T. Y. B. Tech Interdisciplinary Open Course [IOC] Even Semester (AY-22-23)

Sr. No	Department	Course Name	Except
1	Computer and IT	Introduction to Artificial Intelligence	All branches except Computer Engineering and the students those have opted this course at their dept. level.
2	Electrical Engineering	Wind Energy Systems	Except Electrical & Mechanical. Also, this course is not available for the Renewable Minor students and the students who have similar elective courses.
3	E&TC	Digital Image Processing Applications	E & TC
4	Instrumentation	Programmable Logic Controller and Its Applications	All branches except Instrumentation and Control Engineering and the students those have opted Minor in Industrial Automation are not eligible for this course as they have already learned this course.
5	Mechanical Engineering	Renewable Energy	Except Mechanical Engineering.
6	Metallurgical Engineering	Materials and Processes for e-Mobility	Except Metallurgy Engineering
7	Production Engineering	Reliability Engineering	Except Production & Mechanical

(IOC-21002) Introduction to Artificial Intelligence

Teaching Scheme:
Lectures: 1 Hr/week
Laboratory: 2 Hrs/week

Examination Scheme:
Assignment/Quizzes – 40 marks
End Sem Exam - 60 marks

Course Outcomes

Students will be able to

1. Compare AI with human intelligence and traditional information processing and discuss its strength and limitations
2. Apply the basic principles, models and algorithms of AI to recognize, model and solve problems
3. Demonstrate knowledge of basics of the theory and practice of Artificial Intelligence
4. Design and carry out an empirical evaluation of different algorithms on a problem formalisation, and state the conclusions that the evaluation supports.
5. Apply knowledge representation techniques and problem solving strategies to common AI applications.

Course Contents

Introduction: What is AI, History, AI problems, Production Systems, Problem characteristics, Intelligent Agents, Agent Architecture, AI Application (E-Commerce, & Medicine) , AI Representation, Properties of internal representation, Future scope of AI , Issues in design of search algorithms.

[3 Hrs]

Heuristic search techniques: Heuristic search, Hill Climbing, Best first search, mean and end analysis, Constraint Satisfaction, A* and AO* Algorithm**, Knowledge Representation:** Basic concepts, Knowledge representation Paradigms, Structured representation of knowledge, ISA hierarchy

[3 Hrs]

Knowledge Inference: Introduction, Knowledge representation- Production based system, Forward and Backward reasoning, Knowledge representation using non monotonic logic: TMS (Truth maintenance system)

[3 Hrs]

Learning & Planning: What is Learning, Types of Learning (Rote, Direct instruction Analogy, Induction, Deduction) , Planning: Block world, strips, Implementation using goal stack, Non linear planning with goal stacks, Hierarchical planning, Least commitment strategy.

[3 Hrs]

Game playing and Introduction to Machine Learning: Min-max search procedure, Alpha beta cutoffs, waiting for Quiescence, Secondary search, Perception and Action: Perception, Action, Robot Architecture, Machine Learning: Definition of learning systems. Goals and applications of machine learning.

[4 Hrs]

Text Books

- Elaine Rich and Kerin Knight, Artificial Intelligence, 3rd Edition, McGraw Hill. ISBN13: 9780070087705
- Eugene, Charniak, Drew Mcdermott, Introduction to artificial intelligence, Addison- Wesley. ISBN 0-07-052263-4.

Reference Books

- Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, Prentice Hall, 3rd Edition. ISBN 0-13-103805-2.
- Tom Mitchell, Machine Learning, McGraw Hill. *ISBN*-10: 1259096955
- Herbert A. Simon, The Sciences of the Artificial, MIT Press, 3rd Edition, 1998. *ISBN*: 9780262190510.
- George F Luger, Artificial Intelligence: Structures and Strategies for Complex Problem Solving, Pearson Edu., 4th Edition. *ISBN*-13: 978-0-321-54589-3.

List of Assignments

1. Implement A* algorithm .
2. Implement AO* algorithm .
3. Implementation of other Searching algorithm.
4. Implementation of Min/MAX search procedure for game Playing .
5. Implementation of variants of Min/ Max search procedure.
6. Implementation of mini Project using the concepts studied in the AI course.

This list is a guideline. The instructor is free to assign new assignments.

