Online MTech Program in Electric Vehicle (EV) Technology

Coordinators:

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Background

The Government of India (GoI) announced National Electric Mobility Mission Plan 2020 (NEMMP 2020) to achieve national energy security and minimize transportation pollution by promoting electric and hybrid vehicles. Indian Automotive Industry wants to become one of the top three countries in the world in global exports of electrical vehicles (EV) and components. Technology development and skilled human resources are vital to achieving the above objectives. The Automotive Industry in India has self-reliance in design, manufacturing in Internal Combustion Engine Technology. However, the Industry is looking for experts in EV technology by training existing skilled manpower through Industry-academia interaction programs especially in battery management, motor operation and, and controllers for efficient supply of power under different drives. Academic Institutes are willing to collaborate with Industry to conduct the research and address challenges in promoting EV Technology.

IIT Hyderabad with its upcoming dedicated test track for autonomous and electrical vehicles, state of art research in battery technology, motor drive and control, is at the forefront of research and development of electric vehicle technologies. It has also incubated a company "PURENERGY" out of its incubation cell. With the launching of many electric vehicles from OEM companies in recent years and coming up of more than 12 startups in Hyderabad, in order to meet the challenges of future workforce in EV, IIT Hyderabad has taken the lead in EV technology research and skill development through Interdisciplinary Master's Program (IDP). This program will be coordinated by a group of 22 faculty members from Mechanical Engineering, Electrical Engineering, Design, Chemical Engineering, Civil Engineering, Physics and Chemistry disciplines with strong focus in EV research and training to offer PG programs as part of the institute initiative of IDP. Through this online MTech Program in EV Technology, IITH reaches out to industry professionals with an objective to upskill them.

The proposed online MTech Program in EV Technologies encompasses the multidisciplinary approach (one of the main pillars of New Education Policy, NEP-2020) to train the workforce in the technology domains of Drives, Transmission, Batteries, Power Electronics, Safety, and Product Design.

All online class courses to be offered in the evenings and on weekends. *It will not be mixed with regular students.*

Eligibility - Online students need not have GATE qualification. They should have BTech first class (60%) in ME, EE, ECE, CE, and other relevant equivalent degrees and 2 years of industry experience after BTech and they should be currently working in an industry.

Duration: Max 4 Years for MTech (EV) and Max 3 Years for Executive MTech (EV)

A) **MTech (EV) with thesis** – Duration 2-4 Years: 48 Credits (Course credits: 24 + Thesis credits: 24)

- **Courses can be done over 1-3 years**
- **Thesis will be done in the final year only after completing 24 course credits**

***Note*:** Online students will do their project in their own industry and not at IITH. The project can be started only after 24 credits of courses are completed. During the project each candidate will have a guide from IITH and may have another from his/her industry.

B) **Executive MTech (EV) without thesis**: **Duration 1-3 Years**.

Full Course credits: 24

- **Courses can be done over 1-3 years.**

Nomenclature:

ODD: 1st Semester, 3rd Semester, 5th Semester, 7th Semester
Even: 2nd Semester, 4th Semester, 6th Semester, 8th Semester

Course Curriculum

Online MTech: (24 Course Credits and 24 Thesis Credits = 48 Credits)

a) Core Courses: 12 Credits

Semester	Course code	Name of the course	Credit
ODD	ME5710	Design of EV	2
ODD	ME5800	Testing and Certification of EV	1
ODD	EE5210	Power Converter Design	3
ODD	ET5020	Electrochemical Energy Storage Systems: Batteries, Fuel Cells and Super capacitors	3
ODD	ET5040	Energy Management	1
ODD	EE5167	Embedded System Hardware and Design	2

b) Elective Courses: 12 Credits

Semester	Course code	Name of the course(Instructor)	Credit
EVEN	DS5453	Advanced Materials applications in designing of	2

