering	3	-	1	4	4	20	30	50	25	-	-	125
HME6981 / HME6982	VI	System Architecture and Design	3	-	1	4	4	20	30	50	25	-	-	125
HME6983 / HME6984	VI	Model Based System Engineering	3	2	-	5	4	20	30	50	-	-	25	125
HME7981	VII	System Integration, Verification and Validation	3	-	-	3	3	20	30	50	-	-	-	100
HME8981	VIII	Project	-	10	-	10	5	50	-	-	75	-	-	125
			12	**12**	**2**	**26**	**20**	**130**	**120**	**200**	**125**	**--**	**25**	**600**

Abbreviations are: L-Lecture, P-Practical, T-Tutorial, H- Hours, IE- Internal Evaluation, MTE- Mid Term Evaluation, ETE- End Term Evaluation, TW –Termwork, OR - Oral

Course Syllabus

Program:	B. Tech Mechanical Engineering (Honor)			Semester : V				
Course :	Foundations of Systems Engineering			Code : HME5981/HME5982				
Teaching Scheme/week				Evaluation Scheme				
Lecture	**Tutorial**	**Credit**	**Hours**	**IE1**	**IE2**	**ETE**	**TW**	**Total**
3	1	4	4	20	30	50	25	125

Prior knowledge of

Design of Machine Elements, Problem-solving, analytical

Objectives:

Students are expected to study,

1. Viewpoint and perspective of systems engineering
2. Relationship between systems life cycle and its management / manufacturing process
3. Hierarchy of Complex Systems
4. Interaction of system environment with the system
5. Basic system development process through the system life cycle
1. Role of systems engineering Project planning, management and control

Outcomes:

The Students will be able to,

2. Differentiate between systems engineering and other discipline of engineering
3. Understand opportunities and career in systems engineering
4. Draw hierarchy of Complex Systems which include system building blocks
5. Draw context diagram of system showing its interaction with system environment
6. Identify recent developments of few complex systems
7. Describe the general type of the organizational structure in systems engineering

Detailed Syllabus

Unit	Description	Duration (H)
1	**Systems Engineering And The World Of Modern Systems:** The Systems Engineering Landscape, Systems Engineering Viewpoint, Perspectives of Systems Engineering, Examples of Systems Requiring Systems Engineering.	**6**
2	**Systems Engineering Activities And Products:** Systems Engineering Activities and Products, Systems Engineering as a Profession, Systems Engineer Career Development Model.	**6**
3	**System Building Blocks :** System Elements and Interfaces, Hierarchy of Complex Systems, System Building Blocks.	**6**
4	**The System Environment:** The System Environment, Interfaces and Interactions, Complexity in Modern System.	**6**
5	**The System Development Process:** Systems Engineering Through the System Life Cycle, System Life Cycle, Evolutionary Characteristics of the Development Process, The Systems Engineering Method, Testing Throughout System Development.	**6**
6	**Systems Engineering Management :** Managing System Development, Work Breakdown Structure, Systems Engineering Management Plan, Organization of Systems Engineering.	**6**
	Total	**36**

Text Books:

1. **Systems Engineering Principle and Practice** , Alexander Kossiakoff, Samuel J. Seymour, David A. Flanigan, Steven M. Biemer, John Wiley & Sons, Inc., 3rd Edition, 2020.

Reference books:

1. **Systems Engineering Fundamentals and Applications,** Reinhard Haberfellner, Olivier de Weck Ernst Fricke, Siegfried Vössner, Springer Nature Switzerland AG 2019.
2. **NASA Systems Engineering Handbook**, National Aeronautics and Space Administration NASA Headquarters Washington, D.C. 20546 December 2007.
3. **Systems Engineering: Design Principle and Models, Dahai Liu,** CRC Press Taylor & Francis Group, 2016.
4. **Systems Engineering Guidebook-A process for developing systems and Products,** James N Martin, CRC Press, 2000.

Miniature commitment or Assignments:

1. For each of the following areas, list and explain how at least two major technological advances/breakthroughs occurring since 2010 that have radically changed them. In each case, explain how the change was effected.
   (a) Transportation
   (b) Communication
   (c) Financial management
   (d) Manufacturing
   (e) Distribution and sales
   (f) Entertainment
   (g) Medical care
2. What characteristics of an airplane would you attribute to the system as a whole rather than to a collection of its parts? Explain why
3. List the hierarchy consisting of a typical subsystem, component, subcomponent, and part for (i) a terminal air traffic control system, (ii) a personal computer system, (iii) an automobile, and (iv) an electric power plant. For each system you need only name one example at each level.
4. Draw a context diagram for a standard washing machine and coffee maker machine. Make sure to identify all of the external entities, and label all of the interactions.
5. Identify a recent development (since 2010) of a complex system (commercial or military) of which you have some knowledge. Describe the need it was developed to fill and the principal ways in which it is superior to its predecessor(s). Briefly describe the new conceptual approach and/or technological advances that were employed.
6. Describe the general type of the organizational structure in which you work.Discuss instances where this structure has been beneficial, and those where it has not been so beneficial to programs you have been involved in or have some knowledge of.

Program:	B. Tech Mechanical Engineering (Honor)			Semester :VI				
Course :	System Architecture and Design			Code : HME6981/HME6982				
Teaching Scheme/week				Evaluation Scheme				
Lecture	Tutorial	Credit	Hours	IE1	IE2	ETE	TW	Total
3	1	4	4	20	30	50	25	125

Prior knowledge of

Foundations of Systems Engineering, Problem-solving, analytical, and advanced mathematics skills.

Objectives:

Students are expected to study,

1. a valid operational need (or potential market) that exists for a new system or a major upgrade to an existing system, and a feasible approach to fulfilling the need at an affordable cost and within an acceptable level of risk.
2. a well-documented justification for initiating the development of a new system
3. Functions to describe the system's activities, interactions, and operations.
4. Examination of different technological approaches, generally offering a more diverse source of alternatives.
5. The architecture in associated with structures, their relationships, and expectation for their design.
6. The decisions typically made by systems engineers in the development of complex systems.

Outcomes:

The Students will be able to,

1. Identify the need of new system and show that such a system offers a sufficient improvement in capability to warrant the effort to bring it into being.
2. Convert the operationally oriented view of the system derived in the needs analysis phase into an engineering-oriented view required in the concept definition and subsequent phases of development.
3. Select, from a number of alternative system concepts, of a specific configuration that will constitute the baseline for development and engineering.
4. Provide the decision makers with a variety of choices for the system concept.
5. Bring form to function, bring order out of chaos, or convert the partially formed ideas of a client into a workable conceptual model.
6. Make decisions in the development of complex systems.

Detailed Syllabus

Unit	Description	Duration (H)
1	**Needs Analysis :** Originating a New System, Systems Thinking, Operations Analysis, Feasibility Definition, Needs Validation.	6
2	**Requirements Analysis :** Developing the System Requirements, Requirements Development and Sources, Requirements Features and Attributes, Requirements Development Process, Requirements Hierarchy, Requirements Metrics, Requirements Verification and Validation, Requirements Development: TSE vs. Agile.	6
3	**Functional Analysis :** Selecting the System Concept, Functional Analysis and Formulation, Functional Allocation, Functional Analysis Products, Traceability to Requirements, Concept Development Space.	6
4	**Evaluation And Selection :** Evaluating and Selecting the System Concept, Alternatives Analysis, Operations Research Techniques, Economics and Affordability, Events and Decisions for Consideration, Alternative Concept Development and Concept Selection, Concept Validation, Traditional vs. Agile SE Approach to Concept Evaluation.	6
5	**Systems Architecting :** Architecture Introduction, Types of Architecture, Architecture Frameworks, Architectural Views, Architecture Development, Architecture Traceability, Architecture Validation.	6
6	**Decision Analysis And Support :** Decision Making, Modelling Throughout System Development, Modelling for Decisions, Simulation, Trade-Off Analysis, Evaluation Methods.	6
	Total	36

Reference books:

1. **System Requirements Analysis**, Jeffrey O. Grady, Elsevier, 2nd Edition, 2016.
2. **System Verification**: Proving the Design Solution Satisfies the Requirements, Jeffery O. Grady, Elsevier, 2007.
3. **Systems Engineering Fundamentals and Applications,** Reinhard Haberfellner, Olivier de Weck Ernst Fricke, Siegfried Vössner, Springer Nature Switzerland AG 2019.
4. **NASA Systems Engineering Handbook**, National Aeronautics and Space Administration NASA Headquarters Washington, D.C. 20546 December 2007.
5. **Systems Engineering: Design Principle and Models, Dahai Liu,** CRC Press Taylor & Francis Group, 2016.
6. **Systems Engineering Guidebook-A process for developing systems and Products,** James N Martin, CRC Press, 2000.

Miniature commitment or Assignments:

1. Assume that you have a business in garden care equipment and are planning to develop one or two models of lawn tractors to serve suburban homeowners. Consider the needs of the majority of such potential customers and write at least six operational requirements that express these needs. Remember the qualities of good requirements as you do so. Draw a context diagram for a lawn tractor.
2. To meet future pollution standards, several automobile manufacturers are developing cars powered by electricity. Develop five requirements for new electric - powered cars.
3. Develop a top - level function list for an automated teller machine (ATM) system. Limit yourself to no more than 12 functions.
4. Given the personal automobile as the predecessor system to transport users from their homes to their offices, develop five to seven alternative concepts. Organize them by technology used and develop three to five criteria for which to compare all alternatives.
5. Develop functional architecture views for a public transportation system concept; generate a functional architecture that contains eight to ten functions.
6. Identify three to five potential stakeholders for the following concepts, and identify five criteria that a systems engineer would evaluate candidate alternatives:
   a. The design of a traffic light at a new intersection.
   b. The design of a new weather satellite.
   c. The choice of a communications subsystem on a new mid - ocean buoy designed to measure ocean temperature at various depths.
   d. The choice of a security subsystem for a new power plant.

Program:	B. Tech Mechanical Engineering (Honor)			Semester VI					
Course :	Model Based System Engineering			Code : HME6983/HME6984					
Teaching Scheme/week				Evaluation Scheme					
Lecture	Practical	Credit	Hours	IE1	IE2	ETE	TW	OR	Total
3	1	4	4	20	30	50	25		125

Prior knowledge of

CAD software, Foundations of Systems Engineering, , System Architecture and Design,

Objectives:

Students are expected to study:

1. Fundamentals of systems and subsystems which should include different processes, properties
2. Different Engineering design processes, safety assessment Processes configuration managing processes and quality assurance processes.
3. Subjectivity requirements and objectifying requirements of Model based system engineering
4. Basic design model of a system
5. The validation process according to the ARP4754A
6. The verification process according to the ARP4754A

Outcomes:

The Students will be able to,

1. Understand Fundamentals of systems and subsystems
2. Demonstrate Different Engineering design processes, safety assessment Processes configuration managing processes and quality assurance processes
3. Decide Subjectivity requirements and objectifying requirements of Model based system engineering
4. Analyze Design models of system
5. Evaluate the validation process according to the ARP4754A.
6. Evaluate the verification process according to the ARP4754A.

Detailed Syllabus

Unit	Description	Duration (H)
1	**FUNDAMENTALS :** Introduction, Systems, subsystems and levels, Concrete and abstract objects, Properties, States, event, process, behaviour and fact, Systems of interest.	6
2	**ENGINEERING PROCESSES :** Systems engineering process : General framework, Design process, Safety assessment process, Requirement and assumption validation, Verification of the implementation regarding Requirements, Managing configurations, Process (quality) assurance, certification and coordination with authorities	6
3	**DETERMINING REQUIREMENTS AND SPECIFICATION MODELS :** Specifications and requirements, Text-based requirements and subjectivity, Objectifying requirements and assumptions through property-based requirements, Conjunction and comparison of property-based requirements, Interpreting text-based requirements	6
4	**DESIGNING SOLUTIONS AND DESIGN MODELS :** Deriving requirements, Basic system model of a type of systems, Dynamic design models of a type of systems, Derivation and allocation of the system's behavioral requirements, Static design models, Derivation and allocation of system Requirements, The end of the design process and the realization	6
5	**VALIDATING REQUIREMENTS AND ASSUMPTIONS :** The validation process according to the ARP4754A, The validation process according to the property model methodology	6
6	**VERIFYING THE IMPLEMENTATION :** The verification process according to the ARP4754A, The verification process according to the property model methodology.	6
	Total	**36**

Text Books:

Model Based System Engineering : Fundamentals and Methods , Patrice Micouin, John Wiley & Sons, Inc. 1st Edition, 2014

Reference books:

1. **System Requirements Analysis**, Jeffrey O. Grady, Elsevier, 2nd Edition, 2016.
2. **System Verification**: Proving the Design Solution Satisfies the Requirements, Jeffery O. Grady, Elsevier, 2007.
3. **Systems Engineering Fundamentals and Applications,** Reinhard Haberfellner, Olivier de Weck Ernst Fricke, Siegfried Vössner, Springer Nature Switzerland AG 2019.
4. **NASA Systems Engineering Handbook**, National Aeronautics and Space Administration NASA Headquarters Washington, D.C. 20546 December 2007.
5. **Systems Engineering: Design Principle and Models, Dahai Liu,** CRC Press Taylor & Francis Group, 2016.
6. **Systems Engineering Guidebook-A process for developing systems and Products,** James N Martin, CRC Press, 2000.