IOC-21006 Wind Energy Systems

Teaching Scheme:
Lectures: 2 hrs/week
Field Visit: As necessary

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 marks

Course Outcomes:

Students will be able to:

1. understand the basics of wind energy, availability, applications, various types of wind energy systems, introduction to manufacturing of the systems, characterization, quality assurance, standards, certification and economics.
2. a field visits will be designed for firsthand experience and demonstration of the system elements.
3. know and recall core knowledge of the syllabus. (To measure this outcome, questions may be of multiple choice type or of the type-define, identify, state, match, list, name etc.).
4. understand basic concepts. (To measure this outcome, questions may be of the type explain, describe, illustrate, evaluate, give examples, compute etc.).

Unit 1 [6 Hrs]

Physics of Wind Power

History of wind power, Indian and global statistics, wind physics, Betz limit, tip speed ratio, stall and pitch control, wind speed statistics and probability distribution, wind speed and power.

Unit 2 [8 Hrs]

Introduction to Wind Energy Technologies

Introduction to wind turbines, types of wind energy systems, typical construction of various wind energy systems, wind electricity generation, environmental impact of wind electricity generators.

Unit 3 [8 Hrs]

Introduction to Small Scale Wind Electricity Generators

Small scale Wind Electricity Generation (WEG) systems, wind turbine basics, generator designs for small scale WEG, site requirements for small scale WEG, controllers for small scale WEG, grid integration, operation and maintenance of WEG, manufacturing, quality assurance, certification.

Unit 4 [8 Hrs]

Large Scale Wind Power Plants

Large scale wind turbine basics, turbine design basics, generator design, control systems, safety, grid integration, power evacuation, site selection, state of the art wind turbine manufacturers, applicable standards,

certification, power generation forecasting, design of wind farms, operation and maintenance, life.

Unit 5 [4 Hrs]

Economics of Wind Energy Systems

Life cycle costing, payback, return on investment; calculations for selection, costing and payback for WEG system, fiscal incentives, tariff calculations.

Unit 6 [6 Hrs]

Field Visits

One or more of the following visits may be undertaken.

- Small scale wind electricity generator system manufacturer.
- Large scale wind farm.
- Manufacturer of electronics and control systems for WEG.

Reference Books:

- Tony Burton et al, "Wind Energy Handbook", John Wiley & Sons Ltd., New York, USA.
- Ahmad Hemami, "Wind Turbine Technology", Cengage Learning, Clifton Park, New York, USA.
- Research papers and publications from various manufacturers.
- Government and Electricity Board documents ASTM, DIN and BIS standards.

Digital Image Processing Applications

Teaching Scheme
Lectures: 2 hrs./week

Examination Scheme
Test I - 20 Marks Test
II - 20 Marks
End Sem Exam – 60 marks

Course Outcomes:
At the end of the course, students will demonstrate the ability to:

1. Demonstrate knowledge of the Digital Image Processing Systems.
2. Use different digital image processing algorithms.
3. Describe various segmentation techniques for image analysis.
4. Identify and analyze the applications of image processing in various domains of industry.

Unit1 **(4hrs)**

Fundamentals of signal processing: Introduction to signals & systems, Concept of time domain & frequency domain representation of signals, 2D signals, 2D systems, convolution & correlation.

Unit 2 **(4hrs)**

Introduction to image processing: Fundamental steps in digital image processing, image sensing and acquisition, Basic Concepts in Sampling and Quantization, representing digital images.

Unit3 **(6hrs)**

Image Enhancement: Some basic gray level transformations, Histogram Processing, Histogram modification, Image subtraction, spatial filtering, Sharpening Spatial filters, use of first and second derivatives for enhancement; LoG, Gaussian filters, pseudo coloring:
intensity slicing, gray level to colour transformation.

Unit4 **(4hrs)**

Image Segmentation : Some Basic Relationships between pixels, point, line and edge detection, Gradient operators, Canny edge detection, Edge linking and boundary detection, Chain codes, boundary segments.

Unit5 **(3hrs)**

Threshold based Image Segmentation: The role of illumination, global thresholding, adaptive thresholding local thresholding, region-based segmentation, region growing, region splitting and merging.

Unit6 **(4hrs)**

Object Recognition and Case studies: Introduction to Object Recognition- patterns and pattern classes, recognition based on decision – theoretic methods, case studies – image analysis, application of image processing in industries.

