# Rajiv Gandhi ProudyogikiVishwavidyalaya Bhopal
# M.Tech (IoT)
# Third Semester Syllabus
### MTIO 301(A)- AI And Machine Learning

**Course Objectives:**
The objective of this course is to provide an introductory and broad overview of the field of AI and ML.

**UNIT I** Introduction to Artificial Intelligence: The History of AI, AI and Society, Agents, Knowledge based systems; Fields and Applications of Artificial Intelligence, Propositional Logic: First order Predicate Logic: Limitations of Logic

**UNIT II** Search, Games and Problem Solving: Uninformed Search, Heuristic Search, Games with Opponents, Heuristic Evaluation Functions, State of the Art; Reasoning with Uncertainty: Computing with Probabilities, The Principle of Maximum Entropy, Reasoning with Bayesian networks

**UNIT III** Machine Learning: Preliminaries, Examples of Machine Learning Applications, Data Analysis, Regression, The Perceptron, A Linear Classifier, The Nearest Neighbor method, Decision Tree Learning, Cross-Validation and Overfitting, Learning of Bayesian networks, The Naïve Bayes Classifier, One-class learning, Clustering

**UNIT IV** Neural Networks: From Biology to Simulation, Hopfield Networks, Neural Associative Memory, Linear Networks with Minimal Errors, The Back Propagation Algorithm, Support Vector Machines, Deep Learning, Applications of Neural Networks, Reinforcement Learning

**UNIT V** Design and Analysis of Machine Learning Experiments: Factors, response and strategy of experimentation, Guidelines for machine learning experiments, cross-validation and resampling methods, Measuring classifier performance, Hypothesis testing, comparing multiple algorithms, comparison over multiple datasets

**Reference Books:**


1. Wolfgang Ertel, “Introduction to Artificial Intelligence”, Second Edition, Springer, 2017
2. Nils J. Nilsson, “ Artificial Intelligence: A New Synthesis”, Morgan Kaufmann Publishers
3. David Forsyth, “Applied Machine Learning”, Springer
4. Ethem Alpaydin, “Introduction to Machine Learning”, Third Edition, The MIT Press, 2014
5. Mohssen Mohammed, Muhammad Badruddin Khan, Eihab Bashier Mohammed Bashier, “Machine Learning Algorithms and Applications”, CRC Press Taylor & Francis Group, 2017
6. Zsolt Nagy, “Artificial Intelligence and Machine Learning Fundamentals, Packt Publishing, 2018


**Course Outcomes:**
On successful completion of this course the students will be able to-
1. Demonstrate fundamental understanding of artificial intelligence (AI)
2. Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation, and learning
3. Demonstrate proficiency in using models of machine learning
4. Apply knowledge of neural networks to solve various problems
5. Perform machine learning experiments

# MTIO 301(B)- Industrial IOT

**Course Objectives:**
The objective of this course is to enable the students to understand the application of IoT in industries to modify the various existing industrial systems.

**Unit I**
Introduction to Industrial Internet of Things and Industry 4.0: Basics of Industry 4.0, Basics of Industrial Internet of Things (IIoT), Evolution of IIoT – understanding the IT & OT (Operational Technology) convergence, OT components like Industrial control systems, PLC, SCADA, and DCS, Industrial Edge, Open loop and closed loop controls, Components of IIOT, Role of IIOT in Manufacturing Processes, Challenges & Benefits in implementing IIOT, Adoption of IIoT, Market trends and opportunities in IIoT

**Unit II**

Technological Aspects of Industry 4.0 and IIoT: Industrial processes, Industrial sensing and actuation, Industrial networks, Machine-to-machine networks, Business Models and Reference Architecture of IIoT, IIoT design considerations, Key Technologies: Off-site Technologies, On-site Technologies

**Unit III**
Enabling Technologies of IIoT: IIoT Layers, Sensing, Processing, Communication and Networking in IIoT, Sensors, Actuators, Industrial Data Transmission, Industrial Data Acquisition

**Unit IV**
IIoT Analytics: Big Data Analytics and Software Defined Networks, Machine Learning and Data Science in Industries, Security and Fog computing in IIoT