Miniature commitment or Assignments:

Note : Practical will be conducted using the Cameo Software/ Dymola

1. MBSE holds the promise of simplifying reviews and enabling more rapid assessment of model quality. What implications does this have for team structure, cost, and program timing?
2. The United States Department of Defense has enumerated five goals as part of its Digital Engineering Strategy. Which of these do you think is the most critical? Which is the hardest to achieve? Why?
3. Execution of Document-Intensive Systems Engineering (DISE) is mademore difficult because documents are not inherently synchronized; over time, the relevant artifacts associated with a program may "drift" and become inconsistent. What are some potential negative consequences of this?
4. Test plans are one of the DISE artifacts that risk becoming disconnected from the system architecture and requirements; what benefits result from modeling the test architecture in concert with the system architecture?
5. Not all system elements must be modeled with the same level of detail; more effort can be spent on novel or high‐risk elements to fully characterize them (and lower‐fidelity elements may be revisited if analysis indicates the effort is warranted). What elements would you model at lower fidelity in an autonomous automobile? A satellite? An e‐commerce system?
6. craftsman approach has been proposed as a method for developing competent system modelers (with senior modelers mentoring and training junior modelers). Why is this approach a viable alternative? How does it compare with other methods (e.g. lectures, self‐directed exercises)?

Industrial Visit:

Will be planned

Program:	B. Tech Mechanical Engineering (Honor)			Semester : VII				
Course :	System Integration, Verification and Validation			Code : HME7981				
Teaching Scheme/week				Evaluation Scheme				
Lecture	Tutorial	Credit	Hours	IE1	IE2	ETE	TW	Total
3	1	4	4	20	30	50	-	100

Prior knowledge of
Foundations of Systems Engineering, , System Architecture and Design, Model Based System Engineering

Objectives:

Students are expected to study,

1. Requirement and functional analysis
2. System building blocks
3. System integration hierarchy and different types of integration
4. Development of testing and evaluation of system
5. Transition of system design from development to production
6. operations, maintenance and up gradation of system

Outcomes:

1. Analyze the functional requirement of the system
2. Design the system building blocks
3. classify system integration hierarchy and types of integration
4. plan testing and evaluation of the system
5. plan transition of system design from development to production
6. design operations , maintenance and up gradation of system

Detailed Syllabus

Unit	Description	Duration (H)
1	**ADVANCED DEVELOPMENT :** Reducing Uncertainties, Design, Prototype Development as a Risk Mitigation Technique, Development Testing, Risk Reduction.	6
2	**ENGINEERING DESIGN :** Implementing the System Building Blocks, Requirements Analysis, Functional Analysis and Design, Component Design, Design Validation, Configuration Management.	6
3	**SYSTEMS INTEGRATION :** Integrating the Total System, System Integration Hierarchy, Types of Integration, Integration Planning, Integration Facilities.	6
4	**TEST AND EVALUATION :** Testing and Evaluating the Total System, Developmental System Testing, Operational Test and Evaluation, Human Factors Testing, Test Planning and Preparation, Test Traceability, System of Systems Testing	6
5	**PRODUCTION :** Systems Engineering in the Factory, Engineering for Production, Transition from Development to Production, Production Operations, Acquiring a Production Knowledge Base.	6
6	**OPERATION AND SUPPORT :** Installing, Maintaining, and Upgrading the System, Installation and Test, In-Service Support, Major System Upgrades: Modernization, Operational Factors in System Development.	6
	Total	**36**

Text Books:

1. **Systems Engineering Principle and Practice** , Alexander Kossiakoff, Samuel J. Seymour, David A. Flanigan, Steven M. Biemer, John Wiley & Sons, Inc., 3rd Edition, 2020.

Reference books:

1. **System Requirements Analysis**, Jeffrey O. Grady, Elsevier, 2nd Edition, 2016.
2. **System Verification**: Proving the Design Solution Satisfies the Requirements, Jeffery O. Grady, Elsevier, 2007.
3. **Systems Engineering Fundamentals and Applications,** Reinhard Haberfellner, Olivier de Weck Ernst Fricke, Siegfried Vössner, Springer Nature Switzerland AG 2019.
4. **NASA Systems Engineering Handbook**, National Aeronautics and Space Administration NASA Headquarters Washington, D.C. 20546 December 2007.
5. **Systems Engineering: Design Principle and Models, Dahai Liu,** CRC Press Taylor & Francis Group, 2016.
6. **Systems Engineering Guidebook-A process for developing systems and Products,** James N Martin, CRC Press, 2000.

Miniature commitment or Assignments:

1. In the development of a major upgrade to a terminal air traffic control system, what would you except to be three significant risks and what systems engineering approaches would you recommend to mitigate each of these risks. (Consider problems of failing to meet schedule as well as safety problems.) Are there prototypes that would address these risks? How would you expect the outcome of a prototype to provide additional insight to the decision makers?
2. The personal laptop computer is a product that has proven to be very reliable in spite of the fact that it has many interfaces, is operated by a variety of people, operates nearly continuously, and includes a number of internal moving. It is a portable device that operates in a wide range of environments (temperature, shock, vibration, etc.). List six design features or characteristics that contribute to the laptop reliability. Calculate the entire system reliability.
3. Your company is tasked to develop a new public transportation system of light rail and fuel - efficient buses. Identify 5-7 elements of the system that would require human factors integration: create 10-15 requirements involving the user experience with this system. Define the integration facilities that would be needed to evaluate these requirements and describe the types of integration activities that would link to these requirements.
4. In designing system tests, probes are placed at selected internal test points, as well as at system outputs, to enable rapid and accurate diagnosis of the cause of any discrepancy. List the considerations that must be applied to the selection of the appropriate test points (e.g. what characteristics should be examined). Illustrate these considerations using the example of testing the antilock brake system of an automobile.
5. Production is typically the responsibility of a division of a company independent of the development organization. It has been stated that the transition to production and the production process itself requires systems engineering expertise in certain critical areas. List some instances where systems engineering expertise in the production organization is required in the production of medical devices (e.g. implantable pacemakers).
6. In maintaining an operational system, hardware faults are usually corrected by replacing the offending subcomponent by a spare. Software faults are typically coding errors and must be eliminated by correcting the code. In complex systems, software changes must be made with extreme care and must be validated. Discuss ways in which software faults can be handled in a controlled manner where the operating system is remote from the development organization.

Program:	**B. Tech Mechanical Engineering (Honor)**			**Semester :VIII**			
Course :	Project			**Code :** HME8981			
Teaching Scheme/week				**Evaluation Scheme**			
Lecture	**Practical**	**Hours**	**Credit**	**IE1**	**TW**	**OR**	**Total**
-	10	10	5	50	75	-	125

Prior knowledge of

Foundations of Systems Engineering, , System Architecture and Design, Model Based System Engineering and System Integration, Verification and Validation

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Objectives:

Students are expected to study,

1. Systems Engineering in product design and development processes.
2. Various activities involved in the project and its planning to channelize the work.
3. Building, designing, analysis, and implementation of real-time applications using available platforms.

Outcomes:

The students will be able to,

1. Understand, plan and execute a project.
2. Design a real-time application
3. Prepare a technical report based on the project.
4. Deliver technical seminars based on the project work carried out.
5. Understand publication and copyright process of research

Guidelines:

1. A group of 3 to 4 students needs to design and demonstrate the project under the guidance of the allocated guide.
2. Students can choose the project considering their implementation in Major Project.
3. The hardware implementation and or software simulation is compulsory.
4. Project Report should be submitted in compliance with term work associated with the subject.
5. Paper publication associated with the project as research outcome is appreciable.
6. Project work preferably should be completed in the laboratory/ industry.

Detailed Syllabus

Sr. No.	**Activity**	**Duration (H)**
1	Semester VIII (week 1&2): Project guide allotment, Finalization of topic and platform, Planning of the work, Literature review, identifying a problem, and formulating the problem for the project	**20**
2	Semester VII (week 3 & 4): Methodology finalization, finalizing project proposal, Review 1 for finalization of topic and specification.	**20**
3	Semester VII (week 5 & 6): Simulation of Ideas on appropriate software tools and finalization of hardware platform	**20**
4	Semester VII (week 7 & 8): Understanding platform implementation and related software flow and execute the block-level design, Review 2 to understand the progress of the project	**20**
5	Semester VIII (week 9 & 10): Project Report writing and publication or copyright planning and execution.	**20**
6	Semester VIII (week 11 & 12): Demonstration of Project work and Final Review for submission and term work compliances.	**20**
	Total	**120**

Honors in

Electric Vehicle Technology

Curriculum structure

Honor in Electric Vehicle Technology

Course Code	Semester	Course Name	Teaching Scheme					Evaluation Scheme						
			L	P	T	H	CR	IE1	IE2	ETE	TW	PR	OR	Total
HME5983 / HME5984	V	Electric vehicle Systems & Vehicle Dynamics	3	2		5	4	20	30	50	-	-	25	125
HME6985 / HME6986	VI	Battery Technologies for Electrical Vehicles	3	2	-	5	4	20	30	50	-	25	-	125
HME6987 / HME6988	VI	Design of Electrical Vehicles Powertrain	3	2	-	5	4	20	30	50	-	-	25	125
HME7982	VII	Charging Infrastructure & Testing Standards for Electrical Vehicles	3	-	-	3	3	20	30	50	-	-	-	100
HME8982	VIII	Project	-	10	-	10	5	50	-	-	50	-	25	125
Total			**12**	**16**	**-**	**28**	**20**	**130**	**120**	**200**	**50**	**25**	**75**	**600**

Abbreviations: L-Lecture, P-Practical, T-Tutorial, H- Hours, IE- Internal Evaluation, MTE- Mid Term Evaluation, ETE- End Term Evaluation, TW –Termwork, OR - Oral

Course Syllabus

Program:	**B. Tech Mechanical Engineering (Honor)**			**Semester : V**			
Course:	Electric vehicle Systems & Vehicle Dynamics			**Code :** HME5983/HME5984			
Teaching Scheme				**Evaluation Scheme**			
Lecture	**Practical**	**Tutorial**	**Credit**	**IE1**	**IE2**	**ETE**	**Total**
3	2	-	4	20	30	50	100
				Evaluation Scheme			
				TW	OR	PR	Total
	-		-	-	25	-	25

Prior Knowledge of
IC Engines, vehicle systems, machine design , engineering mechanics
is essential

Objectives:

1. To study basic fundamentals of electric vehicle
2. To understand the Electric vehicle Architecture
3. To develop understanding of hybrid electric vehicle
4. Design & analysis of vehicle performance parameters
5. Design of transmission system for electric vehicle
6. To understand the Current scenario of electric vehicle in India

Outcomes:
After learning the course, the learners will be able,

1. To analyze the Current scenario of electric vehicle in India
2. To compare various types of vehicles on road
3. To compare types of Hybrid Electric vehicles
4. To identify electric vehicle components and architectures
5. To evaluate & analyze the vehicle performance parameters
6. To identify various systems of electric vehicles

Detailed Syllabus

Unit	**Description**	**Duration (H)**
1.	**Current scenario & Future of electric vehicle in India**: Technology scenario, Market scenario, Paris climate agreement, social and environmental importance of electric vehicles, impact of modern drive-trains on energy supplies. Policies & regulation, Indian policies, Challenges, National Electric Mobility Mission Plan, FAME 1 and 2 India Scheme	**6**
2.	**Overview of Electric vehicle (EV):** History, Components of Electric vehicles, EV Layouts, EV classification, Working of EV, Comparison with IC Engine, Advantages and disadvantages of EV, Well-to-Wheel Efficiency, Tank-to-Wheel Efficiency, Energy flow analysis for EV & ICEV	**6**
3.	**Hybrid Electric vehicles :** Classification – Micro, Mild, Full, Plug-in, EV, Components, Layout of Hybrid EV, Comparison with EV, Layout & architecture: -Series hybrid vehicle, Parallel hybrid vehicle, Series- a parallel hybrid vehicle, Range Extended HEV ,Advantages and Disadvantages of HEV	**6**
4.	**Electric vehicle Architecture:** Battery electric vehicle (BEV), Electric Vehicle Architectures, Powertrains: Electric motor, Battery pack, Inverter, Charger, converter, Regenerative braking	**6**
5.	**Vehicle Dynamics:** Vehicle resistance, Rolling resistance, Grading Resistance, Aerodynamic drag, Dynamic Equation, Vehicle performance (Maxi. Speed, Gradeability & acceleration), Calculation of acceleration force, maximum speed. Tractive effort, Torque required on the wheel, Torque speed characteristics of electric vehicle	**6**
6.	**Vehicle Systems:** Transmission system: Need, Torque Speed Characteristics of IC Engine and Motor, Comparison with ICEV Transmission system, Selection of transmission system, Estimation of gear ratio, Differential, Brake system, Steering system, Suspension system	**6**
	Total	**36**

Reference Books:

1. Modem Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory, and Design, Mehrdad Ehsaniand Yimin Gao, Power Electronics and application series
2. Build Your Own Electric Vehicle, Seth Leitman arid Bob Brant
3. Electric and Hybrid Vehicles: DesignFundamentals, Iqbal Husain, CRC Press, 2003
4. Fundamental of vehicle dynamics, Thomas D Gillipse, Society of Automotive Engineers, second edition
5. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
6. Theory of Ground Vehicles. Third Edition. J.Y Wong. John Wiley ISBN: 0-471-35461-9

Laboratory Work

Any one of Category I, any 6 of Category II and any one of Category III, total 8 experiments to be performed.