		EV	
ODD	SM5013	Autonomous Navigation	1
ODD	DS4013	Automobile Design Explorations	2
ODD	ME5421	FEM Lab	1
ODD	DS5423	Design Thinking for EV	2
ODD	DS5413	Fundamentals of Design for EV	2
ODD	ME5340	IC Engine Combustion and Pollution	3
ODD	ME5480	Sustainable Energy Technology: Energy Sources, Energy Efficiency, Storage and Optimization	3
EVEN	ME5670	Vehicle Dynamics and Modeling	3
EVEN	ME5650	Engineering Noise Control	3
EVEN	ME5040	Computational Fluid Dynamics Tools	1.5
EVEN	ME5700	Analysis and Design of Composite Structures	3
EVEN	EE5240	Electrical Machines and Analysis Control	3
EVEN	IS5033	Embedded Programming	2
EVEN	EE6360	Introduction to Drones	2
EVEN	ET5230	Energy Audit	1
EVEN	DS5443	Life-Cycle analysis for EV	2
EVEN	DS5403	Form & parametric digital surfacing	2
EVEN	DS5463	Product System and Service Design for EV	2
EVEN	DS5353	Ergonomics for Industrial Designers	2
EVEN	SM5043	Traffic Engineering and Intelligent Transportation	3
EVEN	ET5260	Electric vehicles	1
EVEN	CH6610	Fuel Cell Technology	2
EVEN	ET5220	Photovoltaic (PV) Technology	2

Thesis Stage 1 and 2

Course code	Name of the course	Credit

EV6115	Thesis - 1	12

Course code	Name of the course	Credit
EV6125	Thesis - 2	12

Note: Course Credits: 24 (1-6 Semester) + Thesis Credits: 24 (after completion of course credit).

I) Committees for different function of the Program for at least two years (2021-2023):

A) Overall Coordination: Dr. Ashok and Dr. Venkatesham

B) Industry Interaction committee: Dr. Venkatesham, Dr. Nishant, Dr.Surendra, Dr. Raji

C) Academic course committee: Dr. Rupesh, Dr. Prasad, Dr. Santhosh, Dr. Nishant

D) Admission committee: Dr. Prasad, Dr. Seshadri, Dr. Ashok

E) Placement committee: Dr. Pradeep, Dr. Shivaji, Dr. Digvijay

II) Total number of faculty members offering the courses: 22

S. No.	Name of Faculty/Department	Commitment
1	Dr. Ashok Kumar Pandey, MAE	Confirmed
2	Dr. B Venkatesham, MAE	Confirmed
3	Dr. Nishant Dongari, MAE	Confirmed
4	Dr. R. Gangadharan, MAE	Confirmed
5	Dr. Syed N Khaderi, MAE	Confirmed
6	Prof. Raja Banerjee, MAE	Confirmed
7	Dr. Pankaj Kohle, MAE	Confirmed
8	Dr. Sayak Banerjee, MAE	Confirmed
9	Prof. P Rajalakshmi, EE	Confirmed
10	Dr. Rupesh Wandhare, EE	Confirmed
11	Dr. Seshadri Sravan Kumar V, EE	Confirmed
12	Dr. Shishir Kumar, EE	Confirmed

13	Dr. Pradeep Yemula, EE	Confirmed
14	Dr. Ketan P Detroja, EE	Confirmed
15	Prof. Deepak John Mathe, DS	Confirmed
16	Dr. Prasad Onkar, DS	Confirmed
17	Dr. Shiva Ji, DS	Confirmed
18	Dr. Srikar A V R, DS	Confirmed
19	Dr. Digvijay S. Pawar, CE	Confirmed
20.	Dr. Surendra Kumar Martha, CY	Confirmed
21.	Prof. Vinod Janardhan, CH	Confirmed
22	Dr. Sai Santosh Kumar Raavi, PHY	Confirmed

Course Content of New and Existing Courses

Course Code:ME5800

Course Name: Testing and Certification of EV
Credits: 1
Semester Schedule: ODD Semester
Course type: theory
Prerequisites: None

Course Syllabus:

Electric vehicles are the future of transportation. Electric mobility has become an essential part of the energy transition strategy and will result in significant changes for vehicle manufacturers, governments, companies and individuals.

In this course, you will gain comprehensive knowledge on various tests that are conducted on an electric vehicle, in order for it to qualify for final certification and approval for mass production and introduction into the market. It will help engineers and managers to make appropriate improvements and strategic decisions on their electric vehicle products and their implications.

Battery performance safety test- Evaluation testing of Battery as per AIS 048, ECE R100, USABC, etc., performance testing, life-cycle testing and safety/abusive testing, Material Characterization of battery electrodes and electrolytes.

Electric Motor Characterization – Net Power, Power & Efficiency as per AIS 041, ECE R85. Reliability, durability and overload capacity. Evaluation of torque, speed, motor characteristics Regenerative braking test. Thermal Characteristics.

