Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Third Year B.Tech. (Honors) (Mechanical Engineering)

Semester-V

Hn512: Honors Course: Machine Vision

Teaching Scheme
Lectures : 03 Hours/week, 03 Credits
Practical : 02 Hours/week, 02 Credit

Examination Scheme
ESE : 70 Marks
ISE : 30 Marks
ICA : 25 Marks

Course Introduction:

This course is designed to give the student an in depth understanding of Machine Vision using in suitable software package.

This course requires the students to take part in site visits and case study presentations.

This course covers the fundamentals of Machine Vision such as segmentation, template matching, edge detection, camera calibration, shape analysis, object identification, Cameras (CCD, CMOS, Area Scan, and Line Scan), camera specification and selection etc.

Image Processing **using** suitable software package.

Course Objectives:

During this course, student is expected to:

1. Understand components of a machine vision system and its working.
2. Acquaint with existing market distribution and future trends
3. Understand the fundamentals of image processing and analysis
4. Understand fundamentals of Cameras (CCD, CMOS, Area Scan, and Line Scan)
5. Understand the scope and applications of modern machine vision systems.
6. Understand the technology behind a modern robot machine vision

Course Outcomes:

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

1. Use the Image Processing toolbox available in suitable software package.
2. Use Image Analysis toolbox in in suitable software package.
3. Use Computer Vision toolbox in in suitable software package.
4. Explain components of machine vision and image processing fundamentals.
5. Explain construction and applications of different types of robots.
6. Define segmentation and explain concept such as template matching, edge detection, shape analysis etc.

Section I

Unit 1 – Introduction to Machine Vision **No. of lectures - 06**

Machine Vision definition, Machine vision system components, block diagram of machine vision system, lighting techniques, front light source and back light source, application of machine vision system, Analog to digital converter (A/D Converter),image storage frame grabber

Unit 2 – Image processing fundamentals **No. of lectures -08**

Image processing fundamentals: Image representation, Image processing and analysis, image data reduction, Segmentation, Thresholding, region growing, Edge detection, corner point detection, shape analysis

Unit 3- Image analysis **No. of lectures - 06**

Object identification, template matching, object recognition, lead through programming method, textual robot programming method

Section II

Unit 4 – Cameras **No. of lectures - 06**

Sensing and digitizing function in machine Vision, Cameras: image devices Charge couple device (CCD), Complementary metal oxide semiconductor (CMOS), Area Scan, Line Scan, camera specification and Camera selection, camera calibration.diffrence between CCD and CMOS, Need of CCD and CMOS cameras

Unit 5 – Machine vision system **No. of lectures - 08**

Feature extraction- basic features and measures for 2D object, numericals on finding area, minimum aspect ratio,diameter,centroid,thinness measures of image, training the vision system,

Unit 6 – Application of Machine vision system **No. of lectures - 06**

Robotic applications i.e. inspection, identification, visual serveying and navigation, Agricultural applications of Machine vision system, application of machine vision for control of AGVs

Internal Continuous Assessment (ICA):
List of Experiments/Assignments/Case Studies, etc.

1. Survey assignment on robots, AGVs, control by using machine vision.
2. Theory assignment on Machine vision system.
3. One assignment on Image Processing using suitable software package.
4. One assignment on Image Analysis using suitable software package.
5. Survey assignment on robots industry and manufacturers and applications.
6. One assignment on CCD & CMOS Cameras
7. One assignment on Segmentation
8. One assignment on Problem Solving
9. One theory assignment on Illumination techniques.
10. One assignment on shape analysis.

Text Books:

1. S.K Saha, Introduction to Robotics, McGraw-Hill.
2. Mikell Groover et.al, Industrial Robotics, McGraw Hill.
3. Stuart Russel & Peter Norvig, Artificial Intelligence a Modern Approach.
4. E. Rich and K. Knight, "Artificial intelligence",TMH.
5. N.J. Nilsson, "Principles of AI", Narosa Publ. House, 2000.