I. Simulation based Experiments

Effect of various parameters on tractive efforts (speed, gradeability.....etc)

II. Laboratory Experiments

1. Study of various components of electric vehicle.
2. Analysis of different layouts of electric vehicle
3. Demonstration, Dismantling & Assembling of electric scooter.
4. Calculate & sizing the power rating of given electric vehicle
5. Determination of the Gear Ratios of the given electric vehicle
6. Study & Demonstration of various systems used in electric vehicle.
7. Determination of acceleration performance of electric vehicle
8. Industrial visit to electric vehicle industry (Manufacturer/ startup)

III. Case study-based Experiments

1. Case study on recent research in the field of EV Technology
2. Case study on challenges & future scope of electric vehicle

Program:	B. Tech Mechanical Engineering (Honor)			Semester : VI			
Course :	Battery Technologies for Electric Vehicles			Code : HME6985/HME6986			
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Tutorial	Credit	IE1	IE2	ETE	Total
3	2	-	4	20	30	50	100
				Evaluation Scheme			
				TW	OR	PR	Total
-	-	-	-	-	-	25	25

Prior Knowledge of

basic concepts of electronics ,electrical and thermal engineering, mathematic

is essential

Objectives:

1. To make the learners conversant with various battery chemistries used for Electric Vehicles
2. To impart through understanding of Lithium Ion Battery
3. To understand the various battery performance parameters and testing procedures
4. To make the learners aware of thermal issues of Lithium ion battery and thermal management system
5. To understand the requirements and functioning of battery management system
6. To make the learners conversant with Equivalent Circuit Cell Modeling of Battery

Outcomes:

After learning the course the learners will be able,

1. to select suitable battery for EV application
2. to compare the materials used for the components of the battery
3. to conduct tests on battery cells to determine various performance and operating parameters
4. to estimate heat generation inside battery and propose cooling strategy for the battery pack.
5. to select BMS for given battery pack
6. to design and simulate battery pack for given EV

Detailed Syllabus

Unit	Description	Duration (H)
1.	**Overview of Battery Technology of Electric vehicle (EV) :** History of Battery cells, Primary Battery, Secondary Battery , Performance parameters and operating variables of Battery, Electric vehicle (EV) requirements, Battery Technologies for EV applications, Lead Acid battery, Nickel Cadmium , Nickel Metal Hydrite, Lithium Ion Batteries : Working, chemical reactions, comparison, future battery trends and challenges, Metal-Air Batteries, fuel cells , ultra capacitors	6
2.	**Lithium-Ion Batteries** Introduction, Components, Functions, Cathode Materials, Anode Materials, Electrolytes: salts and solvents, separators, advantages and drawbacks ,Battey cell Manufacturing: Cylindrical, prismatic and Pouch cells**,** recycling/disposal of batteries	6
3.	**Battery Performance and Testing** Battery operating and performance parameters**,** Charge-discharge characteristics of batteries, Measurement of current, voltage, temperature, Estimation of SOC: Coulomb Counting method, OCV method, Estimation of SoH, Capacity, efficiency	6
4.	**Battery Thermal Management** Heat Generation inside battery, Thermal issues of Lithium-Ion Battery, impact of temperature on capacity, cycle life, Thermal Runaway, Cooling strategies: Direct/indirect cooling, Air cooling, liquid cooling, PCM based cooling, advanced colling methods	6
5.	**Battery Electric Management** Primary functions of BMS, sensing voltage, current and temperature of cell and battery pack, estimation of cell SOC and battery pack SOC, Estimation of available energy and power of cell and battery pack, criteria of selection of BMS battery pack balancing: Reasons, balancing set point and when to balance a battery pack ,Passive and active balancing methods, Active balancing methods for battery packs: capacitor-based circuits, transformer-based circuits, Estimation of available battery power using a simplified cell mode	6

6.	**Battery Pack Design, Modelling and simulation** Determination of Power, Voltage, Capacity of battery pack**,** trade-off between parallel and series cell connections, parallel-cell-module (PCM), series-cell-module (SCM) **Equivalent Circuit Modelling:** Modelling OCV and SOC, voltage polarization, Warburg impedance, Estimation of Model parameter values: OCV, Columbic Efficiency, total capacity, temperature dependence of OCV, using the ECM to simulate constant voltage/ power charge/ discharge characteristics	**6**
	Total	**36**

Laboratory Work

Any one of Category I, any 6 of Category II and any one of Category III, total 8 experiments to be performed.

I. Simulation based Experiments

1. Mathematical Modelling of LIB and simulation using suitable software
2. Thermal analysis of LIB by using CFD

II. Laboratory Experiments

1. Study and Demonstration of Battery Voltage Measurement Methods (ADC, A/D, A–D, A2D, or A-to-D)
2. Study and Demonstration of Battery Current Measurement (Shunt Current Sensor, Hall effect sensor, four wire connection etc)
3. Study and Demonstration of Battery Temperature Measurement (Thermocouple, Thermistor etc)
4. Battery Cell testing to determine OCV Vs Time characteristics during charging and discharging , estimating coulombic efficiency and total capacity
5. Battery Cell testing to Estimate SOC
6. Battery Cell testing for Determination OCV -SOC relation
7. Determination of internal resistance of Battery Cell (Constant current Pulse Test)
8. Effect of temperature on Battery capacity, efficiency, charge/discharge characteristics , internal resistance Etc.
9. Battery pack design for given EV application (Testing Various series parallel combinations for given application)

III. Case study-based Experiments

1. Survey of Batteries used for electric vehicles on road
2. Case study on recent research in the field of EV Battery Technology

Reference Books:

1. Gregory L. Plett, Battery Management Systems, Volume I: Battery Modeling, Artech House, London
2. Gregory L. Plett, Battery Management Systems Volume II, Equivalent-Circuit Methods, Artech House, London
3. Gianfranco Pistoia, Boryann Liaw (eds.), Behaviour of Lithium-Ion Batteries in Electric Vehicles_ Battery Health, Performance, Safety, and Cost, Springer International Publication
4. Reiner_Korthauer, Li-I Batteries Basics and Applications, Springer International Publication

Jiuchun Jiang, Caiping Zhang - Fundamentals and Application of Lithium-ion Batteries in Electric Drive Vehicles-Wiley

Program:	**B. Tech Mechanical Engineering (Honor)**					**Semester : VI**	
Course :	Design of Electric Vehicle Powertrain					**Code :** HME6987/HME6988	
Teaching Scheme				**Evaluation Scheme**			
Lecture	**Practical**	**Tutorial**	**Credit**	**IE1**	**IE2**	**ETE**	**Total**
3	2	-	4	20	30	50	100
				Evaluation Scheme			
				TW	OR	PR	Total
-	-	-	-	-	25	-	25

Prior Knowledge of
Machine design, Electric vehicles, vehicle dynamics
is essential

Objectives:

1. To study fundamentals of traction motors used in electric vehicle
2. To identify & analyze motor controllers for Electric vehicle
3. To identify & analyze power converters for electric vehicle
4. To understand Modelling of Electric vehicle powertrain components
5. To design & analyze the EV propulsion system

Outcomes:
After learning the course the learners will be able,

1. To identify electric powertrain components
2. To select proper electric motor as per the requirements for an EV
3. To select appropriate motor controller as per the requirements of the powertrain
4. To select appropriate power converter as per the requirements of the powertrain
5. To develop mathematical model of EV powertrain
6. To design power train for given EV application

Detailed Syllabus

Unit	**Description**	**Duration (H)**
1.	**Fundamentals of EV Powertrain :** Need, Components of electric powertrain : Battery pack, Motor, Controller, Convertor etc. Possible EV Powertrain configurations and their comparison, Comparison with ICEV powertrain	**5**
2.	**Traction Motors** Motor & engine rating, Motor requirements for EV, Types of electric motor, Construction , working principle of DC Motors- shunt, series, PMDC, separately exited , cumulative compound, differential compound DC motor, AC Motors- Induction motors, Permanent magnet synchronous motor, Brush less D C motor, Switched reluctance motor, Synchronous Reluctance motor, Axial flux motor, Torque speed characteristics of traction motors, Advantages & disadvantages of traction motors, Applications	**7**
3.	**Motor controllers** Function of Motor Controller, DC Motor controls, speed control of DC motor- Armature voltage control , flux weakening control, BLDC speed control-sensor equipped BLDC motor, sensor less BLDC motor, Configuration and control of Induction motors, Configuration and control of Permanent magnet motors, Configuration and control of Switch Reluctance Motor drives, Field Oriented Control algorithm	**6**
4.	**Power converters/Electronics** Need of converters, Classification: DC-DC, DC-AC,AC-DC,AC-AC, unidirectional/ bidirectional, Magnetically isolated, , selection of convertor for EV, Location & power flow, four quadrant operation, input/ output voltage relations for converters	**5**
5.	**Modelling and Characteristics of EV Powertrains Components**- ICE Performance Characteristics, Electric Motor Performance Characteristics - Transmission and Drivetrain Characteristics-Regenerative Braking Characteristics-Driving Cycles Modelling and Analysis of Electric Propulsion and Braking - Longitudinal Dynamics Equation of Motion - Vehicle Propulsion Modelling and Analysis - Vehicle Braking Modelling and Analysis	**7**
6.	**Design of Propulsion system**: Matching the electric machine and the internal combustion engine requirements of vehicle , Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems. Traction motor sizing for different condition	**6**
	Total	**36**

Reference Books:

1. Modem Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory, and Design, Mehrdad Ehsani and Yimin Gao, Power Electronics and application series
2. Build Your Own Electric Vehicle, Seth Leitman arid Bob Brant
3. Electric and Hybrid Vehicles: DesignFundamentals, Iqbal Husain, CRC Press, 2003
4. Fundamental of vehicle dynamics, Thomas D Gillipse, Society of Automotive Engineers, second edition
5. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
6. Theory of Ground Vehicles. Third Edition. J.Y Wong. John Wiley ISBN: 0-471-35461-9

Laboratory Work

Any one of Category I, any 6 of Category II and any one of Category III, total 8 experiments to be performed.

I. Simulation based Experiments

1. Estimation of power rating of traction motor for different gradeability by using software
2. Estimation of power rating of traction motor for maximum vehicle speed by using software
3. Simulation of EV Power Train by using MATLAB/ Simulink

II. Laboratory Experiments

1. Study of various components of electric vehicle propulsion system layouts
2. Analysis of different motors used in electric vehicle
3. Speed control for BLDC motor by using V/F method
4. Speed control for IM motor by using PWM method
5. Performance testing of Electric Motor
6. Calculation & sizing the traction motor for given electric vehicle
7. Industrial visit to electric vehicle industry / service center

III. Case study-based Experiments

1. Case study on recent research in the field of EV propulsion system
2. Case study on challenges & future scope of electric vehicle

Program:	**B. Tech Mechanical Engineering (Honor)**		**Semester: VII**			
Course:	Charging Infrastructure & Testing Standards for EVs		**Code:** HME7982			
Teaching Scheme			**Evaluation Scheme**			
Lecture	**Hours**	**Credit**	**IE**1	**IE**2	**ETE**	**Total**
3	**3**	**3**	20	30	50	**100**
			Evaluation Scheme			
				TW	OR	PR
-	-	-	-	-	-	-

Prior Knowledge of
Electric vehicle systems, EV Battery Technology, EV Powertrain Design **is essential**

Objectives:

1. To familiarise the learner with selection and sizing of an electric vehicle charging system
2. To make the learner conversant with the basic elements constituting the charging system of an electric vehicle
3. To make the learner aware of types of chargers and their standards
4. To familiarise the learner with testing standards and instrumentation required for

Outcomes:

After learning the course, the students should be able to:

1. To differentiate between types of chargers and their characteristics
2. To select and size the chargers along with their connectors
3. To understand battery and motor testing standards
4. To demonstrate understanding of standards related to electric vehicle testing
5. To demonstrate understanding of standards related to charging stations
6. To demonstrate understanding of vehicle to grid Technology

Detailed Syllabus:

Unit	**Description**	**Duration (H)**
1	**Introduction to EV Charging Infrastructure** Ministry of Power guidelines for public EV charging stations for safe , reliable and affordable charging , Basic charging Block Diagram of Charger, Difference between Slow charger and fast charger Slow charger design rating, Fast charger design rating, AC charging and DC charging, Inboard and off board charger specification	**6**
2	Charging Connectors for Electric Vehicles EV charger classification : Based on IEC61851 (International Electrotechnical Commission Standard), Classification based on connector configuration : AC chargers: Type 1,2, DC Chargers: AA(CHAdeMO),BB(GB/T) ,EE(CCS1),FF(CCS2),General Topology: AC charger and DC Fast charger Selection sizing of Charger connector cable.	**6**
3	**Battery and Motor testing standards** Battery Testing: AIS048: Safety requirements of traction battery: Mechanical and Electrical Abuse tests Motor Testing**:** Common Motor types used in EVs, AIS041: Max power and nominal power test,	**5**
4	**Electric Vehicle Testing standards**: Electric vehicle standardization in India , categories of EVs in India EV regulation reference standards : AIS 038, 039,040,041,049, , below 250W EV certification, E-Rikshaw, E-cart certification, CMVR approval of retro fitment kits Electro Magnetic Compatibility (EMC) regulations for EVs (AIS 004, part3) Procedure for approval of Retro-fitment kits (ASI-123: Part 1,2.3)	**6**
5	**Charging station Testing standards** Requirement as per IEC 61851-1 for charging system apparatus, Periodic maintenance and assessment of electric vehicle charging stations, Solar powered electric vehicle charging station Calculation and selection - Components of charging station , AIS 138 part-1, Wireless charging	**5**

6	**Vehicle to grid Technology** Current scenario of power generation and distribution in India, centralized and distributed generation of electric power, concept of micro-grid, renewable energy generation integration to grid , Impact of Electric Vehicles on Power Grid , Ability of EV to supply power to grid , (EVs and their battery capacities), Role of EV as a energy storage device for power grid and participation in frequency regulation and emergency power supply, EV Charging strategies: uncontrolled and controlled (Unidirectional and Bidirectional) charging , V2G charging stations, Effect of integrating EVs into power grid, frequency regulation in EV integrated grid, challenges for V2G, Future technology: Wireless Charging, Battery Swap Technology, Charging EVs From Renewables	**8**
	Total	**36**

Reference Books:

1. "Vehicle Inspection Handbook", American Association of Motor Vehicle Administrators
2. Michael Plint& Anthony Martyr, "Engine Testing & Practice", Butterworth Heinmenn, 3rd ed, 2007
Automotive Industry Standards (AIS)-048, 038, 039, 040, 041, 049, 138, 004(Part3), 123 (Part 1,2,3)

Program:	**B. Tech Mechanical Engineering (Honor)**			**Semester : VIII**			
Course:	Project			**Code:** HME8982			
Teaching Scheme/week				**Evaluation Scheme**			
Lecture	**Practical**	**Hours**	**Credits**	**IE1**	**TW**	**OR**	**Total**
0	10	10	5	50	50	25	125

Prior knowledge of
Electric vehicle Systems & Vehicle Dynamics
Battery Technologies and power train for EVs.
Safety Regulations & Testing Standards for EVs

Objectives:

1. To be able to conceive and implement an idea with the understanding gained during the course work.
2. To plan for various activities of the project and direct the work towards product /process development.
3. To build, design, analyse and implement an application using available software/hardware platforms.

Outcomes:
The students will be able to,

1. Understand, plan and execute a project related to **electric mobility**
2. Design a real-time application based on electric vehicle components/process/application
3. Prepare a technical report based on the project.
4. Deliver technical seminars based on the project work carried out.
5. Understand publication and copyright process of research

Guidelines: Total: 24 h (contact) + 48 h (non-contact/implementation)

1. A group of 3 to 4 students needs to design and demonstrate the project under the guidance of the allocated guide.
2. Students can choose the project considering their implementation in Major Project.
3. The hardware implementation and or software simulation is compulsory.
4. Project Report should be submitted in compliance with term work associated with the subject.
5. Paper publication associated with the project as research outcome is appreciable.
6. Project work preferably should be completed in the laboratory/ industry.

Detailed Syllabus

Sr. No.	**Activity**	**Duration (H)**
1	Semester VII (week 1, 2 & 3): Project guide allotment, Finalization of topic and platform, Planning of the work, Literature review, identifying a problem, and formulating the problem for the project	**24**
2	Semester VII (week 4, 5 & 6): Methodology finalization, finalizing project proposal, Review 1 for finalization of topic and specification.	**24**
3	Semester VII (week 7, 8 & 9): Literature review, selection of hardware/software platform for implementation. Review -2 for understanding the methodology of work	**24**
4	Semester VIII (week 10, 11 & 12): Execute the design and analyse results obtained, Review 3 to demonstrate initial results and change in implementation plan	**24**
5	Semester VIII (week 13, 14, 15, 16, 17, 18, 19 & 20): Project Report writing and publication or copyright planning and execution.	**24**
6	Semester VIII (week 21, 22, 23, & 24): Demonstration of Project work and Final Review for submission and term work compliances.	**24**
	Total	**48**

Minor Course

Product Design and Development

Curriculum structure

Minor In Product Design and Development

Course Code	Semester	Course Name	Teaching Scheme					Evaluation Scheme						
			L	P	T	H	CR	IE1	IE2	ETE	TW	PR	OR	Total
MME5991 / MME5992	V	Design Thinking	3	-	1	4	4	20	30	50	25	-	-	125
MME6991 / MME6992	VI	Aesthetic and Ergonomic in Design	3	-	1	4	4	20	30	50	25	-	-	125
MME6993 / MME6994	VI	Design for X and Sustainability	3	-	1	4	4	20	30	50	25	-	-	125
MME7991	VII	Rapid Prototyping	3	-	-	3	3	20	30	50	--	-	-	100
MME8991	VIII	Integrated Project	-	10	-	10	5	50	-	-	75	-	--	125
		Total	**12**	**10**	**3**	**25**	**20**	**130**	**120**	**200**	**150**	**-**	**--**	**600**

Abbreviations are: L-Lecture, P-Practical, T-Tutorial, H- Hours, IE- Internal Evaluation, MTE- Mid Term Evaluation, ETE- End Term Evaluation, TW –Term-work, OR - Oral

Course Syllabus

Program:	**B. Tech Mechanical Engineering (Minor)**			**Semester: V**				
Course:	Design Thinking			**Code:** MME5991/MME5992				
Teaching Scheme/week				**Evaluation Scheme**				
Lecture	**Tutorial**	**Credit**	**Hours**	**IE1**	**IE2**	**ETE**	**TW**	**Total**
3	1	4	4	20	30	50	25	125

Prior knowledge of

Problem solving and Analytical skill, Design cycle of Products

Objectives:

1. To highlight the importance of thinking and creativity and impart the skills needed for enhancing design thinking
2. To introduce the concept of design thinking and understanding of design process
3. To learn various tools for design thinking

Outcomes:

The students will be able to,

1. Have fundamental capabilities in the methods used for practicing design Thinking.
2. Understand challenges and benefits of design Thinking.
3. Be able to communicate clearly about design Thinking.
4. Have a process and mindset suited to innovation and creative problem-solving.
5. Investigate design problems and generate ideas by creative thinking.

Detailed Syllabus

Unit	**Description**	**Duration (H)**
1	**Design Thinking tools** Concept of Design Thinking and Its Role within NPD and Innovation, Framework of Design Thinking, Principles and the "Mindset" of Design Thinking, Identifying Customer Needs, Product Specifications	**6**
2	**Phases of Design Thinking** - Empathize, Define	**6**
3	**Applied Creativity** Creativity, brainstorming, and concept generation process in designing.	**6**
4	**Phases of Design Thinking** - Ideate, Design Heuristics – Opposite, Concept, User needs,	**6**
5	**Phases of Design Thinking** - Prototype and Test	**6**
6	Apply Agile method to developing software, Design an App using the principles of Design Thinking, Develop an App for Android	**6**
	Total	**36**

Text Books:

1. Design Thinking, M G Luchs, K C Swan, Wiley-Blackwell, 2015

Reference books:

1. Design Thinking Methodology, Emrah Yayici , Publisher Emrah Yayici, 2016
2. Designing for Growth: A design thinking toolkit for Managers, Tim Ogilvie ,Columbia Business School Publishing
3. Integrated Design Engineering - Interdisciplinary and Holistic Product Development, Sándor Vajna, Springer International Publishing,Springer (2020)

Assignments:

1. **Use of Idea Generation software**
2. **Case Study - Analyzing existing product for improvement.**

Program:	**B. Tech Mechanical Engineering (Minor)**			**Semester: VI**				
Course:	Aesthetics and Ergonomics in Design			**Code:** MME6991/MME6992				
Teaching Scheme/week				**Evaluation Scheme**				
Lecture	**Tutorial**	**Credit**	**Hours**	**IE1**	**IE2**	**ETE**	**TW**	**Total**
3	1	4	4	20	30	50	25	125

Prior knowledge of
Design cycle of Products

Objectives:
1. To impart a basic understanding of Ergonomics in product design.
2. To make the learner aware of Aesthetic concepts.
3. To be able to understand the relation between Ergonomics and Industrial safety
4. To be able to apply aesthetics and ergonomics in Product design.

Outcomes:
The students will be able to,
1. Use basics of ergonomics and aesthetics in product design.
2. Apply aesthetic concepts such as colour code ,styles controls while designing product
3. Apply safety and occupational health and environment in industry.
4. Analyze field failure and reliability tests data using a suitable software package.

Detailed Syllabus

Unit	Description	Duration (H)
1	**Ergonomics and Production:** Ergonomics and product design –ergonomics in automated systems- expert systems for ergonomic design. Anthropometric data and its applications in ergonomic, design- limitations of anthropometric data- use of computerized database. Case study.	**6**
2	**Aesthetic Concepts**: Concept of unity- concept of order with variety - concept of purpose style and environment-Aesthetic expressions. Style components of style- house style, observation style in capital goods, case study	**6**
3	**Colour**: Colour and light -colour and objects- colour and the eye –colour consistency- colour terms- reactions to colour and colour continuation - colour on engineering equipments	**6**
4	**Ergonomics and Industrial Safety (EIS)**: Introduction - general approach to the man-machine relationship-workstation design-working position and posture. An approach to industrial design - elements of design structure for industrial design in engineering applications in manufacturing systems.	**6**
5	**Control and Displays:** configurations and sizes of various controls and displays;- design of controls in automobiles, machine tools etc., - design of furniture, design of instruments	**6**
6	**Safety & Occupational Health and Environment**: Application of Ergonomics in industry for Safety, Health and Environment Control; Prevention and specific safety measures for manufacturing and processing industry – safety in the use of machines, precaution for certain chemical industry. Environmental Safety and ISO 14000 System. Occupational Health – Health and Safety consideration; Personal protective Equipment	**6**
	Total	**36**

Text Books:
1. Product Design and Development Karl T. Ulrich, Steven G. Eppinger; Irwin McGraw Hill
2. Product Design and Manufacturing A.C. Chitale and R.C. GuptaPHI.
3. Introduction to Ergonomics R.C. Bridger McGraw Hill Pub.
4. Industrial Design for Engineers, Mayall W.H London, Hiffee booksLtd**.**

Reference books:
1. Industrial Design for Engineers: Mayall W.H, London, Hiffee books Ltd, 1988
2. Applied Ergonomics, Hand Book: Brien Shakel (Edited) Butterworth Scientific, London 1988.
3. Introduction to Ergonomics – R.C.Bridger, McGraw-Hill Pub.
4. Human Factor Engineering – Sanders & McCormick, McGraw-Hill Publications

Assignments:

Design Case studies Based on the Ergonomic design of Entity / Aesthetic design

1. Development of any product using high end CAD software considering following points

a. Needs of customer. market survey
b. Invention/Innovation of a product
c. Aesthetic & ergonomic considerations in product design
d. Preparation of various views of product
e. Design for assembly procedures
f. Product and maintenance manual
g. Product database management

2. Case study on any two points given below

a. Aesthetic & ergonomic considerations in product design
b. Industry – safety in the use of machines
c. Health safety in product design
d. Environment safety and ISO 14000 systems

Program:	**B. Tech Mechanical Engineering (Minor)**			**Semester: VI**				
Course:	Design for X and Sustainability			**Code:** MME6993/MME6994				
Teaching Scheme/week				**Evaluation Scheme**				
Lecture	**Tutorial**	**Credit**	**Hours**	**IE1**	**IE2**	**ETE**	**TW**	**Total**
3	1	4	4	20	30	50	25	125

Prior knowledge of

- Problem solving and Analytical skill
- Design cycle of Products

Objectives:

Students are expected to study,

1. Design for manufacturing and assembly (DFMA),
2. Applying DFX Experience in Design for Environment
3. Developing DFX tools and implementing design for X tools
4. Design for Inspectability
5. Design for Quality
6. Design for optimal environmental impact

Outcomes:

Course Outcomes: Learner will be able to…

1. Apply the principles in of Design for manufacturing and assembly (DFMA).
2. Apply the DFX Experience in Design for Environment in developing the sustainable product.
3. Develop DFX tools and implementing design for X tools in the new product development process
4. Apply the principle of Inspectability
5. Apply the Quality concepts in the development of new product.
6. Design product considering the Environmental Impact for sustainability

Detailed Syllabus

Unit	**Description**	**Duration (H)**
1	**Design for Manufacture and Assembly** Boothroyd- Dewhurst DFA Method, Boothroyd-Dewhurst Manufacture Analysis,, How DFMA Works, results of DFMA applications, roadblocks in implementation of DFMA, case experience with Hitachi, Lucas and Boothroyd - Dewhurst DFA methods	**5**
2	**Applying DFX Experience in Design for Environment** DFE as a member of the DFX family, DFE adds new aspects to DFX, DFE implementation has not yet had its breakthrough,	**7**
3	**Developing DFX tools and implementing design for X tools** Generic design for X (DFX) development framework: Seven-steps procedure for developing a DFX tool using the DFX shell, "design for x"- driven concurrent engineering, micro DFX procedure, macro BPR procedure,	**6**
4	**Design for Inspectability** Concurrent design: manufacturability and Inspectability, impacts of current changes in manufacturing and service status of design for Inspectability	**6**
5	**Design for Quality** Design and quality management, a design for quality methodology, design for quality software, case study of design for quality	**6**
6	**Design for environmental and Sustainability** Environmentally conscious design, a methodology of design for environment, case study **Failure Modes and Effects Analysis (FMEA)** Concept of failure – definition, modes, causes, root causes, mechanisms, effects, Types of FMEA and their associated benefits, - design level FMEA, system-level FMEA, and process-level FMEA, Steps for performing FMEA, Criticality assessment – risk priority number technique, military standard technique, FMEA information needs, data sources and users, FMEA implementation-related factors and general guidelines, Advantages of FMEA.	**6**
	Total	**36**

Text Books:

1. G. Q. Huang, Design for X, "Concurrent Engineering Imperatives, First Edition", Chapman & Hall, London, UK (2012).

Reference books:

1. Applications of Design for Manufacturing and Assembly, Ancuta Carmen Păcurar · 2019
2. Product Design for Manufacture and Assembly, Geoffrey Boothroyd, Peter Dewhurst, Winston A. Knight · 2010
3. The Engineering Design Primer, CRC, K. L. Richards · 2020

Assignments:

Case study on :

1. Design For Manufacturing and Assembly
2. Design for Quality
3. Design for Environmental
4. Design for Inspectability

Program:	B. Tech Mechanical Engineering (Minor)			Semester: VII				
Course:	Rapid Prototyping			Code: MME7991				
Teaching Scheme/week				Evaluation Scheme				
Lecture	Tutorial	Credit	Hours	IE1	IE2	ETE	TW	Total
3	--	3	3	20	30	50	--	100

Prior knowledge of
-Polymers Materials

Objectives:

1. To introduce students the basics of additive manufacturing / rapid prototyping and its applications in various fields, reverse engineering techniques.
2. To familiarize students with different processes in rapid prototyping systems.
3. To teach students about mechanical properties and geometric issues relating to specific rapid prototyping applications

Outcomes:

The students will be able to,

1. Demonstrate the knowledge of Additive Manufacturing and Rapid Prototyping technologies.
2. Understand and use techniques for processing of CAD models for rapid prototyping.
3. Understand and apply fundamentals of rapid prototyping techniques.
4. Use appropriate tooling for rapid prototyping process.
5. Use rapid prototyping techniques for reverse engineering.

Detailed Syllabus

Unit	Description	Duration (H)
1	**Introduction to Rapid Prototyping (RP)** Generic Additive Manufacturing (AM) Process, Need of RP in context of batch production, Basic principles of RP, Steps in RP, Process chain in RP in integrated CAD- CAM environment, Advantages of RP, Medical applications.	6
2	**CAD Modelling and Data Processing for RP** CAD model preparation, Data interfacing: formats (STL, SLC, CLI, RPI, LEAF, IGES, HP/GL, CT, STEP), conversation, validity checks, repair procedures; Part orientation and support generation, Support structure design, Model Slicing algorithms and contour data organization, direct and adaptive slicing, Tool path generation.	6
3	**RP Systems** Photopolymerization , Stereolithography (SL), SL resin curing process, SL scan patterns, Micro stereolithography, Applications of Photopolymerization Processes. Powder Bed Fusion: Selective laser Sintering (SLS), Powder fusion mechanism and powder handling, SLS Metal and ceramic part creation, Electron Beam melting (EBM), Applications of Powder Bed Fusion Processes.	8
4	**Extrusion-Based RP Systems** Fused Deposition Modelling (FDM), Principles, Plotting and path control 3 D Printing: 3D printing (3DP), Research achievements in printing deposition, technical challenges in printing, Printing process modelling, Applications of Printing Processes.	8
5	**Sheet Lamination** Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC), Gluing, Thermal bonding, LOM and UC applications. **Beam Deposition:** Laser Engineered Net Shaping (LENS), Direct Metal Deposition (DMD), Processing-structure-properties, relationships, Benefits and drawbacks	4
6	**Errors in RP Processes** Pre-processing, processing, post-processing errors, Part building errors in SLA, SLS.	4
	Total	**36**

Text Books:

1. Ian Gibson, David W. Rosen, Brent Stucker , "Additive Manufacturing Technologies" ,Springer,2009
2. Chua C. K., Leong K. F., and Lim C. S., "Rapid Prototyping: Principles and Applications", Second Edition, World Scientific Publishers (2003),.
3. Patri K. Venuvinod, Weiyin Ma "Rapid Prototyping: Laser-Based and Other Technologies" Springer , 2004

Reference books:

1. Noorani R, Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley & Sons. 4. Hilton P, Jacobs P F, Rapid Tooling: Technologies and Industrial Applications, CRC press.
2. Liou W L, Liou F W, Rapid Prototyping and Engineering applications: A tool box for prototype development, CRC Press.
3. Kamrani A K, Nasr E A, Rapid Prototyping: Theory and practice, Springer.

Program:	**B. Tech Mechanical Engineering (Minor)**			**Semester: VIII**			
Course:	Project			**Code:** MME8991			
Teaching Scheme/week				**Evaluation Scheme**			
Lecture	**Practical**	**Hours**	**Credits**	**IE1**	**TW**	**OR**	**Total**
-	10	10	10	50	75	--	125

Prior knowledge of

Design Thinking, Design for X, Ergonomics and Aesthetics, Rapid Prototyping

Objectives:

Students are expected to study,

1. Design Evolution process in product design and development cycle.
2. Designing, analysis, and implementation of real-time applications using available platforms.
3. Various activities are involved in the project and it's planning to channelize the work.

Outcomes:

The students will be able to,

1. Understand, plan and execute a project.
2. Design a real-time application
3. Prepare a technical report based on the project.
4. Deliver technical seminars based on the project work carried out.
5. Understand publication and copyright process of research

Guidelines: Total: 24 h (contact) + 96 h (non-contact/implementation)

1. A group of 3 to 4 students needs to design and demonstrate the project under the guidance of the allocated guide.
2. Students can choose the project considering their implementation in Major Project.
3. The hardware implementation and or software simulation is compulsory.
4. Project Report should be submitted in compliance with term work associated with the subject.
5. Paper publication associated with the project as research outcome is appreciable.
6. Project work preferably should be completed in the laboratory/ industry.

Detailed Syllabus

Sr. No.	**Activity**	**Duration (H)**
1	Week 1 & 2: Project guide allotment, Finalization of topic and platform, Planning of the work, Literature review, identifying a problem, and formulating the problem for the project	**20**
2	Week 3 & 4: Methodology finalization, finalizing project proposal, Review 1 for finalization of topic and specification.	**20**
3	Week 5 & 6: Simulation of Ideas on appropriate software tools and finalization of hardware platform	**20**
4	Week 7 & 8: Understanding platform implementation and related software flow and execute the block-level design, Review 2 to understand the progress of the project	**20**
5	Week 9 & 10: Project Report writing and publication or copyright planning and execution.	**20**
6	Week 11 & 12: Demonstration of Project work and Final Review for submission and term work compliances.	**20**
	Total	**120**

Minor Course

Reliability and Maintainability Engineering

Curriculum structure

Minor In Reliability and Maintainability Engineering

Course Code	Semester	Course Name	Teaching Scheme					Evaluation Scheme						
			L	P	T	H	CR	IE1	IE2	ETE	TW	PR	OR	Total
MME5993 / MME5994	V	Statistical Methods for Reliability	3	-	1	4	4	20	30	50	25	-	-	125
MME6993 / MME6994	VI	System Reliability & Maintainability Modeling	3	-	1	4	4	20	30	50	25	-	-	125
MME6995 / MME6996	VI	Design for Reliability & Maintainability	3	-	1	4	4	20	30	50	25	-	-	125
MME7992	VII	Reliability Testing	3	-	-	3	3	20	30	50	-	-	-	100
MME8992	VIII	Integrated Project	-	10	-	10	5	50	-	-	75	-	-	125
		Total	**12**	**10**	**3**	**25**	**20**	**130**	**120**	**200**	**150**	**-**	**-**	**600**

Abbreviations are: L-Lecture, P-Practical, T-Tutorial, H- Hours, IE- Internal Evaluation, MTE- Mid Term Evaluation, ETE- End Term Evaluation, TW –Termwork, OR - Oral

Course Syllabus

Program:	B. Tech Mechanical Engineering (Minor)			Semester: V				
Course:	Statistical Methods for Reliability			Code: MME5993/MME5994				
Teaching Scheme/week				Evaluation Scheme				
Lecture	Tutorial	Credit	Hours	IE1	IE2	ETE	TW	Total
3	1	4	4	20	30	50	25	125

Prior knowledge of

Basics of probability and statistics

Objectives:

1. To impart a basic understanding of probability and statistical techniques used in reliability engineering.
2. To make the learner aware of applications of probability distributions in modeling and analyzing failure data.
3. To be able to understand the techniques used to identify anomalies present in the data.
4. To be able to use software packages for estimating distribution parameters and reliability metrics.

Outcomes:

The students will be able to,

1. Use basics of reliability and its measures for analyzing components and systems.
2. Apply probability distributions to estimate reliability functions such as reliability, CDF, PDF, hazard rate, etc.
3. Select best-fit distribution using goodness-of-fit tests and estimate distribution parameters using a suitable method.
4. Predict the failure behavior of a component or a system and give recommendations for design modifications and maintenance planning.
5. Analyze field failure and reliability tests data using a suitable software package.

Detailed Syllabus

Unit	Description	Duration (H)
1	**Introduction** Reliability Engineering in 21st Century, Concept of failure, Failures of engineering systems, Causes of failures, Definitions – reliability, maintainability and availability, Reliability and quality, Repairable and non-repairable systems, Reliability objectives, How to meet reliability objectives. **Basic reliability mathematics:** Universe, Population, Sample, Random variables – Random variables - discrete and continuous, Probability mass function, Probability density function (PDF), Cumulative distribution function, Reliability function, Cumulative distribution function (CDF), Moments of time to failure - mean time to failure (MTTF), mean time between failure (MTBF), the median time to failure, mode, skewness, kurtosis, variance and standard deviation, Hazard rate function, Bathtub curve, Conditional reliability, Percentiles of product or system life.	8
2	**Discrete Probability Distributions and Their Applications in Reliability** Binomial distribution, Poisson distribution, Introduction to - geometric distribution, negative binomial distribution, and hypergeometric distributions.	4
3	**Continuous Probability Distributions – I** **Weibull Distribution**: Reliability function, CDF, PDF, Design life, MTTF, Variance, Standard deviation, Distribution parameters – shape, scale and location, Burn-in screening for Weibull, Failure modes, Identical Weibull components, 1-parameter and 2-parameter Weibull distribution. **Exponential Distribution:** Reliability function, CDF, PDF, MTTF, Variance, Standard deviation, Design life, Distribution parameters – hazard rate, location parameter, Memorylessness, Failure modes, Failures on demand, Repetitive loading, Reliability bounds, 1-parameter exponential distribution, Poisson process.	6
4	**Continuous Probability Distribution – II** **Normal (Gaussian) Distribution:** Reliability function, CDF, PDF, Design life, MTTF, Variance, Standard deviation, Distribution parameters – mean and standard deviation, Central limit theorem. **Lognormal Distribution:** Reliability function, CDF, PDF, Design life, MTTF, Variance, Standard deviation, Distribution parameters – shape parameter and location parameter, Relationship between Lognormal and Normal distributions. **Introduction to Other Distributions:** Uniform, Marginal, Rayleigh, Beta, Pareto, Gamma. **Probability Plotting**: Probability plotting papers - Weibull, exponential, and lognormal, etc., Steps in probability plotting, Rank statistics – Midpoint plotting position, expected plotting position, median rank, median rank estimate and Kaplan-Meier ranks, Linearizing	6

	reliability function or CDF, Determination of the distribution parameters - probability plotting papers, rank regression, maximum Likelihood Estimation.	
5	**Reliability Data** **Data sources and collection methods:** Data sources and collection methods – collection of primary data, collection of secondary data primary, Reliability of data, Suitability of data, Adequacy of data, Selection of a suitable method for data collection. **Categories of data –** Qualitative data, Quantitative data, Grouped and non-grouped, Time to failure data – complete, right censored, interval censored and left censored data, static life estimation. **Data Processing** – Processing operations – editing, coding, classification, tabulation,	**6**
6	**Goodness-of-fit Tests** Chi-square test, Kolmogorov-Smirnov, Bartlette's test, Mann's test, Goodness-of-fit test for large sample size, small sample size, complete and censored data, on fitting distributions, Goodness-of-fit tests, and parameter estimating using suitable software package/ programming language, Confidence level, and significance level	**6**
	Total	**36**

Text Books:

2. An Introduction to Reliability and Maintainability Engineering by C. E. Ebeling, Waveland Press inc., 2019.
3. Reliability Engineering by K. C. Kapur, and M. Pecht, Wiley, 2014.
4. Reliability Engineering by K. K. Agarawal, Springer International Edition, 2012.