Text Books:

- S. Sridhar, "Digital Image processing", Oxford University Press, Second Edition, 2018.
- A. K. Jain, "Fundamentals of Digital Image Processing", 1st edition, Prentice Hall India, 1988

Reference Book:

- Gonzalez & Woods, "Digital Image Processing", Second Edition, Pearson Education, 2003

[IOC-21001] Programmable Logic Controllers and Its Applications

Teaching Scheme	**Examination Scheme**
Lectures: 3 Hrs/week	T1 and T2: 20 Marks each End-Sem Exam: 60 Marks

Course Description:

This course develops the functional design, hardware configuration, programming and application of Programmable Logic Controllers (PLC). The design and programming of control circuits using examples from industrial applications will be emphasized.

Course Outcomes:

- **Explain** the generic architecture and constituent components of a Programmable Logic Controller.
- **Develop** a ladder logic program using modern engineering software tools and technique for analog and discrete control.
- **Apply** knowledge gained about PLCs to identified real-time industrial applications.
- **Select** proper PLC configuration, analog and discrete input-output devices, communication protocols for industrial control.

Course Contents

Unit I **(7 hrs)**

Introduction to PLC: Definition and Evolution of PLC, PLC Architecture, PLC Input and Output modules, central processing unit, CPUs and Programmer/monitors, Solid state memory, the processor, Input modules (Interfaces), Power supplies, PLC classifications and their general specifications, selection criteria for PLC.

Unit II **(8 hrs)**

Programming of PLC: Fundamentals of PLC ladder diagram, Basic components and their symbols in ladder diagram, Boolean logic and relay logic, Analog and discrete Input-output (I/O) devices, Programming instructions set, Timer and counter types along with wave form, shift registers, sequencer function, latch instruction; Arithmetic and logical instruction with various examples.

Unit III **(8 hrs)**

Advanced PLC Function, Analog PLC operation, PID control of continuous processes, PLC interface, and developing ladder logic for sequencing of motors, tank level control, ON-OFF temperature control, elevator, bottle filling plant and car parking. Motors Controls: AC Motor starter, AC motor overload protection, DC motor controller, Variable speed (Variable Frequency) AC motor Drive.

Unit IV **(7 hrs)**

Overview of Open systems interconnection (OSI) Model, Functions of OSI Model Layers, OSI Protocols, Functions of Transmission control protocol / Internet protocol (TCP/IP) Layers, TCP/IP protocol, DNP3 protocol, IEC61850 layered architecture, Control and Information Protocol (CIP), DeviceNet, ControlNet, EtherNet/IP, Flexible Function Block process (FFB), Process Field bus (Profibus).

Text Books

- Computer-based Industrial Controls by Krishan Kant, 2nd edition, PHI India, New Delhi, 2004.
- Computer Control of Process by M. Chidambaram, 1st edition, Narosha Publishing. 2005.
- Introduction to Programmable controller by Garry Dunning, 2nd Edition, Thomson Asia, Pte, Ltd, Singapore, 2002.
- Programmable Logic Controllers Programming Methods and Applications by John R. Hackworth, Frederick D., Hackworth Jr., 3rd edition, Pearson Education, 2005.
- Programmable Logic Controllers with Applications by P. K. Srivstava, BPB Publications, 1 st edition, 2001.
- Programmable Controllers Theory and Implementation by L. A. Bryan, E. A. Bryan, Industrial Text Company Publication, 2nd edition, 1998.

Reference Books

- Distributed Computer Control for Industrial Automation by D. Popovic and Vijay Bhatkar, 1st edition, Marcel Dekker Inc., 1998.
- Programmable Logic Controllers: Principles and Application by John W. Webb, Ronald A. Reis, 5 th Edition, McGraw Hill Inc., 2006.
- Securing SCADA System by Ronald L. Krutz, 1st edition, Wiley Publishing, 2007.
- Programmable Controllers by Batten G. L., 2nd Edition, McGraw Hill Inc., 2004.
- Instruments Engineers Handbook Process Control ,VoL-II by Bela G. Liptak, CRC Press, 4 th edition, 2006.