**Unit V**

Applications of IIoT and Case Studies: Healthcare Applications in Industries, Inventory Management and Quality Control, Plant Safety and Security, Oil, chemical and pharmaceutical industry, Integration of products, processes, and people, Smart factories and cyber-physical systems, Case Studies, IIoT Application Development, Protocols used in building IIoT applications

**References:**

1. "Introduction to Industrial Internet of Things and Industry 4.0", By Sudip Misra Chandana Roy, Anandarup Mukherjee, CRC Press, 2020
2. "Industrial Internet of Things for Developers", Ryane Bohm, Wiley
3. "Handbook of Industry 4.0 and Smart Systems", Diego Galar Pascual, Pasquale Daponte, Uday Kumar, CRC Press, 2019


**Course Outcomes:**
After the completion of this course, the students will be able to:
1. Understand the role of IIOT in manufacturing processes
2. Apply knowledge of IIoT design considerations and IIoT technologies to develop solutions for Industries
3. Collect, communicate and leverage the IIoT data
4. Analyze the IIoT data by using various machine learning algorithms
5. Identify, formulate and solve engineering problems by using Industrial IoT.

## MTIO 301(C)- IOT Application & Web Development

**Course Objectives:**
The objective of this course is to enable the students to learn and apply the programming skills in developing IoT applications pertaining to Industrial, medical, agricultural field etc.

**Unit I**
Markup Language: Introduction to Markup language, HTML document structure, HTML forms, Style (CSS), Multiple CSS stylesheets, DHTML, Tools for image creation and manipulation, User experience design, IoT development using charts

**Unit II**
Scripting Language: Introduction to JavaScript, Functions, DOM, Forms, and Event Handlers, Object Handlers, Input validation, J2ME, application design using J2ME , IoT development using Real time rules, platforms, alerts

**Unit III**
Android Programming Framework: Mobile app development: Android Development environment, Simple UI Layouts and layout properties, GUI objects, Event Driven Programming, opening and closing a Database

**Unit IV**
Industrial IoT: IIoT Fundamentals and Components, Industrial Manufacturing, Monitoring, Control, Optimization and Autonomy, Introduction to Hadoop and big data analytics

**Unit V**
Applications: Smart Farming: Weather monitoring, Precision farming, Smart Greenhouse, Drones for pesticides, Energy Consumption Monitoring, Smart Energy Meters, Home automation, Smart Grid and Solar Energy Harvesting, Intelligent Parking, Data lake services scenarios, Architecture of IoT for Healthcare, Multiple views coalescence, SBC-ADL to construct the system architecture. Use Cases : Wearable devices for Remote monitoring of Physiological parameter, ECG, EEG, Diabetes and Blood Pressure.

**References:**

1. John Dean, Web Programming with HTML5, CSS and JavaScript, 2018, Jones and Bartlett Publishers Inc., ISBN-10: 9781284091793
2. DiMarzio J. F., Beginning Android Programming with Android Studio, 2016, 4th ed., Wiley, ISBN-10: 9788126565580
3. Fadi Al-Turjman, Intelligence in IoT- enabled Smart Cities, 2019, 1st edition, CRC Press, ISBN-10: 1138316849
4. Giacomo Veneri, and Antonio Capasso, Hands-on Industrial Internet of Things: Create a powerful industrial IoT infrastructure using Industry 4.0, 2018, Packt Publishing.
5. Subhas Chandra Mukhopadhyay, Smart Sensing Technology for Agriculture and Environmental Monitoring, 2012, Springer, ISBN-10: 3642276377


**Course Outcomes:**
After the completion of this course, the students will be able to:
1. Design dynamic web forms to acquire and process user & sensor data
2. Interactive forms using Java Script with a focus on internet of things
3. Implement mobile application using android SDK
4. Understand the IoT architecture and building blocks for various domains
5. Devise multidisciplinary case to case modelling and execute wide range of application

## MTIO 302(A)- Wearable Computing

**Course Objectives:**

The objective of this course is to familiarize the students with the need for development of wearable devices and its implications on various sectors.

**Unit I** Introduction to Wearable Devices: Motivation for development of Wearable Devices, The emergence of wearable computing and wearable electronics, Types of wearable sensors: Invasive, Non-invasive; Intelligent clothing, Industry sectors' overview – sports, healthcare, Fashion and entertainment, military, environment monitoring, mining industry, public sector and safety.