Reference books:

4. Reliability Engineering by E. Balagurusamy, Tata McGraw Hill, 2017.
5. Reliability Engineering and Risk Analysis – A practical Guide by M. Modarres, K. Kaminsky, and V. Krivstov, CRC Press, Taylor and Francis Group, 2017.
6. Practical Reliability Engineering by P. D. T. O'Conner, John Wiley and Sons, 2012.
7. Life cycle reliability engineering by G. Yang, John Wiley and Sons, 2007.
8. Engineering Maintainability by B. S. Dhillon, Prentice Hall of India, 1999.

Miniature commitment or Assignments:

Group A – (Any three problems for a failure data set using suitable software package/ programming language)

1. Plotting reliability characteristics
2. Poisson/ Binomial distribution
3. Weibull distribution
4. Exponential distribution

Group B – (Any two problems for a failure data set using suitable software package/ tool)

5. Normal/ Lognormal distribution
6. Probability plotting and parameter estimation
7. Estimation of best-fit distribution using goodness-of-fit tests

Group C (Mandatory)

One mini project based on the above contents and using mechanical/ electronics/ electrical/ civil/ computer engineering application dataset.

Program:	**B. Tech Mechanical Engineering (Minor)**			**Semester: VI**				
Course:	System Reliability & Maintainability Modeling			**Code:** MME6993/MME6994				
Teaching Scheme/week				**Evaluation Scheme**				
Lecture	**Tutorial**	**Credit**	**Hours**	**IE1**	**IE2**	**ETE**	**TW**	**Total**
3	1	4	4	20	30	50	25	125

Prior knowledge of

Statistical methods used in reliability and maintainability

Objectives:

1. To be familiar with the techniques used in system reliability and maintainability modeling.
2. To expose the learner to the basic concepts of maintainability and availability.
3. To be familiar with the stochastics processes used in repairable systems modeling.
4. To expose the learners to the concept of human reliability in the engineering system.
5. To make the learner aware of software packages used for system reliability and maintainability modeling.

Outcomes:

The students will be able to,

1. Apply reliability block diagrams and fault tree analysis for reliability modeling.
2. Solve system reliability problems using suitable methods such as reliability block diagrams and fault tree analysis.
3. Apply suitable methods to identify anomalies and trends present in the failure data.
4. Analyze failure and repair data to predict the system's reliability, maintainability, and availability.
5. Evaluate human reliability in engineering systems.
6. Develop a life cycle costing model for a given system using suitable methods and data.

Detailed Syllabus

Unit	**Description**	**Duration (H)**
1	**Reliability Block Diagrams (RBDs):** Series system, Redundant systems: active and passive, k-out-of-n systems, Series-parallel/ Parallel -series systems, High level versus low-level redundancy, Reliability of complex systems - complete enumeration method, conditional probability method (total law of probability), Minimal path/ cut sets based SDP (sum of disjoint products), Redundancy limitations - common-mode failures, load sharing, switching and standby failures, confidence interval estimations, measures of component importance, reliability allocation, redundancy allocation, Use suitable software package to solve reliability block diagrams.	**6**
2	**Fault Tree Analysis (FTA):** History, Steps involved in FTA, building blocks of fault tree diagram – primary events, gate symbols, transfer symbols, Boolean algebra, Qualitative and quantitative evaluation of fault tree, an analogy between fault tree diagram and reliability block diagrams, Cut-sets and tie sets, Top-down and bottom-up approach, Use of FTA approach, FTA report, FTA analysis using a suitable software package.	**5**
3	**Repairable System Reliability and Maintainability** Repairable and non-repairable systems, Maintenance definition, Need of maintenance, Analysis of downtime, repair time distributions – exponential, lognormal, etc., **Stochastic point processes** – renewal process, homogeneous Poisson process, superimposed renewal process, minimal repair process, non-homogeneous Poisson process, Overhaul and cycle time, System repair time – system having redundant components, Reliability under preventive maintenance, State-dependent systems with the repair. **Repairable System's Data Analysis -** Need and methods of trend analysis, Graphical methods - timeline plot, cumulative failures versus time, scatter plot of successive service lives, Nelson-Aalen plot, Total time on test plot, Analytical methods - Mann test, Military handbook test, Test for Power Law process model,	**7**
4	**Availability** Concepts and definitions, Categories of availability – inherent, achieved, operational availability, generalized operational availability, Markov models/ chains – state-space diagrams, Exponential availability model, System availability – availability with standby systems, steady-state availability, matrix approach, Inspection, and repair availability model, Design trade-off analysis – maintainability allocation, economic analysis, concave cost, convex cost functions, Profit and life cycle cost trade-offs.	**6**

5	**Life Cycle Costing (LCC)** Introduction, Reasons and uses of LCC and required inputs, LCC steps and activities, Skills requirements areas of LCC analysts and associated professionals, LCC program evaluation area and LCC estimate report, Time-dependent formula, LCC estimation models, Cost estimation models, Cost capacity model, Motor operation cost estimation model, Corrective maintenance labor cost estimation model, Life cycle costing data, Cost sources, LCC advantages, and disadvantages.	**6**
6	**Human Reliability in Engineering System** Introduction, Terms and definitions, Human error occurrence classification, types and causes, Human performance and stress, Human performance reliability in continuous and mean time to human error measure, Human reliability evaluation methods – probability tree method, fault tree method, Markov method, Human error data.	**6**
	Total	**36**

Text Books:

1. An Introduction to Reliability and Maintainability Engineering by C. E. Ebeling, Waveland Press inc., 2019.
2. Reliability Engineering by K. C. Kapur, and M. Pecht, Wiley, 2014.
3. Reliability Engineering by K. K. Agarawal, Springer International Edition, 2012.
4. Design Reliability: Fundamentals and Application by B. S. Dhillon, CRC Press, 1999.

Reference books:

1. Reliability Engineering: Theory and Practice by A. Birolini, Springer International Edition, 2017.
2. Reliability Engineering by E. Balagurusamy, Tata McGraw Hill, 2017.
3. Reliability Engineering and Risk Analysis – A practical Guide by M. Modarres, K. Kaminsky, and V. Krivstov, CRC Press, Taylor and Francis Group, 2017.
4. Reliability Engineering by L. S. Shrinath, East-West Press, New Delhi, 2005.
5. Practical Reliability Engineering by P. D. T. O'Conner, John Wiley and Sons, 2012.
6. Life cycle reliability engineering by G. Yang, John Wiley, and Sons, 2007.
7. Maintenance, Replacement, and Reliability: Theory and Applications by A. K. S. Jardine, and H. C. Tsang, Taylor and Francis, 2006.
8. Engineering Maintainability by B. S. Dhillon, Prentice Hall of India, 1999.

Miniature commitment or Assignments:

Group A – (Any three problems for a failure and repair data set using suitable software package)

1. Series system/ redundant system/ Series-parallel system
2. Complex system
3. Fault tree analysis
4. Maintainability modeling including anomaly detection and trend analysis

Group B – (Any two problems for a failure and repair data set using suitable software package/ tool)

1. Availability modeling using Markov models
2. Life cycle costing
3. Human reliability analysis

Group C (Mandatory)

One mini project based on the above contents and using mechanical/ electronics/ electrical/ civil/ computer engineering application dataset.

Program:	**B. Tech Mechanical Engineering (Minor)**			**Semester: VI**				
Course:	Design for Reliability and Maintainability			**Code:** MME6995/MME6996				
Teaching Scheme/week				**Evaluation Scheme**				
Lecture	**Tutorial**	**Credit**	**Hours**	**IE1**	**IE2**	**ETE**	**TW**	**Total**
3	1	4	4	20	30	50	25	125

Prior knowledge of

Statistical methods used in reliability and maintainability
System reliability modeling

Objectives:

1. To expose students to the concept of failure, failure modes, mechanisms, causes, and their effects at component, sub-system, and system level.
2. To familiarize students with methods used for the reliability allocation.
3. To be able to understand the stress-strength model and probabilistic approach in design.
4. To expose students to learn the concept of maintainability.
5. To impart basic understanding of FIDES: handbook-based reliability predictions.

Outcomes:

The students will be able to,

1. Apply FMEA technique to identify critical failure modes, mechanisms, and their effects on the system.
2. Select a suitable method for reliability allocation and solve problems.
3. Use stress-strength models and probabilistic approaches in design and solve reliability problems.
4. Apply to select suitable maintainability method for maintenance planning, spare allocation, and maintainability predictions.
5. Analyze failure and repair data and provide methods to improve system reliability and maintainability.
6. Apply handbook-based methods to predict the reliability of electronic components.

Detailed Syllabus

Unit	**Description**	**Duration (H)**
1	**Failure Modes and Effects Analysis (FMEA)** Concept of failure – definition, modes, causes, root causes, mechanisms, effects, Types of FMEA and their associated benefits, - design level FMEA, system-level FMEA, and process-level FMEA, Steps for performing FMEA, Criticality assessment – risk priority number technique, military standard technique, FMEA information needs, data sources and users, FMEA implementation-related factors and general guidelines, Advantages of FMEA.	**5**
2	**Reliability Allocation** Definition, Reliability allocation methods – equal allocation, weighting factor, and optimal reliability allocation. **Weighting factor methods –** ARINC, AGREE, Feasibility of objectives, Aggarwal's method, Integrated factor. **Optimal reliability allocation methods:** Redundancy allocation, Cost minimization problem formulation, Sharma and Venkateswaran method.	**7**
3	**Reliability Predictions from Stress-Strength Models** Introduction, Stresses due to internal and external environments, Physics of failure, Reliability from stress-strength distributions, Reliability from similar stress-strength distributions, Reliability from dissimilar stress-strength distributions, Graphical approach, Time-dependent stress-strength models, **Probabilistic Design for Reliability and factor of safety –** Design for reliability, Design of a tension element, Reliability models for probabilistic design, Relationship between reliability, the factor of safety and variability, Functions of random variables, Steps for probabilistic design.	**6**
4	**Design for maintainability** Maintenance requirements – measurements and specifications, maintenance concepts and procedures, component reliability and maintainability, Design methods – fault-diagnosis and self-diagnostics, parts standardization and interchangeability, modularization and accessibility, repair versus replacement, Proactive maintenance – preventive, predictive, Human factors and ergonomics, Maintenance and spare provisioning, Maintainability predictions and Demonstration, Birth-death queueing model, Reliability centered maintenance.	**6**

5	**Reliability Improvement Methods** Usage of better components, System simplifications, Derating, Redundancy, Controlling the work environment, Maintenance, Process control and product reliability, Application of Burn-in tests, Worst-case design, Human reliability. **Warranty Analysis:** Product warranties, Warranty returns information, Warranty policies, Warranty and reliability, Warranty cost analysis, Warranty and reliability management.	**6**
6	**Handbook Based Reliability Predictions** What is handbook-based reliability prediction, Handbook-based reliability prediction methods, FIDES: FIDES general model, Factors considered and its classification, 217+ based reliability predictions.	**6**
	Total	**36**

Text Books:

1. An Introduction to Reliability and Maintainability Engineering by C. E. Ebeling, Waveland Press inc., 2019.
2. Reliability Engineering by K. C. Kapur, and M. Pecht, Wiley, 2014.
3. Reliability Engineering by K. K. Agarawal, Springer International Edition, 2012.

Reference books:

1. Reliability Engineering: Theory and Practice by A. Birolini, Springer International Edition, 2017.
2. Reliability Engineering by E. Balagurusamy, Tata McGraw Hill, 2017.
3. Reliability Engineering and Risk Analysis – A practical Guide by M. Modarres, K. Kaminsky, and V. Krivstov, CRC Press, Taylor and Francis Group, 2017.
4. Reliability Engineering by L. S. Shrinath, East-West Press, New Delhi, 2005.
5. Practical Reliability Engineering by P. D. T. O'Conner, John Wiley and Sons, 2012.
6. Life cycle reliability engineering by G. Yang, John Wiley, and Sons, 2007.
7. Maintenance, Replacement, and Reliability: Theory and Applications by A. K. S. Jardine, and H. C. Tsang, Taylor and Francis, 2006.
8. Engineering Maintainability by B. S. Dhillon, Prentice Hall of India, 1999.