Reference Books

1. Asitava Ghosal, Robotics: Fundamental Concepts and Analysis, Oxford Press.
2. Siegwart et.al, Autonomous Mobile Robots, Prentice Hall India.
3. Robin R Murphy, Introduction to AI Robotics, PHI Publication, 2000.
4. Bishop et.al, Handbook of Mechatronics, CRC Press.
5. Schilling, Fundamentals of Robotics, Prentice Hall India.
6. Robert Babuška, Fuzzy Modeling for Control, Springer.
7. Dan Patterson, Introduction to Artificial Intelligence and Expert Systems, Prentice-Hall.
8. International Federation of Robotics - https://www/ifr.org

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Third Year B.Tech. (Mechanical Engineering)

Semester-V

Hn522: Honors Course: 3D Printing Materials

Teaching Scheme	**Examination Scheme**
Lectures : 03 Hours /week, 03 Credits	**ESE : 70 Marks**
Practical : 01 Hour /week, 01 Credit	**ISE : 30 Marks**
	ICA : 25 Marks

Course Introduction:

3D printing-is-an additive-manufacturing process whereby objects are built up from plastic filament, liquid resin, layers of powder, or even bio-compatible and edible materials. Desktop 3D printing is today's printing press, putting rapid prototyping, customizable products, and individualized medical appliances in reach of the general public.

Course Objectives:

The course aims to:

1. Understand basics of Additive Manufacturing.
2. Know various types of Additive Manufacturing materials.
3. Be familiar with the characteristics of various materials that are used in additive manufacturing.
4. Understand framework for choosing the right 3D Printing Material
5. Understand selection of machine specification for various materials

Course Outcomes:

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

1. Identify basics of Additive Manufacturing.
2. Identify various types of Additive Manufacturing materials.
3. Choose various materials that are used in additive manufacturing.
4. Choose framework for choosing the right 3D Printing Material.
5. Select of machine specification for various materials.

6. Explain manufacturing process of 3d Printing material forms.

Section I

Unit-1: Introduction to 3D Printing **No. of lectures- 06**

Introduction, Product design process, Steps in 3D printing, Classification, Advantages, Additive V/s Conventional Manufacturing processes, Applications.

Unit-2: Plastic 3D Printing Materials (Plastic & Composites) **No. of lectures- 08**

Types of Plastic Materials, properties, characteristics and application of all types (ABS, PLA, PVA, HDPE, PET, PETG etc) Types of Composites Materials, properties, characteristics and application of all types.(N6,N12,ABS Carban Fiber, etc.)

Unit-3: Plastic 3D Printing Materials (Metals) **No. of lectures- 06**

Types of plastic materials, properties, characteristics and application of all types.

Section II

Unit-4: Various forms of 3D printing materials **No. of lectures- 06**

Various forms of raw material- Liquid, Solid, Wire, Powder, Powder Preparation and their desired properties, Polymers and their properties.

Unit-5: Framework for Choosing the Right 3D Printing Material **No. of lectures- 08**

Define Performance Requirements, ranslate Performance Requirements to Material Requirements, Make a selection, and find the best 3D Printing material for your project.

Unit-6: 3D Printing Applications **No. of lectures- 06**

Application in Engineering, analysis and planning, aerospace industry, automotive industry, jewelry industry, medical and bioengineering.

Internal Continuous Assessment (ICA):
List of Experiments/Assignments/Case Studies, etc.

1. Assignment on Introduction to 3D Printing.
2. Assignment on Plastic 3D Printing Materials (Plastic & Composites).
3. Assignment on Plastic 3D Printing Materials (Metals).
4. Assignment on Various forms of 3D printing materials.
5. Assignment on Framework for Choosing the Right 3D Printing Material.
6. Assignment on 3D Printing Applications.
7. Select appropriate 3D printing material for following application:-
    a. Prototyping
    b. Medical appliances
    c. Construction.
8. Selection of 3d printing machine specification for following materials:-
    a. Polymers
    b. Composites
    c. Metals

Text Books:

1. Gebhardt A., "Rapid prototyping", Hanser Gardener Publications, 2003.
2. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", Third Edition, World Scientific Publishers, 2010.
3. Khanna Editorial, "3D Printing and Design", Khanna Publishing House, Delhi.

Reference Books

1. Liou L.W. and Liou F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2007.
2. Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer, 2006. 3. Hilton P.D. and Jacobs P.F., "Rapid Tooling: Technologies and Industrial Applications", CRC press, 2000.

3. DouglesBryden, “CAD and Protyping for Product Design”, 2014.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Third Year B.Tech. (Mechanical Engineering)
Semester-V
Hn532:Honors Course: Energy Conservation, Management And Audit

Teaching Scheme
Lectures : 03 Hours/week, 03 Credits
Practical : 02Hours/week, 01 Credit

Examination Scheme
ESE : 70 Marks
ISE : 30 Marks
ICA : 25 Marks

Course Introduction: In this course, students will be engaged to help them acquire technical and commercial knowledge and skills associated with energy conservation, energy management and energy auditing.