IOC 21005 Renewable Energy

Teaching scheme
Lectures: 2 hrs/week

Examination Scheme
Internal Test 1: 20 Marks each
Internal Test 2: 20 Marks
End– Sem. Exam: 60 marks

Course Outcomes (COs):

At the end of the course students will be able to:

- Understand effect of fossil fuels on global warming and their relative impact on the environment.
- Comprehend the energy scenario of india and the scope of non-conventional energy sources.
- Describe the difference between the non-conventional energy and the renewable.
- Evaluate the performance of the various non-conventional and renewable energy sources.
- Comprehend the recent advancements in energy generations.
- Design skills in non-conventional energy systems and enhance written communication.

Unit 1 (5 hrs)

Introduction to energy:

Energy demand growth and supply, Historical perspectives, Fossil fuels: Consumption and Reserves, Environmental impacts of burning fossil fuels, Sustainable development and the role of renewable energy.

Unit 2 (6 hrs)

Wind and Hydro power systems :

Atmospheric circulations, factors influencing the winds, wind turbines and types, coefficient of power, torque, Betz limit, Aerodynamic design principle for blades, Introduction to hydro power plant and types, overview of micro, mini and small hydropower plant, types and operational characteristics of hydro turbine

Unit 3 (6 hrs)

Bio energy and bio-fuels:

Biomass source and characterization, direct combustion, pyrolysis, mechanism of bio-renewable energy, Gasifiers, updraft gasifier, downdraft gasifier, gasifier-basedelectricity-generating systems, application of biogas slurry in agriculture, bio ethanol for energy generation

Unit 4 (8 hrs)

Fuel cells:

Working principle of fuel cells, fuel cell electrochemistry, types of fuel cells: Alkaline fuel, Fuel Cells, Phosphoric acid fuel cell, Solid oxide fuel cell, Molten carbonate fuel cell, Direct methanol Fuel Cell, their applications, relative merits and demerits. Introduction to thermal heat storage.

Unit 5 (6 hrs)

Tidal energy:

Tidal power plants: single basin & two basin plants, variation in generation level, Ocean thermal electricity conversion, electricity generation from waves, shortline and floating wave systems.

Unit 6 (6 hrs)

Geothermal energy :

Introduction, Geothermal sites in India, high temperature and low temperature sites in India, Conversion technologies, Steam and binary systems, geothermal power plant, open loop and closed loop system

Text Books

- Godfrey Boyle, Renewable energy, Oxford press, 2012
- Twidell J and Weir T., Renewable energy resources, Taylor and Francis, 2006
- Rai G.D., Non-conventional energy sources, Khanna Publication, 2009
- B.H. Khan, Non-conventional energy sources, Mcgrawhill education, 2006.

Reference Books

- Wind Energy Systems by Johnson G. L., Prentice Hall,1985
- Introduction to Hydro Energy Systems: Basics, Technology and Operation by Wagner H. and Mathur J, Springer, 2009.
- Bio-fuels: biotechnology, chemistry, and sustainable development by DM Mousdale, CRC Press, 2008.
- Fuel Cells: From Fundamentals to Applications by S Srinivasan, Springer, 2006.

[MT(IOC) -21004] Materials and Processes for e-Mobility

Teaching Scheme:
Lectures :2 hrs /week

Examination Scheme:
T1 and T2: 20 Marks each
End Sem Exam : 60 marks

Course Outcomes:

At the End of Course students will be able to

1) Select appropriate battery technologies based on energy density, power density, life span, safety, cost, performance and environmental impact.
2) Establish structure - microstructure - electrical performance correlations for various components of a battery.
3) Recommend various hybrid vehicle configurations based on applications.
4) Adopt appropriate rare-earth and rare-earth free magnets for applications in various e-vehicles.
5) Design the processes for fabrication of various components required in e-vehicles.

Unit 1 **[4 hrs]**

Introduction to e-vehicles and their classification, Comparison with the IC Engine Technology, e-vehicles life cycle analysis and raw material availability, Economic considerations for batteries in e-vehicles, Value chain for electric car batteries, Concept of energy density and power density, Comparative study of energy and power density of various battery technologies

Unit 2 **[6 hrs]**

Structure of Li ion battery: electrolyte, cathode and anode active materials, binder and separator, Performance requirement of battery components, Electrolytes in Li-ion batteries: Synthesis, fabrication, microstructure investigation and determination of electrical properties, Chemistry of cathode and anode materials for Li-ion batteries, integration of cathode, anode and electrolyte, measurement of electrical properties of cells, Recycling of battery materials