Miniature commitment or Assignments:

Group A – (Case studies on following topics using suitable software package/ programming language - Any four)

1. Failure modes and effects analysis (FMEA)
2. Reliability allocation
3. Stress-strength models
4. Maintainability analysis
5. Handbook-based reliability predictions.

Group C (Mandatory)

One mini project based on the above contents and using mechanical/ electronics/ electrical/ civil/ computer engineering application dataset.

Program:	B. Tech Mechanical Engineering (Minor)			Semester: VII				
Course:	Reliability Testing			Code: MME7992				
Teaching Scheme/week				Evaluation Scheme				
Lecture	Tutorial	Credit	Hours	IE1	IE2	ETE	TW	Total
3	-	3	3	20	30	50	-	100

Prior knowledge of

Statistical methods used in reliability and maintainability
System reliability modeling
Design for reliability and maintainability

Objectives:

1. To introduce basic concepts of reliability testing, and accelerated life testing (ALT), highly accelerated life testing (HALT), and reliability growth testing.
2. To expose students to the concepts of design of experiments and analysis of variance.
3. To explain physics reliability models and their applications to model failure mechanisms.
4. To impact the basic understanding of non-destructive testing methods.

Outcomes:

The students will be able to,

1. Explain basic concepts of reliability and life.
2. Use suitable methods to solve problems on ALT, HALT, and HASS.
3. Perform design of experiments and analysis of variance.
4. Use physical reliability model for various failure mechanics.
5. Select appropriate reliability testing methods for analyzing reliability tests data.
6. Select a suitable non-destructive technique for a given application.

Detailed Syllabus

Unit	Description	Duration (H)
1	**Introduction: Reliability Testing** Product testing, Objectives of life tests, Types of reliability tests – life test with censoring, test with or without replacement, burn-in tests, storage/ operation tests/ transportation/ shipment test, data collection, highly accelerated life testing (HALT), Test time calculations – length of test, Burn-in testing, Acceptance testing – Binomial testing/ sequential testing, Introduction to qualification and demonstration testing.	6
2	**Accelerated Life Testing (ALT)** Introduction, Basic concepts, Accelerated life testing – number of units on tests, accelerated cycling, constant stress model, Experimental design, Competing failure modes, Methods of ALT data quantification, Temperature stress and failure rates – acceleration factor, Stress combinations in ALT – Eyring model, power model/ stress scale model, combined temperature-humidity stresses, Recent Developments, Limitations, Step-stress methods for ALTs, Accelerated cycling, Constant accelerated stress model, Cumulative damage model, Arrhenius model, degradation model.	6
3	**Highly Accelerated Life Testing (HALT)** What is HALT, Goals of HALT, HALT plan, the Stress level for HALT, highly accelerated stress screening (HASS) – stress level, optimization, highly accelerated stress audit (HASA), Equipment for HALT and HASS – vibration shakers, thermal equipment, Distribution excitation, Precautions while Performing HALT and HASS. **Reliability Growth testing** The reliability growth process, Idealized growth curve, Duane growth model, AMSAA model, parameter estimation for the Power law intensity function, other growth models.	6
4	**Design of Experiments (DoE)** Fundamentals of design of experiments, Terms used in DoE – factors, levels, blocks, center point, repetitions, replications, etc., Types of DoEs - Full factorial design, fractional factorial design, Taguchi designs. **Analysis of variance (ANOVA)** – Introduction, Principle of analysis of variance, Types – one-way and two-way ANOVA.	6
5	**Physical Reliability Models** Covariate models – Proportional hazards models, Location scale model. Static models – Random stress and constant strength, Constant stress and random strength, Random stress and random strength. Dynamic models – Periodic loads, random loads,	6

	Physics of failure Models - conceptual model, Norris-Landzberg model, Arrhenius law, Peck's model, Basquin's law, Comparison of covariate and physics of failure models.	
6	**Non-Destructive Testing** Comparison of destructive and non-destructive testing (NDT), the scope of NDT, Classification - Liquid penetrant testing, Eddy current tests, Ultrasonic testing, Radiography, Magnetic particle method.	**6**
	Total	**36**

Text Books:

1. Reliability Engineering and Life Testing by V. N. A. Naikan, PHI Learning, 2008.
2. Accelerated Testing and Validation by A. Porter, Elsevier, 2012.
3. Accelerated Reliability and Durability Testing Technology by L. M. Klyatis, Wiley, 2012.
4. An Introduction to Reliability and Maintainability Engineering by C. E. Ebeling, Waveland Press inc., 2019.

Reference books:

1. Reliability Engineering: Theory and Practice by A. Birolini, Springer International Edition, 2017.
2. Reliability Engineering by E. Balagurusamy, Tata McGraw Hill, 2017.
3. Reliability Engineering and Risk Analysis – A practical Guide by M. Modarres, K. Kaminsky, and V. Krivstov, CRC Press, Taylor and Francis Group, 2017.
4. Reliability Engineering by L. S. Shrinath, East-West Press, New Delhi, 2005.
5. Practical Reliability Engineering by P. D. T. O'Conner, John Wiley and Sons, 2012.
6. Life cycle reliability engineering by G. Yang, John Wiley, and Sons, 2007.
7. Maintenance, Replacement, and Reliability: Theory and Applications by A. K. S. Jardine, and H. C. Tsang, Taylor and Francis, 2006.
8. Engineering Maintainability by B. S. Dhillon, Prentice Hall of India, 1999.
9. FIDES: Handbook Based Reliability Predictions by FIDES, 2010.

Miniature commitment or Assignments:

Group A – (Any two problems for reliability tests data set using suitable software package)

1. Life testing with censoring
2. Life testing with replacement
3. Life testing without replacement

Group B – (Any three problems for a failure data set using suitable software package/ tool)

1. Accelerated life testing
2. Highly accelerated life testing
3. Design of experiments/ analysis of variance
4. Physics of failure models
5. Non-destructive testing

Program:	B. Tech Mechanical Engineering (Minor)			Semester: VIII			
Course:	Project			Code: MME8992			
Teaching Scheme/week				Evaluation Scheme			
Lecture	Practical	Hours	Credits	IE1	TW	OR	Total
-	10	10	5	50	75	-	125

Prior knowledge of

Basics of probability distributions used in system reliability and maintainability modeling and analysis.
Basics of design approaches used in designing, reliability testing.
Basics of suitable software packages used for the analysis of failure data.

Objectives:

Students are expected to study,

1. Reliability and maintainability in product design and development processes.
2. Various activities are involved in the project and its planning to channelize the work.
3. Building, designing, analysis, and implementation of real-time applications using available platforms.

Outcomes:

The students will be able to,

1. Understand, plan and execute a project.
2. Design a real-time application
3. Prepare a technical report based on the project.
4. Deliver technical seminars based on the project work carried out.
5. Understand publication and copyright process of research

Guidelines:

1. A group of 3 to 4 students needs to design and demonstrate the project under the guidance of the allocated guide.
2. Students can choose the project considering their implementation in Major Project.
3. The hardware implementation and or software simulation is compulsory.
4. Project Report should be submitted in compliance with term work associated with the subject.
5. Paper publication associated with the project as research outcome is appreciable.
6. Project work preferably should be completed in the laboratory/ industry.

Detailed Syllabus

Sr. No.	Activity	Duration
1	Semester VIII (week 1 & 2): Project guide allotment, Finalization of topic and platform, Planning of the work, Literature review, identifying a problem, and formulating the problem for the project	20
2	Semester VII (week 3 & 4): Methodology finalization, finalizing project proposal, Review 1 for finalization of topic and specification.	20
3	Semester VII (week 5 & 6): Simulation of Ideas on appropriate software tools and finalization of hardware platform	20
4	Semester VII (week 7 & 8): Understanding platform implementation and related software flow and execute the block-level design, Review 2 to understand the progress of the project	20
5	Semester VIII (week 9 & 10): Project Report writing and publication or copyright planning and execution.	20
6	Semester VIII (week 11 & 12): Demonstration of Project work and Final Review for submission and term work compliances.	20
	Total	120

Minor Course

Entrepreneurship Development

Curriculum structure

Minor In Entrepreneurship Development

Course Code	Semester	Course Name	Teaching Scheme					Examination Scheme					
			L	P	T	H	CR	IE1	IE2	ETE	TW	OR	Total
MME5995	V	Introduction to Entrepreneurship	4	-	-	4	4	20	30	50	-	-	**100**
MME6995	VI	Business Opportunity Identification	4	-	-	4	4	20	30	50	-	-	**100**
MME6997 / MME6998	VI	Management and Mini Project in Entrepreneurship	2	4	-	6	4	20	30	-	50	50	**150**
MME7993	VII	Start up and New venture Management	3	-	-	3	3	20	30	50	-	-	**100**
MME8993	VIII	Project / Internship in Entrepreneurship		10	-	10	5	-	-	-	100	50	**150**
		Total	**13**	**14**	**0**	**27**	**20**	**80**	**120**	**150**	**150**	**100**	**600**

Abbreviations are: L-Lecture, P-Practical, T-Tutorial, H- Hours, IE- Internal Evaluation, MTE- Mid Term Evaluation, ETE- End Term Evaluation, TW –Term work, PR-Mini Project / Major Project OR - Oral

Course Syllabus

Program:	B. Tech Mechanical Engineering (Minor)			Semester :V				
Course :	Introduction to Entrepreneurship			Code : MME5995				
Teaching Scheme/week				Evaluation Scheme				
Lecture	Tutorial	Hours	Credits	IE1	IE2	ETE	PR	Total
4	-	4	4	30	20	50	-	100

Prior knowledge of

-No any Prior knowledge required**.**

Objectives:

1. To develop entrepreneurship awareness
2. To inculcate entrepreneurial mind-set into the minds of young professionals
3. To identify entrepreneurial opportunities
4. To leverage skills for founding, leading & managing Startups

Outcomes:

At the end of course, student will be able to:

1. Develop traits and factors influencing development of entrepreneurship as a profession
2. Discover skill sets required for successful Entrepreneurship
3. Make use of Business Laws in India to start Business
4. Examine essentials to avoid failure in Entrepreneurship.

Detailed Syllabus

Unit	Description	Duration (H)
1	**Introduction to Entrepreneurship** **-** Meaning, Definition and concept of Enterprise, Entrepreneurship Development, Evolution of Entrepreneurship, Motivation theories- McClelland's Need Achievement Theory, Concepts of Entrepreneurship, Entrepreneur v/s Entrepreneur, Entrepreneur Vs. Manager, Role of Entrepreneurship in Economic Development, Factors affecting Entrepreneurship, Problems of Entrepreneurship **Case Study of Indian Entrepreneurs in Pre-Independence Era and Post-Independence Era**	**8**
2	**The Entrepreneur:** Why to become entrepreneur ,Types of Entrepreneur , Concept of Social Enterprise and Social Entrepreneurship**,** Social Entrepreneurs, Rural Entrepreneurship, Family Business Entrepreneurship**,** The entrepreneurial decision process, **Case Study of Entrepreneurship in different Sectors**	**8**
3	**Women Entrepreneurs:** Significance of women entrepreneurship , Factors contributing to women Entrepreneurship, Characteristics – Challenges faced by Women Entrepreneurs , Growth of women Entrepreneurship Achievements of Woman Entrepreneurs, Role Models of Woman Entrepreneur. **Case Study of First Generation Women Entrepreneurs in India**	**8**
4	**Skills for Successful Entrepreneurs:** Communication Skills, Creativity and Problem solving, Innovation, Negotiation Skills, Risk management **Case Study of Successful Entrepreneurs- Cases of Tata, Birlas, Kirloskar and new generation entrepreneurs in India**	**8**
5	**Business Organizations and Business Laws:** Types of Business Organizations -Sole Proprietorship, Joint Hindu Family Business, Partnership, Limited Liability Partnership (LLP), Corporate Governance, Franchising, Business Laws in India to start Business	**8**
6	**Concepts of Entrepreneurship Failure:** Issues of Entrepreneurial failure, Reasons of Entrepreneurial Failure, Essentials to Avoid failure in Entrepreneurship. **Case Study of failure in Entrepreneurship**	**8**
	Total	**48**

Activities (Suggested but not limited to):

1. Interview with First Generation Entrepreneurs
2. Case Study of Successful Entrepreneurs
3. Alumni Talk on Entrepreneurship by Successful Entrepreneur (Alumni)
4. Training program for developing soft skills for Entrepreneurs (Communication Skills, Creativity and Problem solving, Innovation, Negotiation Skills, Risk management)
5. Study Visit to Incubation Centre
6. Participation in Entrepreneurship Awareness Camp (EAC)

Reference books:

1. Dynamics of Entrepreneurship Development – Vasant Desai.
2. Entrepreneurship: New Venture Creation – David H. Holt
3. Entrepreneurship Development New Venture Creation – Satish Taneja, S.L.Gupta
4. Entrepreneurship Development and small business management – Poornima M. Charantimath

Program:	**B. Tech Mechanical Engineering (Minor)**			**Semester : VI**				
Course :	Business Opportunity Identification			**Code :** MME6995				
Teaching Scheme/week				**Evaluation Scheme**				
Lecture	**Tutorial**	**Hours**	**Credits**	**IE1**	**IE2**	**ETE**	**PR**	**Total**
4	-	4	4	30	20	50	-	100

Prior knowledge of Introduction to Entrepreneurship

Objectives:

1. To develop entrepreneurship awareness
2. To inculcate entrepreneurial mind-set into the minds of young professionals
3. To identify entrepreneurial opportunities
4. To learn & understand the processes and practices in business and their applications
5. To create successful Entrepreneurs

Outcomes:

1. At the end of course, student will be able to:
2. Determine Business Opportunities Identification
3. Make use of the different Government initiatives and different support organizations in encouraging and supporting Entrepreneurship
4. Make use of the Intellectual Property Rights

Detailed Syllabus

Unit	**Description**	**Duration (H)**
1	**Business Opportunity Identification** Concept of Business Opportunity, What is a business idea, How to generate Business Ideas? Business Opportunities Identification Process, Business Value Chain, different sections of the business value chain for potential opportunities	**8**
2	**Business opportunity Identification Techniques,** Business Opportunities in India, Different Business Models, Identifying the right Business Model Canvas, Opportunities in different industries / Sectors Opportunities arising out of digitization	**8**
3	**Startup opportunities** Meaning of Startup The Rise of The startup Economy Startup Policy, Startup opportunities, Registration and Legal Process of Startups. The Startup Ecosystem -Entrepreneurship in India.	**8**
4	**Government Initiatives:** Role of Government in promoting Entrepreneurship in India, Start up India, Atmanirbhar Bharat, Make in India Assistance to an Entrepreneur Industrial Park , Special Economic Zone , MSME Act , MSME policy in India Financial assistance to MSME , Various Government schemes - PMEGP, CGTMSE, PMKVY, Mudra loan Case studies of Start ups	**8**
5	**Role of Institutional Support** Agencies for Policy Formulation and Implementation: District Industries Centres (DIC), Small Industries Service Institute (SISI), Entrepreneurship Development Institute of India (EDII), National Institute of Entrepreneurship & Small Business Development (NIESBUD) Concept of Incubation, Role of Incubation Centres, Support from Incubation centres Role of Mentors , Role of consultancy organizations in promoting Entrepreneurs	**8**
6	**Intellectual Property Rights and Entrepreneurship:** Concept of Intellectual Property Rights, Role of IPR in Entrepreneurship, IP strategy for start-up and MSME Patent, Trademark, Copyright, Industrial Design Act	**8**
	Total	**48**

Activities (Suggested but not limited to):

1. Interview with First Generation Entrepreneurs
2. Case Studies
3. Alumni Talk on Entrepreneurship by Successful Entrepreneur (Alumni)
4. Study Visit to Incubation Centre, Accelerator, MSME, Government office
5. Participation and completion certificate of EAC/EDP/WEDP
6. Business Presentations

Reference books:

1. Dynamics of Entrepreneurship Development – Vasant Desai.
2. Entrepreneurship: New Venture Creation – David H. Holt
3. Entrepreneurship Development New Venture Creation – Satish Taneja, S.L.Gupta
4. Entrepreneurship Development and small business management – Poornima M. Charantimath

Program:	**B. Tech Mechanical Engineering (Minor)**					**Semester :VI**			
Course :	Management and Mini Project in Entrepreneurship					**Code :** MME6997/MME6998			
Teaching Scheme/week				**Evaluation Scheme**					
Lecture	**Practical /Activity**	**Hours**	**Credits**	**IE1**	**IE2**	**ETE**	**TW**	OR	**Total**
2	4	4	6	30	20	-	50	50	150

Prior knowledge of

- **No any Prior knowledge required.**

Objectives:

1. To develop entrepreneurship awareness
2. To inculcate entrepreneurial mind-set into the minds of young professionals
3. To leverage managerial & leadership skills for founding, leading & managing Startups
4. To learn & understand the processes and practices in business and their applications
5. To create successful Entrepreneurs

Outcomes:

At the end of course, student will be able to:

1. Make use of key concepts of management
2. Determine Marketing management, marketing mix concept for business.
3. Discover Inter Personal Relationship ,leadership skills essential for entrepreneurial success
4. Apply customer relations concepts related to business functions

Detailed Syllabus

Unit	**Description**	**Duration (H)**
1	**Management:** Meaning, Definition, Need and Process of Management Managerial levels/Hierarchy: Top Level, Middle Level, Lower Level Five Functions of Management: Planning, Organizing, Staffing, Directing, Controlling Managerial Skills: Technical Skill, Human Skill, Conceptual Skill	**4**
2	**Organizing and staffing:** Importance and Process of Organizing, Organizational structure: Functional organization, Product Organization, Territorial Organization Staffing and its importance in the organization, Recruitment and Selection Process, Performance Appraisal	**4**
3	**Marketing Management:** Definition & Functions of Marketing- Scope of Marketing, Core concepts of marketing: -Need, Want, Demand, Customer Value, Exchange, Customer Satisfaction, Customer Delight, Customer loyalty Company orientation towards market place, Segmentation, Target Marketing & Positioning,	**4**
4	**Marketing Mix:** Marketing Mix, 7P's - Product, Price, Place, Promotion, People, Process, Physical evidence. Product Life Cycle	**4**
5	**Inter Personal Relationship and Understanding Individual Behavior** Importance of maintaining good inter personal relationship with related people in business Need for leadership in the enterprise development Characteristics of a good leader Various styles of Leadership Definition Personality, importance of personality in Performance Ego State, Johari window- Transactional Analysis	**4**
6	**Customer Relationship Management (CRM)** What is CRM? , Customer Life Cycle, Use of CRM in Business, Five steps consumer buyer decision process – Problem Recognition, Information Search, Evaluation of Alternatives, Purchase Decision, Post Purchase behavior.	**4**
	Total	**24**

Reference books:

1. Dynamics of Entrepreneurship Development – Vasant Desai.
2. Entrepreneurship: New Venture Creation – David H. Holt
3. Entrepreneurship Development New Venture Creation – Satish Taneja, S.L.Gupta
4. Entrepreneurship Development and small business management – Poornima M. Charantimath 5. Organizational Behaviour - Stephen Robbins
6. Marketing Management: A South Asian Perspective, 14th Edition (English), Philip Kotler, K. Keller, Abraham Koshy and Mithileshwar Jha

Practical /Activity	
Description	**Duration (H)**
Activities (Suggested but not limited to): 1. Case Studies 2. Role Plays 3. Achievement Motivation Trainings 4. Management Skill Enhancement Workshops 5. Participation and completion certificate of EAC/EDP/WEDP 6. Business Presentations **Expected to submit Mini Project using concepts of following topics:** 1. Management 2. Organizing and staffing 3. Marketing Management 4. Marketing Mix 5. Inter Personal Relationship and Understanding Individual Behavior 6. Customer Relationship Management (CRM) **Mini Project submissions should be based on concepts learned during theory sessions of this subject.** **Mini Project (Suggested but not limited to):** 1. Market Survey for MSME 2. Survey to improve Customer Relationship 3. Development of New Product /Prototype 4. Business Presentations with scope 5. Use of Marketing Mix for developing business strategy 6. Interview and Analysis of MSME -	**24**
Total	**24**

Program:	**B. Tech Mechanical Engineering (Minor)**				**Semester :VII**		
Course :	Start up and New venture Management				**Code :** MME7993		
Teaching Scheme/week				**Evaluation Scheme**			
Lecture	**Tutorial**	**Hours**	**Credits**	**IE1**	**IE2**	**ETE**	**Total**
3	-	3	3	30	20	50	100

Prior knowledge of

- Introduction to Entrepreneurship ,Business Opportunity Identification

Objectives:

1. To develop entrepreneurship awareness
2. To inculcate entrepreneurial mind-set into the minds of young professionals
3. To learn & understand the processes and practices in business and their applications
4. To create successful Entrepreneurs

Outcomes:

At the end of course, student will be able to:

1. Assess Business plan, business pitch as an entrepreneurial tool
2. Make use of concepts of Business Management
3. Identify Financial Support System for Business Management
4. Select Market Survey techniques for business
5. Discover different ways for new venture development

Detailed Syllabus

Unit	**Description**	**Duration (H)**
1	**Business Plan** The Business plan as an entrepreneurial tool, Elements of Business Plan Market Analysis Technical Analysis Financial Analysis Economic Analysis SWOT analysis, Internal and External Environment Analysis	**6**
2	**Business Management** Business model for venture, Value Proposition, Customer Segments, Channels and Partners, Revenue Model and Streams, Key Resources Manage a Team, Concept of Costs, Profits, and Losses, Project Manager, Project Life Cycle,	**6**
3	**The Financial Road Map:** Financial Support System: Forms of Financial support, Long term and Short term financial support, Sources of Financial support, Planning/Budgeting, Developing a financial roadmap, How to budget for startup success, sources of funding, Informal capital– Friends & Family, MPDA, SFURTI. Crowd funding, Venture capital, Private Equity, Financing Mix Role of Commercial Banks - SIDBI, NABARD, EXIM Bank and Other Agencies; Institutional Assistance for Small Enterprises	**6**
4	**Market Survey and Research:** What is a market survey? Process of conducting a market survey, Primary and secondary sources of information, Market survey tools, Preparation of schedule, Techniques of data collection Questionnaire	**6**
5	**New Venture Development:** Enterprise growth, expansion & diversification New venture Expansion Strategies and Issues Features and evaluation of joint ventures, acquisitions, merges, franchising. Public issues, rights issues, bonus issues and stock splits. Critical risk contingencies of the proposal	**6**

6	**Business Pitch**: The Business Pitch, Preparing for your investor presentation, Elements of the perfect investment pitch How to Deliver an investor pitch to a panel of investors	**6**
	Total	**36**

Activities (Suggested but not limited to):

1. Case Studies
2. Management Skill Enhancement Workshops
3. Participation and completion certificate of EAC/EDP/WEDP
4. Business Plan Presentations
5. Interaction with CAs, Bank Managers.
6. Participation in National Level competitions- Start-ups /hackathon / business plan / Business pitch event.
7. Participation in Government of India / Government of Maharashtra initiative related Startup activity
8. Study Visits

Reference books:

1. Dynamics of Entrepreneurship Development – Vasant Desai.
2. Entrepreneurship: New Venture Creation – David H. Holt
3. Entrepreneurship Development New Venture Creation – Satish Taneja, S.L.Gupta
4. Entrepreneurship Development and small business management – Poornima M. Charantimath 5. Project management – K. Nagarajan.
5. Innovation and Entrepreneurship – Peter F. Drucker

Program:	**B. Tech Mechanical Engineering (Minor)**			**Semester :VIII**					
Course :	Project / Internship in Entrepreneurship			**Code :** MME8993					
Teaching Scheme/week				**Evaluation Scheme**					
Lecture	**Practical**	**Hours**	**Credits**	**IE1**	**IE2**	**ETE**	**TW**	**OR**	**Total**
-	10	10	5	-	-	-	100	50	150

Prior knowledge of

Introduction to Entrepreneurship ,Business Opportunity Identification, Start up and New venture Management

Objectives:

1. To inculcate entrepreneurial mind-set into the minds of young professionals
2. To identify entrepreneurial opportunities
3. To learn & understand the processes and practices in business and their applications
4. To leverage managerial & leadership skills for founding, leading & managing startups
5. To create successful Entrepreneurs

Outcomes:

At the end of course, student will be able to:

1. Decide processes and practices in business and their applications
2. Develop different skills for founding, leading & managing startups
3. Discover entrepreneurial opportunities

	Description	Duration (H)
	Project / Internship is an integral part of the curriculum, which will give sound knowledge in how to build and run very own enterprise. **Following activities (but not limited to) can be considered:** **Internship in Entrepreneurship:** Internship in MSME /company/Business with following purposes: 1. Analysis for cost effectiveness 2. Market Survey 3. Survey for Customer relationship 4. Branding Activity 5. Trademark registration 6. Assistance for improving business activities **Project in Entrepreneurship:** 1. Registration of Own Startups 2. Registration Enrollment of Business at Incubation Centre 3. Market Survey for MSME with scope 4. Participation in National / International Level competitions- Start-ups Business plan / Business pitch event. 5. Starting small business with legal documents like Shop Act, PAN card, GSTIN, Udyam Registration etc. 6. Receiving grand /Funds for own business activity from Government or any other supporting Agency 7. Seed funding 8. Development of New Product /Prototype with business plan	
	Total	**120**

Higher Study Scope: PhD. Research Centre at PCCOE.

- Computer Engineering
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"There are no secrets to success. It is the result of preparation, hard work, learning from failure."

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