Course Objectives:

The course aims to:

1. Know the importance of energy sector in country's development
2. Identify various auditing services
3. Prepare the organizational structure energy policy
4. Get the concept of management in process industries
5. Explain how to take tax considerations

Course Outcomes:

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

1. Know energy scenario both India and world
2. Review and asses the various audit tools
3. Understand energy policy planning and take energy management as a profession
4. Minimize Waste Minimization and Resource Conservation
5. Analyze energy security, codes, standards
6. Arrange the financial arrangements for industries

Section I

Unit-1: Global & Indian Energy Scenario **No. of lectures- 6**

Basics of Energy and its various forms - Classification of Energy sources- Applications of Non - Conventional and Renewable Energy Sources - Energy needs of growing economy-Energy sector reform, Energy and Environment: Global Environmental Concerns

Unit-2: Energy Audit **No. of lectures- 7**

Material and Energy Balance - Energy Action Planning - Energy Monitoring and Targeting - Types of energy audit, Energy Auditing Services , Basic Components of an Energy Audit, Specialized Audit Tools, Industrial Audits, Commercial Audits, Residential Audits

Unit-3: Energy Management **No. of lectures-7**

Program Organizational Structure, Energy Policy Planning ,Audit Planning, Educational Planning, Strategic Planning, The Value of Energy Management, The Energy Management Profession, Some Suggested Principles of Energy Management, Energy Management Systems Justification of EMCSs Systems Integration.

Section II

Unit-4: Energy Efficiency in Thermal Utilities **No. of lectures-8**

Fuels and Combustion - Boilers -Steam System - Furnaces - Insulation and Refractory - FBC Boilers -Cogeneration - Waste heat recovery- Compressed Air System. - Diesel Generating System Energy Efficiency in Electrical Utilities - Electrical Systems -Electric Motors - Lighting System - Energy Efficient Technologies in Electrical Systems

Energy Performance Assessment for Equipment and Utility systems –

Turbines (Gas, Steam) - Heat Exchangers - Fans and Blowers - Pumps and Pumping System- Water Pumps - Compressors.

HVAC Systems - Refrigeration System. - Cooling Tower

Unit-5: Waste Heat Recovery **No. of lectures-6**

Waste Minimization and Resource Conservation - Energy Management in Process Industries, Energy Security, Codes, Standards, Electricity Act, Energy Conservation Act. Economics of Waste-Heat Recovery, Energy management in water and waste water treatment – solid waste treatment- air pollution control systems. Energy Management in Boilers and Fired systems – Steam and condensate systems – cogeneration

Unit-6: Performing Financial Analysis **No. of lectures-6**

Introduction, General Characteristics of Capital Investments, Sources of Funds ,Tax Considerations, Time Value of Money, Concepts Project Measures of Worth Economic Analysis-Financing Energy Management Projects Introduction Financial Arrangements: A Simple Example Financial Arrangements: Details and Terminology Applying Financial Arrangements: A Case Study "Pros" & "Cons"

Internal Continuous Assessment (ICA):

List of Experiments/Assignments/Case Studies, etc.

1. Assignment on Global & Indian Energy Scenario
2. Case study on Energy Audit
3. Assignment on Energy Management
4. Assignment on Energy Efficiency in Thermal Utilities.
5. Assignment on Energy Performance Assessment for Equipment and Utility systems.
6. Assignment on Waste Heat Recovery
7. Assignment on Performing Financial Analysis

Text Books:

1. Energy Management and Conservation by Sharma , K.V. Venkataseshaiah IK International Publishing House pvt Ltd 2011
2. Energy Management by Singh , Sanjeey ; Rathire, Unmesh S K Kataria & Sons New Delhi ISBN
3. Energy Engineering and Management by Chakrabarti, Amlan e-books kindle Edition
4. Energy Management by Murphy W.R Buterworth –Heinemann Publication

Reference Books

1. CB Smith, "Energy Management Principles", Pergamon Press.. New York, 1981
2. W R Murphy, G McKay, "Energy Management", Butterworth Heinemann, 2007.
3. W.C. Turner, "Energy Management Handbook", 5/e, Marcel Dekker, Inc, New York, 2005.
4. W. C. Turner, W. J. Kennedy, "Guide to Energy Management, B. L. Capehart", CRC Press, New York, 2005

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Third Year B.Tech. (Mechanical Engineering)

Semester-V

Hn542: Honors Course: Introduction to Electric and Hybrid Electric Vehicles

Teaching Scheme
Lectures: 03 Hours/week, 03 Credits
Practical: 02 Hours/week, 01 Credit

Examination Scheme
ESE: 70 Marks
ISE: 30 Marks
ICA: 25 Marks

Course Introduction:

The objective of this course is to provide a fundamental understanding of the various systems of typical electric and hybrid electric vehicles.