Durability Tests of Electric Vehicle – Lab simulation of tracks. Simulations for environmental conditions like temperature and humidity.

Vehicle Performance on Chassis Dynamometer and Test Tracks – Electric energy consumption as per AIS 039 and ECE R101. Electric range as per AIS 040 and ECE R101. Power at wheels as per AIS 041. Brakes, gradeability, noise.

Charger Testing and Certification – Testing as per AIS 138, Testing as per Bharat EV Charger specification AC001 and DC001.

Reference:

1.Standards as per ARAI, Pune. https://www.araiindia.com/

2. Standards as per the production of the e-motor company, https://pureev.in/

Course Code:DS5453

Course Name: Advanced Materials applications in designing of EV
Credits: 2
Semester Schedule: Even Semester
Course type: theory
Prerequisites: None

Course Syllabus:
Properties and use of thermoplastics, thermosetting plastics. Process of selection and applications of plastics for engineering products. Design Limitations and specific advantages of plastic modelling processes.

Properties and use of rubber and glass. Properties of alternative materials like wood, bamboo, cane, leather,cloth, jute etc..and their use from craft and industry perspectives.

Assembly and Decorative techniques for plastic product Manufacturing processes and assembly techniques for Ferrous and non-ferrous metals.

Concepts of structure and costing. Significance of form in structural strength of products. Influence of materials and processes on product aesthetics.

Industrial finishes for plastic, wood and metals.

References:

1. Beadle, John D : Product treatment and finishes, Macmillan, London 1971
2. Beck R. D.: Plastic Product Design, Van Nostrand Reinhold Co., New York, 1980
3. Cleminshaw D., Design in Plastics, Rockport Publishers Inc. (22 February 1994)
4. Garratt J.: Design and Technology, Cambridge University Press, UK, 2004
5. Thompson R.: Manufacturing processes for design professionals, Thames & Hudson, London 2007
6. Ashby, Michael; Johnson, Kara; Materials and Design: The Art and Science of Material Selection in Product Design, Publisher: Butterworth-Heinemann; 2002

Course Code:DS5463

Course Name: Product System and Service Design for EV
Credits: 2
Semester Schedule: Even Semester
Course type: theory
Prerequisites: None

Course Syllabus: Fundamentals of Product-service systems, Design Methodologies for PSS systems: Service CAD, PSS Design, The dimensions of PSS design, etc. Electric Vehicle (EV) infrastructure, Business models for EVs, Challenges for OEMs, Cost and Benefits of PSS for EVs. Last-mile connectivity issues. E-Mobility Services – Hardware infrastructure: Charging network and service infrastructure, Digital infrastructure: Map based services, Rental E-mobility

References:

1.Vezzoli, C., Kohtala, C., Srinivasan, A., Xin, L., Fusakul, M., Sateesh, D., Diehl, J.C. Product-Service System Design for Sustainability. 1st Edition Routledge Publications, 2014.

2.Pai Zheng Chun-Hsien Chen Zuoxu Wang Smart Product-Service Systems, 1st Edition, Elsevier, 2021

3.Other Research Publications

Course Code:DS5403

Course Name: Form & parametric digital surfacing
Credits: 2
Semester Schedule: Even Semester
Course type: theory
Prerequisites: None

Course Syllabus: The course deals with creating an aesthetic appeal and 3D form for the mobility solutions keeping using digital technologies for an efficient and futuristic design aesthetic. The new approach is needed to harness computational advancements over material-based efforts.

References:

1. Habraken, N John., et al. 2014. Conversations with FORM. Routledge.

2. Pawlyn, Mchael. 2016. Biomimicry in Architecture. Sec ed. RIBA publishing.

3. Brown, Tim. 2009. Change by Design. HarperCollins.

Course Code:DS5413

Course Name: Fundamentals of Design for EV
Credits: 2
Semester Schedule: Odd Semester
Course type: theory
Prerequisites: None

Course Syllabus: Principles of Design: contrast, balance, emphasis, proportion, hierarchy, repetition, rhythm, pattern, white space, movement, variety, and unity. Elements of Design line, shape, space, value, color and texture. Form language for vehicles. Form abstraction, form expression, Form transition-use of metaphors.

Reference:

1. Wucius Wong ; Principles of Two-Dimensional Design, Publisher: Wiley, 1972

2. Wucius Wong ; Principles of Three-Dimensional Design. Publisher: Van Nostrand Reinhold 1977

3. Stephen Luecking ; Principles of Three-Dimensional Design: Objects, Space and Meaning. Publisher: Prentice Hall, 2002.