Unit 3 **[6 hrs]**

Materials for sealing of batteries, Cell to battery pack manufacturing, electrical insulations in Battery packs, thermal management materials in battery packs, Tradeoffs between specific power, specific energy, performance, cost, life span and safety in principal Li-ion battery technologies, Looking beyond Li-ion batteries: Mg, Al and Fe ion batteries, pros and cons w.r.t. Li-ion batteries, Indian Scenario for Li and alternate battery materials

Unit 4 **[6 hrs]**

Superpercpacitors for electrical vehicles, principle and materials used, key electrical characterization techniques, Battery-supercapacitor hybrid arrangement for e-vehicles, Fuel cells

for electric vehicles, principle and materials used, key electrical characterization techniques, Battery-fuel cell hybrid arrangement for e-vehicles, Concept of battery-biofuel hybrid arrangement for e-vehicles

Unit 5 [6 hrs]

Critiitical Metals for electric motors: Nd, Eu, Y, Tb, Dy; manufacturing of rare earth and rare-earth free magnets for electric motors, Comparative Study on magnetic properties of rare earth and rare-earth free magnets, Recycling of magnetic materials from motors in e-vehicles, Structural materials for EVs: fibre reinforced composites, steels, Al etc., Materials required in charging stations

Text Books

- Richard Folkson, Alternative fuels and advanced vehicle technologies for improved environmental performance: Towards zero carbon transportation, Woodhead Publishing, 1st Edition, 2014
- M. Ehsani, Y. Gao, S. Longo, K. Ebrahimi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles, CRC Press, 3rd Edition, 2018
- R. Xiong, S. Weixiang, Advanced Battery Management Technologies for Electric Vehicles, Wiley, 1st Edition, 2019

Reference Books

- J. Jiang, C. Zhang, Fundamentals and Application of Lithium-ion Battery Management in Electric Drive Vehicles, Wiley, 1st Edition, 2019
- D. Beeton, G. Meyer, Electric Vehicles Business Models: Global Perspectives, Springer, 1st Edition, 2015

IOC) (IOC21007) Reliability Engineering

Teaching Scheme	Examination Scheme
Lectures : 2 hrs/week	100 marks: Continuous evaluation- Assignments /Quiz- 40 Marks, End Sem Exam- 60 marks

Course Outcomes:

- Student will be able to understand and familiarize with concept of reliability and maintainability.
- Student will be able to understand the that how to analyze a system for reliability assessment and life cycle costing.
- To familiarize with condition monitoring in maintainability.
- Student will be able to understand the importance and application of reliability.
- Student will be able to use the concepts of reliability in designing and maintenance of products.
- Student will be able to simulate techno economic life which is very important for industry application

Syllabus Contents:

Unit 1 **(6 hrs)**

Reliability

Definition -methods of improving reliability, derivation of Reliability function, configurations of reliability, series parallel & mixed configuration, simple problems

Unit 2 **(6 hrs)**

Reliability Calculations

methods of improving reliability, redundancy element, unit stand-by redundancy, reliability models, constant hazard, simple problems, hazard models.

Unit 3

Maintenance Systems **(6 hrs)**

Objective, of maintenance, maintainability and availability concepts, types of availability - mean time to failure-mean time between failures-mean time to repair-mean down time- Reliability allocation

Unit 4 **(6 hrs)**

Life Cycle Costing

Techno economic Life; Reliability effort function, simple cost models for Life cycle.

Unit 5 **(4 hrs)**

Maintenance Management

Principles types of maintenance breakdown, periodic, preventive and total productive maintenance etc

Text Books:

- L. S. Srinath Reliability Engineering, -Affiliated East -West press, 2002.
- S.K. Basu & B.Bhadury, Terotechnology: Reliability Engg& maintenance Management, Asian book Private Ltd., Delhi, 1stEdition, 2003.

Reference Books:

- K. K. Ahuja, Industrial management and Organizational Behaviour, Khanna Publications. 1999
- H. P. Garg, Industrial Maintenance, S. Chand & company. Ltd, Third Edition 1990.
- Dr. Shankar, Industrial engineering Management Golgotia Publications Pvt. Ltd. 1997
- A.K. Gupta, Reliability Engineering & Terotechnology