The covered systems are battery electric vehicles their types, components and applications, hybrid electric vehicles (HEVS), types of HEVs, batteries for EVs and HEVs, charging techniques and connectors, and the future of EVs and HEVs.

Course Objectives:

The Course aims to:

1. Understand the construction and working of EVs
2. Understand the construction and working of HEVs
3. Understand the types of electric motors and drives for EVs
4. Understand the types of control methods for electric motors

Course Outcomes:

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

1. Define all nomenclature associated with EVs and HEVs.
2. Explain construction and working of EVs and HEVs.
3. Perform basic calculations about EV performance.
4. Explain the construction, operation and selection of motors for different EV and HEV applications.
5. Explain different types of EV drive cycles.
6. Explain different types of EV motor Controller

Section I

Unit-1: EV history and fundamentals **No. of lectures - 8**

History of the electric vehicle, Electric vehicle components, Vehicle mass and performance, electric motor and engine ratings, fuel economy, Electric vehicle market. Electric Vehicles, Overview of Electric Vehicles in India, Gravitational Energy Density, Volumetric Energy Density, Energy Efficiency, Capital Cost of EV Battery, Operational Cost of EV Battery, Battery cost reduction strategy, Swapped battery, Vehicle Weight, Range Anxiety, Fast charge, Slow charge, Range-Extender batteries.

Unit-2: EVs **No. of lectures - 6**

Electric vehicle configurations, electric motor characteristics, tractive effort and transmission requirements, tractive effort in normal driving, energy consumption and vehicle performance.

Unit-3: HEVs **No. of lectures - 6**

Concept of Hybrid Electric Drive Trains, Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains, Plug-In Hybrid Electric Vehicle, Powertrain Component Sizing, Mass Analysis and Packaging.

Section II

Unit-4: Electric Motors for EVs **No. of lectures - 6**

Basic construction working and control principles of DC motors, BLDC motors, AC induction and synchronous motors, SRM motors.

Unit-5: Motor Controllers **No. of lectures - 6**

Choppers, Inverters, VFDs, torque control of DC motors, speed control of DC motors, torque and speed control of AC motors.

Unit-6: Drive Cycle **No. of lectures - 8**

Drive cycle, Energy Efficiency, Speed, Acceleration, Idling, Deceleration, Standard Drive Cycle, India Drive Cycle, Regeneration Efficiency, Modified Indian Drive Cycle, Electric Compact Sedan, Compact Sedan Energy Efficiency, Low-End Electric Trucks, Delivery Truck Specifications, Truck MIDC, Traction Energy for Drive Cycle, Summary of the impact of various parameters.

Internal Continuous Assessment (ICA):
List of Experiments/Assignments/Case Studies, etc. (Any Eight)

1. History and development of EVs and HEVs
2. EV types and components
3. HEV types and components
4. Basic performance calculations for EVs
5. DC motors for EVs.
6. AC motors for EVs.
7. DC motor modelling and control.
8. AC motor modelling and control.
9. Motor controllers and power electronics.
10. Drive Cycles

Text Books:

1. Iqbal Husain, *Electric and Hybrid Vehicles Design Fundamentals*, Taylor and Francis, 2021
2. Ehsani, et al, *Modern Electric, Hybrid Electric, and Fuel Cell Vehicles,* CRC press
3. R.Krishnan, "Electric Motor Drives – Modeling, Analysis and Control", Prentice-Hall of India, Pvt. Ltd., New Delhi, 2003.

Reference Books

1. Austin Hughes, "Electric Motors and Drives – Fundamentals, Types and Applications", Elsevier – a division of Reed Elsevier India Private Limited, New Delhi, 2006.
2. Vedam Subramanyam, "Electric Drives – Concepts and Applications", Tata McGraw Hill,2000.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Third Year B.TECH. (Mechanical Engineering)

Semester-V

Seminar

Teaching Scheme
Practical : 02Hours/week, 01 Credit

Examination Scheme
ICA : 50 Marks

Topic Selection: Topic should be based on the literature survey on any topic relevant to Honors subject. At least five journal papers should be referred for topic selection.