4. Johannes Itten ; Design and Form: The Basic Course at the Bauhaus and Later, Revised Edition, publisher: Wiley; Revised edition, 1975

5. Johannes Itten ; The Elements of Color, Publisher: Wiley, 1970.

Course Code:DS5423

Course Name: Design Thinking for EV
Credits: 2
Semester Schedule: Odd Semester
Course type: theory
Prerequisites: None

Course Syllabus and Objective: This course teaches a unique approach to strategic problem solving to create experiences customers love. With EVs becoming mainstream in India and with unique challenges and opportunities Indian context pose, the student will get to practice design thinking on a real-life project and equip himself with a powerful set of tools to become more collaborative, innovative, and effective. In the course the student will explore:

- Understanding the problem from your customer' s perspective.
- Brainstorm innovative ideas.

- How to go about creating prototypes to test new ideas before investing a lot of time and money.

References:

1.Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation; Tim Brown (2009)

2. The Design Thinking Playbook: Mindful Digital Transformation of Teams, Products, Services, Businesses and Ecosystems: Michael Lewrik (2017)

3. 101 Design Methods: A Structured Approach for Driving Innovation in Your Organization : Vijay Kumar (2012)

Course Code:DS5443

Course Name: Life-Cycle analysis for EV
Credits: 2
Semester Schedule: Even Semester
Course type: theory
Prerequisites: None

Course Syllabus: The environmental impacts of electric vehicles (EVs) need to be addressed before it becomes the next generation of vehicles commonly owned by the people. Certain battery types are already on the radar of environmental concerns owing to their hazardous nature of elements used and their disposal. The same needs to be checked and understood for minimizing the impacts. A component wise analysis is imperative to understand the factors influencing the environmental impact of EVs from LCA perspective. A quantitative ecological assessment of various stages such as EV charging, battery footprint, real world emissions, realistic lifetime mileages, comparative emissions of EVs,.

Reference:
1. Hauschild, Michael Z., et al. 2018. Life Cycle Assessment. Springer
2. Giudice, Fabio. 2006. Product Design for the Environment. Taylor & Francis.

Course code: EE5210
Course Name: Power Converter Design
Credits: 3
Semester schedule: Odd semester
Course type: Theory, Core or Elective
Prerequisite: Basic Power Electronics(from Btech curriculum or hands-on experience in Industry)
Course syllabus: Characteristics of power electronic switches, Drive circuits, Voltage and current sensing mechanism, Introduction to Human Machine Interface, Basics of DC-DC converters, DC/AC inverters (single phase and three phases) and PWM Control techniques, Modelling procedures of the power converters, State space averaging, Linearization,

Designing of the close loop control of a power converter, AC to DC rectifiers (single phase/three-phase), analysis and performance with passive loads:

References:

1. DC-DC Switching Regulator Analysis by Daniel M. Mitchell ;
2. Voltage Sourced Converters in Power Systems: Modeling, Control, and Applications by Amirnaser Yazdani, Reza Iravani

Course code: EE5240

Course Name: Electrical Machine Analysis and Control

Credits: 3

Semester schedule: Even semester

Course type: Theory

Prerequisite: Basic Electrical Machines(from Btech curriculum or hands-on experience in Industry)

Course syllabus: Basic principles of electric machines, magnetically coupled circuits, machine windings and air-gap MMF, Winding inductances and voltage equations, DC machines - Theory of DC machines, voltage and torque equation (DC Machine) in machine variables and Block diagrams . Reference Frame theory - equations of transformation, commonly used reference frames, transformation between reference frames, transformation of a balanced set. Induction machine Voltage and torque equation in machine variables, arbitrary reference frame equivalent circuits, voltage and torque equations in arbitrary reference frame variables, dynamic performance of induction motor, Vector control of induction motor. Synchronous machine - Voltage and torque equations in machine variables, equivalent circuits of 3-phase synchronous machines in arbitrary reference frames.