Report: Each student has to prepare a write-up of about 25 to 50 pages. The report typed on A4 sized sheets and bound in the necessary format, should be submitted after approved by the guide and endorsement of the Head of Department.

Seminar Delivery: The student has to deliver a seminar talk in front of the teachers of the department and his classmates. The Guide based on the quality of work and preparation and understanding of the candidate shall do an assessment of the seminar.

ICA : The ICA marks should be distributed as follow

Report writing: - 25 marks

Seminar Presentation: - 25 marks

Above Guidelines will be applicable for all Honors Subject

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Third Year B.Tech. (Honors) (Mechanical Engineering)

Semester-VI

Hn613: Honors Course: Industrial Networks and Controllers

Teaching Scheme	**Examination Scheme**
Lectures : 03 Hours/week, 03 Credits	**ESE : 70 Marks**
Practical : 02 Hours/week, 01 Credit	**ISE : 30 Marks**
	ICA : 25 Marks

Course Introduction:

This course is designed to give the student an in depth understanding of Industrial Networks. This course requires the students to take part in site visits and case study presentations. This course covers the fundamentals of Controllers and The control problem, state equations, actuator dynamics, set point tracking trajectory planning, joint space schemes, Cartesian space schemes, issues in trajectory planning Simple block diagrams and transfer function, simple trajectory calculations.

Mobile robotics. Design, classification, navigation, AGVs, applications

Course Objectives:

The course aims to:

1. Understand fundamentals of manipulator control
2. Acquaint with existing market distribution and future trends.
3. Understand the fundamentals of trajectory planning.
4. Understand modern control strategies used in industrial robots
5. Understand robot programming languages and types of programming.
6. Understand the scope of AGVs and other mobile robots for industrial applications.

Course Outcomes:

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

1. Draw a generalized block diagram for robot joint control
2. Identify control issues and suggest control techniques based on applications.
3. Identify control issues and suggest control techniques based on applications.
4. Identify robot programing languages used by different robot manufacturers.
5. Explain construction and applications of different types of robots.
6. Select mobile configuration based on applications.

Section I

Unit 1 – Introduction to Robot control **No. of lectures - 07**

Basic control systems concepts and models, Mathematical Models ,transfer function, Generalized block diagram for robot joint control., The control problem, state equations, actuator dynamics, joint space schemes

Unit 2 – Robot Controllers **No. of lectures - 06**

Overview of advanced control techniques such as force control,controllers,On-off control, proportional control, Integral control, PI control, PD control, PID control, control system analysis, transient, steady state response.

Unit 3 – Robot Trajectory **No. of lectures - 07**

Basics of Trajectory, obstacle and collision avoidance, Set point tracking trajectory planning, joint space schemes, Cartesian space schemes, issues in trajectory planning

Section II

Unit 4 – Actuators **No. of lectures - 06**

Pneumatic and hydraulic actuators, Electric motors, DC Motor block diagram, Power transmission system, Gears, Power screws, comparison between hydraulic, pneumatic, electric actuators

Unit 5 – Robot Programming **No. of lectures - 07**

Robot cell layout, considerations in workcell design, workcell control, cell safety, human machine interface, robot cell controller. Lead through programming, walk through programming, offline programming.

Unit 6 – AGV Navigation **No. of lectures - 07**

AGVs, classification, navigation techniques, applications.

Mobile robots: Classification, wheeled and tracked robots, autonomous navigation and control methods and applications.

Internal Continuous Assessment (ICA):
List of Experiments/Assignments/Case Studies, etc.

1. One software assignment robot motor control using suitable software package.
2. Theory assignment on robot control.
3. One assignment on workcell simulation in any suitable robot simulation software.
4. Survey assignment on robots, AGVs, Navigation..
5. Survey assignment on obstacle and collision avoidance.
6. One assignment on Generalized block diagram for robot joint control
7. One assignment on transient, steady state response
8. One assignment on Problem Solving
9. One theory assignment on robot cell controller.
10. One assignment on human machine interface.

Text Books:

1. S.K Saha, Introduction to Robotics, McGraw-Hill.
2. Mikell Groover et.al, Industrial Robotics, McGraw Hill.
3. Stuart Russel & Peter Norvig, Artificial Intelligence a Modern Approach.
4. E. Rich and K. Knight, "Artificial intelligence",TMH.
5. N.J. Nilsson, "Principles of AI", Narosa Publ. House, 2000.

Reference Books

1. Asitava Ghosal, Robotics: Fundamental Concepts and Analysis, Oxford Press.
2. Siegwart et.al, Autonomous Mobile Robots, Prentice Hall India.
3. Robin R Murphy, Introduction to AI Robotics, PHI Publication, 2000.
4. Bishop et.al, Handbook of Mechatronics, CRC Press.
5. Schilling, Fundamentals of Robotics, Prentice Hall India.
6. Robert Babuška, Fuzzy Modeling for Control, Springer.
7. Dan Patterson, Introduction to Artificial Intelligence and Expert Systems, Prentice-Hall.
8. International Federation of Robotics - https://www/ifr.org

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Third Year B.Tech. (Mechanical Engineering)

Semester-VI

Hn623: Honors Course: Printing Hardware and Software

TeachingScheme	**Examination Scheme**
Lectures:03Hours/week, 03Credits	**ESE:70Marks**
Practical :01Hours/week, 01Credit	**ISE:30Marks**
	ICA:25Marks

Course Introduction:

This course introduces 3D printing technologies including history and basics of 3D printing, currently available 3D printing methods and printable materials as well as current and emerging applications of 3D printing. Students will get a general idea on the major players in 3D printing industry and global effects of 3D printing. The course will be composed of a lecture, during which students will understand the 3D design and print a functional prototype.

Course Objectives:

The course aims to:

1. Understand the vatrious method of 3D printing Technology.
2. Understand the vatrious steps of 3D printing Technology.
3. Understand use of Software for modeling.
4. Understand use of Software for slicing.
5. Set all parameters of 3D Printer

Course Outcomes:

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

1. Select method of 3D printing Technology for various applications.
2. Use Modeling software used in 3D printing Technology.
3. Use Slicing software used in 3D printing Technology.
4. Set all parameters of 3D Printer.
5. Print various models by using 3D Printer.
6. Perform Post Processing Operations

Section I

Unit-1: Introduction and Basic Principles of 3D Printing Technology **No. of lectures-08**

Development of 3D Printing Technology: Introduction, Computers, Computer-Aided Design Technology, Other Associated Technologies, The Use of Layers, Classification of 3D Printing Processes, Metal Systems, Hybrid Systems, Milestones in 3D Printing Development, 3D Printing around the World.

Unit-2:Starting with a 3D Printer **No. of lectures-04**

Software, Generating STL files, Slice, Fixup, 3D Printer Anatomy, 3D Positioning System, 3D Printer Parts, Choosing a Filament

Unit-3: 3D Printing Technologies **No. of lectures-08**

Stereolithography (SLA), Digital Light Processing (DLP), Fused Deposition Modeling (FDM), Selective Laser Sintering (SLS), Selective Laser Melting (SLM) Electronic Beam Melting (EBM), Laminated Object Manufacturing (LOM)

Section II

Unit-4: Design, Guidelines for Process Selection & Software Issues **No. of lectures-10**

Design for 3D Printing - Design for Manufacturing and Assembly, Core DFM for 3D Printing Concepts and Objectives, 3D Printing Unique Capabilities, Exploring Design Freedoms, Design Tools for 3D Printing.

Guidelines for Process Selection - Selection Methods for a Part, Challenges of Selection, Preliminary Selection, Production Planning and Control.

Software Issues for 3D Printing - Preparation of CAD Models – the STL File, Problems with STL Files, STL File Manipulation, Beyond the STL File, Additional Software to Assist 3D Printing.

Unit-5:Software for 3D Printing **No. of lectures-05**

3D Modeling/CAD Software, Slicing/CAM Software, Printer Control/Client Software

Unit-6: 3D Scanning **No. of lectures- 05**

Introduction to 3D Scanning, Limitations, Introduction to 123D Catch, Concept of Cloud upload, Cleaning and Repairing Scans for 3D Printing, Autodesk Mesh Mixer

Internal Continuous Assessment (ICA):
List of Experiments/Assignments/Case Studies, etc.

1. Assignment on Introduction and Basic Principles of 3d Printing.
2. Assignment on Starting with a 3D Printer
3. Assignment on 3D Printing Technologies
4. Assignment on Design, Guidelines for Process Selection & Software Issues
5. Assignment on Software for 3D Printing
6. Assignment on 3D Scanning
7. Manufacturing of small models used in day today life by using 3D printers.

Text Books:

1. Gebhardt A., "Rapid prototyping", Hanser Gardener Publications, 2003.
2. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", Third Edition, World Scientific Publishers, 2010.
3. Khanna Editorial, "3D Printing and Design", Khanna Publishing House, Delhi.