References:

1. Analysis of Electric Machinery and Drive Systems by PC Krause ;
2. Electric machinery by AE Fitzgerald, S.D.Umans

Course code: EE6360

Course Name: Introduction to Drones

Credits: 2

Semester schedule: Even semester

Course type: Theory and Lab

Prerequisite: Basic control engineering

Course syllabus: Introduction to UAVs/Drones, Drone Applications, Working Principle and Design, Inertial Measurement Unit, Sensors and Calibration, PID - Implementation and Tuning, Flight controller, Remote Controller, Quadcopter dynamics, Hands-on project - Precautions while assembling, Exercise based on Different Flight controller boards like Ardupilot APM 2.x, 3.x, hobby king KK 5.0, CC3D, Pixhawk, etc.

References:

1. Open source datasheets

Course Code: EE5167

Course Name: Embedded System Hardware and Design

Credits: 2

Semester Schedule: Odd Semester

Course type: Theory
Prerequisites: None
Course Syllabus: Overview of microcontrollers and a closer look at ARM Cortex M series and MSP430. Major components: clocks, timers and PLLs, sleeping modes and power saving, display interfaces. Sensors and transducers: electromagnetic, pneumatic, motors and servos. Example usage. PID control examples. Sensor specification and calibration with examples. BUS protocols: I2C, SPI, USB, CAN, Ethernet, Flexray, JTAG, Time-triggered systems. Wireless communications protocols for IoT and sensor networks. Web technologies for communications: websockets, MQTT/zeroMQ, Resource allocation and process management in RTOS and OS, multithreaded designs Software environments and tool chains: make, gcc tool chain, low level C, Finite state machines and their use AutoSAR and its internals, Electronic Interfacing of common components for use with sensors
References:
Due to diverse topics, the topical references will be provided during lectures or put on the course website.

Course Code: **IS5033**

Course Name: Embedded Programming
Credits: 3
Semester Schedule: Even Semester
Course type: theory
Prerequisites: None

Course Syllabus: Introduction to Embedded Systems, Architectures of embedded processors, Memory hierarchy and its management Basics of Microcontrollers –timers, interrupts, analogy to digital conversion, bootloaders Interaction with devices -buses, memory management, device drivers and wireless comm., Interfacing sensors, actuators and peripherals. Real-time principles -multi-tasking, scheduling, synchronization Building low-power high-performance systems –code profiling and optimization Architecture, Case Studies of Real time. Microcontrollers/Microprocessor: Arduino, Raspberry-pi, ARM, FPGA, ESP32, RL78etc)

Course Code: SM5013

Course Name: Autonomous Navigation
Credits: 1
Semester Schedule: Odd Semester
Course type: theory
Prerequisites: None

Course Syllabus: An Introduction to Navigation systems: History, System architecture, Application; Modes of Navigation – Land, Aerial, Underwater, Aeronautic; Sensors for autonomous navigation: Radar, Inertial Navigation system (INS), LiDAR, GNSS; Introduction to Simultaneous Location and Mapping (SLAM); Case study: Route and Flight path planning for UAVs for autonomous flying

Course Code: SM5043

Course Name: Traffic Engineering & Intelligent Transportation Systems

Credits: 3
Semester Schedule: Even Semester
Course type: theory
Prerequisites: None

Course Syllabus: Traffic Operations:Traffic stream components, Theories of traffic flow,traffic studies,design of control strategies for simple systems..Intelligent transportation system:goal of ITS, ITS design, Highway ITS, concepts of operation,ITS system architecture,ADAS, ITS in India

Course Code: EE5220
Course Name: Advanced Control Systems
Credits: 3
Semester Schedule: Odd Semester
Course type: theory
Prerequisites: None
Course Syllabus: Introduction to Multivariable systems, Why Multivariable systems are important?, Interaction dynamics and its role on control system, design, Multivariable control-classical approaches, Structure, selection - variable pairing, tuning single loop controllers for MIMO, systems, Transmission zeros and transmission zero direction, Advanced control approach, State space representation, Conversion from SS to/from TF, Controllability, Observability, State transfer problem, solution to state transfer problem, pole placement controller design, Design of observer, Kalman filter design, Model (observer) based predictive controllers, LQR/LQG, various MPC schemes.

Course Code: ET5020
Course Name: Electrochemical Energy Storage Systems: Batteries, Fuel Cells and Supercapacitors
Credits: 2
Semester Schedule: Odd Semester
Course type: theory
Prerequisites: None

Course Syllabus:Principles of Operation of Cells and Batteries; Electrochemical Principles and Reactions; Factors Affecting Battery Performance; Battery Design; Primary Batteries; Secondary Batteries: Advanced Lead-acid, Ni-based and lithium ion batteries (Fundamentals, Materials, Electrode preparation, Battery Assembly, Testing, Failure Analysis, Safety issues); Flow Batteries; Next Generation Batteries; Fuel cells, Supercapacitors, Selection and Application of energy storage systems for UPS, Solar, Telecom, Aerospace, Grid and Electric Vehicle Systems.