Reference Books

1. Liou L.W. and Liou F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2007.
2. Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer, 2006. 3. Hilton P.D. and Jacobs P.F., "Rapid Tooling: Technologies and Industrial Applications", CRC press, 2000.
3. DouglesBryden, "CAD and Protyping for Product Design", 2014.
4. Ian Gibson, Davin Rosen, Brent Stucker "Additive Manufacturing Technologies, Springer, 2nd Ed, 2014.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Third Year B.TECH. (Mechanical Engineering)

Semester-VI

Hn633:Honors Course: Energy Conversion Systems

Teaching Scheme

Lectures : 04 Hours/week, 04 Credits

Practical : 02Hours/week, 01 Credit

Examination Scheme

ESE : 70 Marks
ISE : 30 Marks
ICA : 25 Marks

Course Introduction:

To detail on the different technologies in general for converting one form of energy to another.

Course Objectives:

The Course aims to: To analyze the working principle, pros and cons of

1. Conventional energy conversion techniques
2. Direct energy conversion systems
3. Need and necessity of energy storage systems and their desirable characteristics & Fuel cells

Course Outcomes:

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

1. Understand various mechanisms for energy conversion
2. Identify different converter.
3. Review technologies for storage of energy
4. Know merits, constraints and drawbacks of storage of energy
5. Know merits, constraints and drawbacks of Fuel Cell.
6. Explain Solar photovoltaics and performance parameters of solar module

Section I

Unit-1: Conventional Cycles **No. of lectures- 8**

Reversible and irreversible cycles - Thermodynamics analysis of Carnot - Stirling – Ericsson – Otto – Diesel – Dual – Atkinson - Brayton, Rankine**.**

Unit-2: Different Types Of Converters **No. of lectures-6**

Fundamentals of converters - Thermoelectric Converters - Thermionic converters – MHD - Ferro electric converter - Nernst effect generator**.**

Unit-3: Energy Storage Devices **No. of lectures-6**

Different types of Batteries – Working - Performance governing parameters - Hydrogen energy.

Section II

Unit-4: Fuel Cells **No. of lectures-7**

Basics – Types – Working - Comparative analysis - Thermodynamics and kinetics of fuel cell process - Performance of fuel cell – Applications - Advantages and drawbacks.

Unit-5: Energy Storage Technologies **No. of lectures-7**

Mechanical energy - Electrical energy - Chemical energy - Thermal Energy.

Unit-6: Solar Photovoltaics **No. of lectures-6**

Introduction to solar photovoltaics systems, Construction and working of solar cell, Photovoltaic cells, modules and arrays, Solar Cell I-V Characteristic, Short Circuit Current of PV Module, Open Circuit Voltage (V_{oc}), Fill Factor of a Solar Module, Efficiency of solar module

Internal Continuous Assessment (ICA):
List of Experiments/Assignments/Case Studies, etc.

1. Test on solar photovoltaic module
2. Assignment on Types of Converters
3. Assignment on Types of Converters
4. Assignment on Energy Storage Devices
5. Assignment on fuel cells
6. Assignment on Energy Storage technologies
7. Visit to Solar Power plant

Text Books:

1. Principles of Energy Conversion, Archie.W.Culp, McGraw-Hill Inc., 1991, Singapore.
2. Fuel Cell and Their Applications, Kordesch. K, and Simader.G, Wiley-Vch, Germany 1996.
3. Direct Energy Conversion, Kettari, M.A. Addison-Wesley Pub. Co 1997.

Reference Books

1. Fuel Cells: Theory and Application, Hart A.B and Womack, Prentice Hall Newyork Ltd., London 1989.
2. Energy Conversion Systems**,** Rakosh Das Begamudre,New Age International(P) Ltd.,New Delhi

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Third Year B.Tech. (Mechanical Engineering)

Semester-V

Hn643: Honors Course: Battery Technology and Charging Infrastructure

Teaching Scheme	**Examination Scheme**
Lectures: 04 Hours/week, 04 Credits	**ESE: 70 Marks**
Practical: 02 Hours/week, 01 Credit	**ISE: 30 Marks**
	ICA: 25 Marks

Course Introduction: The objective of this course is to provide a fundamental understanding of the various systems of battery for electric vehicles and hybrid electric vehicles.

The topics covered include battery fundamentals, types of battery, battery chemistry, battery parameters, and battery design considerations including mechanical and thermal design considerations.