References

1. Kirby W. Beard. Linden's Handbook of Batteries, Fifth Edition (McGraw-Hill Education: New York, Chicago, San Francisco, Athens, London, Madrid, Mexico City, Milan, New Delhi, Singapore, Sydney, Toronto, 2019).

2. Vladimir S. Bagotsky, Alexander M. Skundin and Yury M. Volfkovich (A.N. Frumkin Institute of Physical Chemistry and Electrochemistry of the Russian Academy of Science, Russia) Electrochemical Power Sources: Batteries, Fuel Cells, and Supercapacitors" By, John Wiley & Sons Inc, New Jersey, USA, 2015, 372 pages, ISBN: 978-1-118-46023-6.
3. Ying-Pin Chen, Sajid Bashir, Jingbo Louise Liu, Nanostructured Materials for Next-Generation Energy Storage and Conversion: Advanced Battery and Supercapacitors, Springer Nature, 10-Oct-2019 - Technology & Engineering - 472 pages.
4. D. Pavlov, Lead-Acid Batteries: Science and Technology, Elsevier 31-May-2011 - Technology & Engineering - 656 pages.
5. C. Vincent, Bruno Scrosati, Modern batteries, Elsevier, 26-Sep-1997 - Technology & Engineering - 368 pages.

Course Code: ET5040
Course Name: Energy Management
Credits: 1
Semester Schedule: Odd Semester
Course type: theory
Prerequisites: None

Course Syllabus: Energy generation, Energy storage, Generation-side management, Network operation, Demand-side management, Design example of the autonomous power supply using solar PV and battery to study energy management, Energy management smart parking lot with EVs.

Course Code: ET5230
Course Name: Energy Audit
Credits: 1
Semester Schedule: Even Semester
Course type: theory
Prerequisites: None

Course Syllabus: Concept, types of audit, energy index, cost index, pie charts, Sankey diagrams, load profiles, Energy efficiency in electrical utilities, Energy performance assessment for utility systems, building energy audit, campus energy audit.

Course Code: ET5260
Course Name: Electric vehicles
Credits: 1
Semester Schedule: Even Semester
Course type: theory
Prerequisites: ET5020

Course Syllabus: Introduction, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design, Vehicle Dynamics, drive train design methodology and control principles, Battery-fuel cell-supercapacitor requirements, BMS, Advantages and disadvantages of EVs.

Course Code: ET5220
Course Name: Photovoltaic (PV) Technology
Credits: 2
Semester Schedule: Even Semester
Course type: theory
Prerequisites: None

Course Syllabus: Characteristics of the photovoltaic cell; Semiconductor Basics; Silicon solar cells; Thermodynamic limit to efficiency, Light management, electrical losses, thin-film silicon solar cells; Advanced strategies for high-efficiency solar cells; Chalcogenides & III-V Technologies; Organic Photovoltaics; Hybrid Technologies; PV modules.

Course Code: CH6610

Course Name: Fuel Cell Technology
Credits: 2
Semester Schedule: Even Semester
Course type: theory
Prerequisites: None

Course Syllabus: Types of fuel cells, advantages and disadvantages of different fuel cell types, fuel cell thermodynamics, electrode kinetics, charge transport, fuel cell characterization, modeling of electrochemical processes.

Course Code: ME5421

Course Name: FEM LAB
Credits: 1
Semester Schedule: Odd Semester
Course type: theory/computational Lab
Prerequisites: None

Course Syllabus: Finite element methods for solving boundary value problems in solid mechanics. Introduction, Spatial Modelling, Geometric discretization, Element Library, Material Modelling, Loading and Boundary Conditions, Constraints, Surface/Interfaces modelling, Step and job handling and Post-processing. FEA Implementation and Visualization of 1D Problems, Truss Problem, Beam bending, Plane and axisymmetric Problems and 3D problems. Various analysis such as, Static, Transient, Harmonic, Modal, Dynamics and Multi Physics (Thermomechanical, etc).