The course also covers battery charging, swappable batteries, protocols, and standards.

Course Objectives:

The course aims to:

1. Understand the various battery terminology parameters
2. Understand the construction and working of Li-ion batteries.
3. Understand the types of charging standards and connectors
4. Understand the mechanical and thermal Design considerations of EV Battery.

Course Outcomes:

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

1. Define various battery terminology parameters
2. Explain the construction and working of Li-ion batteries.
3. Explain types of charging standards and connectors.
4. Explain mechanical Design considerations of EV Battery.
5. Explain Thermal Design considerations of EV Battery.
6. Explain alternative battery types for EV

Section I

Unit -1: Introduction to Battery Parameters **No. of lectures - 8**

State of Charge, Charging at C-Rate of battery, Discharging at C-Rate of battery, Specific Energy Density, Charge-discharge rates, Life-cycles, V Battery Life, Energy Capacity, Depth of Discharge, Useable Capacity, Parameters for EV battery selection, Battery Chemistry, Gravimetric ED, battery cost and economics

Unit -2: Li-ion battery **No. of lectures - 8**

Li-Ion battery chemistries, battery safety, cost per kWh, LCO, NMC, LMO, LFP, LTO, NCA Li-Ion battery cell construction, Container, Cylindrical cells, Pouch cells, Prismatic Cells, Cell failure, Battery Pack Design, Safety Issues, Cell Balancing, Equal Charge, Equal Discharge, Design considerations for pack, Battery Management System, Electrical Design of battery pack, mPnS, nSmP

Unit -3: Other types of battery **No. of lectures - 4**

Li-Polymer, Lithium-air, Li-metal, Solid-state Lithium, Lithium-Sulphur, Sodium-ion, Lithium-Manganese-iron-phosphate Nickel rich cathode, Silica in the anode.

Section II

Unit-4: Battery pack design and mechanical considerations **No. of lectures - 6**

Needs of a battery pack, Battery Pack Development Process, Electrical Design, Thermal Design, Mechanical Design, BMS Design, Stages of Battery Pack Design, Mechanical considerations: Forces acting on the battery pack, Base Plate dimension calculations, Material Selection Criteria, Ashby Methodology, Endplate support, vibration analysis

Unit-5: Thermal Design considerations **No. of lectures - 6**

Thermal Considerations: Required functions of Thermal Design, Battery Pack Temperature Considerations, Heat Generation in the battery pack, Heat Load Determination, Thermal Resistance, Conduction, Convection, Radiation, Active thermal management, Passive Thermal Management, Forced Air Convection, Liquid cooling of the battery pack, Immersion Cooling, Peltier cooling, Determination of Thermal Management, Heat Sink Natural Convection, Heat Pipe Cooling, Thermal Interface Material, Phase Change Material.

Unit 6: Battery Swapping and Charging **No. of lectures - 8**

EV Charger Introduction, Charger Architecture, Additional Interfaces, On-board and Off-board chargers, Slow and Fast Charge Chargers, Charging Infrastructure, Charging Protocols, EV Chargers Types, Charging Standards, AC Chargers, Protocol Standards, Charging States Battery Swapping, Energy Operator, Battery Leasing Charges, Investments by EO, Locked Smart Swappable batteries, Standardization, Bulk Charger Standardization, Swappable battery standardization, Battery Specification, CC and CV Mode of Charging, Chargers and Power Electronics, Distributed Architecture, Standalone Model, Centralized Architecture, Hub and Spoke Model, International Swap Standards, Comparisons between Swap standards, LS - VBCC Protocol, India Open Standard.

Internal Continuous Assessment (ICA)

List of Experiments/Assignments/Case Studies, etc. (Any Eight)

1. Types of batteries for EVs
2. Lion battery construction
3. New battery technology
4. Battery swapping
5. Charging infrastructure and protocols
6. AC and DC charging methods
7. Mechanical design of battery
8. Thermal design of battery
9. Alternative to Lion batteries
10. Protocols and standards regarding battery and charging

Text Books:

1. Kiehne, ***Battery Technology Handbook***, Marcel Decker
2. Dhameja Sandeep, ***Electric Vehicle Battery*** Systems, Newnes

Reference Books

1. John G. Hayes, G. Abas Goodarzi, ***Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles***, Wiley 2017
2. Iqbal Husain, ***Electric and Hybrid Vehicles Design Fundamentals***, Taylor and Francis, 2021
3. Rahn,Wang, ***Battery Systems Engineering,*** Wiley 2020