References

1. R. D. Cook, D. S. Malkus, M. E. Plesha, R. J. Witt, “Concepts and Applications of Finite Element Analysis”, Wiley, 2001.
2. O. C. Zienkiewicz and R. L. Taylor, J. Z. Zhu, “The Finite Element Method: Its Basis and Fundamentals”, Butterworth-Heinemann, 2013.

3. A. F. Bower, “Applied Mechanics of Solids”, Online Resource: http://solidmechanics.org/, CRC Press, Taylor & Francis, 2010.
4. R. J. Boulbes, “Troubleshooting Finite-Element Modeling with Abaqus”, Springer, 2020.

Course Code:ME5040

Course Name: Computational Fluid Dynamics Tools
Credits: 1.5
Semester Schedule: Even Semester
Course type: theory/computational Lab
Prerequisites: None

Course Syllabus:Introduction to Navier Stokes equation, basics of discretization methods, finite volume formulation of convection-diffusion equation, pressure-velocity coupling, boundary condition implementation, mesh generation techniques in CFD, CFD applications in manufacturing processes through examples - heat removal during machining process, laser welding process, casting, spray coating process.

Course Code:ME5480

Course Name: Sustainable Energy Technology: Energy Sources, Energy Efficiency, Storage and Optimization
Credits: 3
Semester Schedule: ODD Semester
Course type: theory
Prerequisites: None

Course Syllabus:Introduction:- Review of thermodynamics; Energy Demand and Supply Outlook; Climate Change: projections and risks. Non-renewable Energy sources (Coal, Oil, Natural Gas, Nuclear) and their impact on the environment (climate change , atmospheric pollution, radioactive waste); Renewable Energy Sources - Wind, Solar PV, Solar-Thermal, Geo-thermal, Hydropower – technology and deployment; Carbon Neutral Fuels – biomass to fuel conversion, biofuel combustion technology, hydrogen as fuel, CO2 to fuel conversion, fuel cell technology; Energy Storage Technology – chemical storage and battery technology, electro-mechanical storage, thermal storage; Energy Efficiency and Emission Reduction – Use of Exergy to optimize energy use, Clean Combustion Technology, Carbon Capture and Storage, Energy efficient buildings, Life Cycle Assessment (LCA), Distributed Energy and Smart Grid systems.

Course Code:ME5670

Course Name: Vehicle Dynamics and Modeling
Credits: 3
Semester Schedule: EVEN Semester
Course type: theory

Prerequisites: None

Course Syllabus: Vehicle Mechanics - Forces under static and dynamic equilibrium. Free body diagram of different vehicle components. Simple linearized rigid models of different components. Dynamic stability and the vehicle performance under different operating conditions such as understeering, neutral steering, and oversteering. Concept of vehicle ride comfort. Vehicle stability controls. Driveline models, Performance characteristics of a comfortable vehicle ride. Introduction to the development of vehicle model using different software such as MATLAB Simulink, MAPLESIM, System Modeller, ADAMS, CarSIM.

Course Code:ME5650

Course Name: Engineering Noise control
Credits: 3
Semester Schedule: EVEN Semester
Course type: theory
Prerequisites: None

Course Syllabus: Introduction to noise control: definition of sound, acoustic wave equation, sound level and spectra, octave and 1/3 octave bands, weighting networks (a, b, c and linear), hearing, psychological response to noise, loudness interpretation, NC curves, masking, sound propagation, plane wave, spherical wave, sound power, its use and measurement, sound power and sound pressure level estimation procedure, characteristics of noise sources, source ranking, passive noise control methods, sound absorption coefficient measurement, transmission loss, room acoustics, sound in enclosed spaces, basics of muffler design, lined plenum absorption, pipe wrapping, vibration isolation, vibration damping.

Course Code:ME5700

Course Name: Analysis and Design of Composite Structures
Credits: 3
Semester Schedule: EVEN Semester
Course type: theory
Prerequisites: None

Course Syllabus: Introduction to composite materials, Concepts of isotropy vs. anisotropy, Micro-mechanics of composite lamina, Macro-mechanics of composite laminate, Classical Lamination Plate theory (CLPT), Failure criteria, Bending and buckling analysis of laminated composite plates, Inter-laminar stresses, First Order Shear Deformation Theory (FSDT), Delamination models, Composite tailoring and design issues.

Course Code:ME5340

Course Name: IC Engine Combustion and Pollution
Credits: 3
Semester Schedule: ODD Semester
Course type: theory
Prerequisites: None

Course Syllabus: Introduction: Engine types and their operation, Engine design and operating parameters, Thermochemistry of fuel-air mixtures; Combustion in Spark-Ignition Engines: Essential features of process, Thermodynamic analysis of SI engine combustion, Flame structure and speed, cyclic variations in combustion, partial burning and misfire, Spark ignition, Abnormal combustion: Knock and surface Ignition; Combustion in Compression-Ignition Engines: Essential features of process, Types of Diesel combustion Systems, Phenomenological model of CI engine combustion, Analysis of cylinder pressure data, Fuel spray behavior, Ignition delay, Mixing-controlled combustion; Modeling real engine flow and combustion processes: Purpose and classification of Models, Governing equations for open thermodynamic system, Intake and exhaust flow models, Thermodynamic-based In-Cylinder models, Fluid-mechanics based multidimensional models; Pollutant formation and control: Nature and extent of problem, Nitrogen oxides, Carbon monoxide, unburned hydrocarbon emissions, Particulate emissions, Exhaust gas treatment; Nonconventional Engines: Common rail diesel injection, Dual fuel and multi-fuel engine, Free piston engine, Gasoline direct injection engine, Homogenous charge compression ignition engine, Lean burn engine, Stirling engine, Stratified charge engine, Variable compression ratio engine, Wankel engine.

Course Code:ME5710

Course Name: Design of EV
Credits: 2
Semester Schedule: ODD Semester
Course type: theory
Prerequisites: None

Course Syllabus:

Introduction to Electrical Vehicles, EV Subsystems, Design of EV Drivetrain, Battery Performance Parameters, Mechanical and Thermal Design of EV, Noise and Vibration requirements

References:

1. Husain, I. (2021). Electric and Hybrid Vehicles: Design Fundamentals. United Kingdom: Taylor & Francis Group.

2. M. Ehsani, Y. Gao, S. Gay and A. Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, CRC Press, 2005.

3. C. C., Chau, K. T. (2001). Modern Electric Vehicle Technology. United Kingdom: Oxford University Press.

Course Code:DS3313

Course Name: Automobile Design Explorations
Credits: 2
Semester Schedule: Odd Semester
Course type: theory

Prerequisites: None

Course Syllabus:The course intends to deliver skills of visualization and design delivery for the need of mobility. Utilizing core subject knowledge competence with creative blend for automobile design and development of mobility solutions across personal to mass transportation. Elements of engineering, anthropometry, ergonomics, alternative energy systems, materials and styling would be used to amalgamate and come up with innovative ideas to address complex requirements. The course embraces the design and development process by user research, scenario study, applying new materials, utilizing cutting edge technologies to address the changing paradigm. Explorations and the design process would be emphasized to come up with fresh ideas in the initial stage. Further students would move to solve comfort, functional, safety and technical requirements and refine the design in physical and digital mediums for a final design solution. It is a challenging process to achieve good design and would require in-depth attention towards development of form, function and innovation for achieving future-ready rewarding mobility solutions. Lectures would be supported by hands-on exercises, field study, research and model making.

Course Code:DS5353

Course Name: Ergonomics for Industrial Designers
Credits: 2
Semester Schedule: Even Semester
Course type: theory
Prerequisites: None

Course Syllabus: Overview of ergonomics and design relevance; Man- the prime system component; Man machine environment interaction system and user-friendly design practice; Human compatibility, comfort and adaptability; Fundamentals of ergonomics: Physical (anthropometrics, human body- structure and function, posture, movement and biomechanics), Physiological (work physiology) and Psychological aspects (behavior, cognitive aspects and mental workload); Information processing, human error and risk perception; Visual performance and visual displays; environmental factors influencing human performance; Occupational stress; safety and health issues; Ergonomics criteria/check while designing; Design process involving ergonomics check and ergonomic design evaluation and Participatory ergonomics aspects.

References:

1. Bridger, RS: Introduction to Ergonomics, 2nd Edition, Taylor & Francis, 2003.
2. Dul, J. and Weerdmeester, B. Ergonomics for beginners, a quick reference guide, Taylor & Francis, 1993.
3. Green, W.S. and Jordan, P .W, Human Factors in Product Design, Taylor & Francis, 1999.
4. D. Chakrabarti, Indian Anthropometric Dimensions for ergonomic design practice, National Institute of Design, Ahmedabad, 1997
5. G. Salvendy (edit), Handbook of Human Factors and ergonomics, John Wiley & Sons, 2012.