**Unit II** Wearable Inertial Sensors: Accelerometers, Gyroscopic sensors and Magnetic sensors; Modality of Measurement- Wearable Sensors, Invisible Sensors, In-Shoe Force and Pressure Measurement; Applications: Fall Risk Assessment, Fall Detection , Gait Analysis, Quantitative Evaluation of Hemiplegic and Parkinson's Disease patients; Physical Activity monitoring: Human Kinetics, Cardiac Activity, Energy Expenditure measurement: Pedometers, Actigraphs.

**Unit III** Wearable Devices for Healthcare: Wearable ECG devices: Basics of ECG and its design, Wearable EEG devices: Principle and origin of EEG, Basic Measurement set-up, Wearable Blood Pressure (BP) Measurement: Cuff-Based Sphygmomanometer, Cuffless Blood Pressure Monitor. Study of flexible and wearable Piezoresistive sensors for cuffless blood pressure measurement. Wearable sensors for Body Temperature: Intermittent and Continuous temperature monitoring, Detection principles; Noninvasive Glucose Monitoring Devices, wearable pulse oximeter

**Unit IV** Wearable Cameras and Microphones for Navigation: Cameras in wearable devices, Applications in safety and security, navigation, Enhancing sports media, Automatic digital diary. Cameras in smart-watches; Use of Wearable Microphones: MEMS microphones, Bioacoustics, Microphones and AI for respiratory diagnostics and clinical trials. Wearable Assistive Devices for the Blind - Hearing and Touch sensation, Assistive Devices for Fingers and Hands, Assistive Devices for wrist, for arm and feet, vests and belts, head-mounted devices

**Unit V** Other Wearable Devices: Wearable devices with Global Positioning System (GPS) integration for tracking and navigation. Wearable Optical Sensors -chemical sensors, optical glucose sensors, UV exposure indicators, speech recognition using lasers; Photoplethysmography (PPG), 3D imaging and motion capture.

**References:**


1. "Seamless Healthcare Monitoring", Toshiyo Tamura and Wenxi Chen, Springer 2018
2. "Wearable Sensors -Fundamentals, Implementation and Applications", by Edward Sazonov and Michael R. Neuman, Elsevier Inc., 2014.
3. "Wearable and Autonomous Biomedical Devices and Systems for Smart Environment", by Aimé Lay-Ekuakille and Subhas Chandra Mukhopadhyay, Springer 2010


**Course Outcomes:**

After the completion of this course, the students will be able to:

1. Identify and understand the need for development of wearable devices and its influence on various sectors.
2. Discus the applications of various wearable inertial sensors for biomedical applications.
3. Comprehend the design and development of various wearable activity monitoring devices for use in healthcare applications.
4. Acquaint the usage of wearable devices as assistive devices, diagnostic devices and other modern applications.
5. Design and develop various wearable devices for detection of biochemical and physiological body signals, environmental monitoring, safety and navigational assistive devices.

# MTIO 302(B)- Augmented And Virtual Reality

**Course Objective:**
The objective of this course is to provide students a general introduction of Virtual and Augmented Environments followed by an analysis of features, requirement and issues in real-life applications.

**Unit I** Introduction to Virtual Reality- Virtual Reality and Virtual Environment: Introduction, Applications of Virtual Reality, Computer graphics, Real time computer graphics, Flight Simulation, Virtual environment requirement, benefits of virtual reality, Historical development of VR, Scientific Landmark 3D Computer Graphics: Introduction, The Virtual world space, positioning the virtual observer, the perspective projection, human vision, stereo perspective projection, 3D clipping, Colour theory, Simple 3D modeling, Illumination models, Reflection models, Shading algorithms, Radiosity, Hidden Surface Removal, Realism-Stereographic image.

**Unit II** Geometric Modeling- Geometric Modeling: Introduction, From 2D to 3D, 3D space curves, 3D boundary representation Geometrical Transformations: Introduction, Frames of reference, Modeling transformations, Instances, Picking, Flying, Scaling the VE, Collision detection Generic VR system: Introduction, Virtual environment, Computer environment, VR technology, Model of interaction, VR Systems.

**Unit III** Virtual Environment -Animating the Virtual Environment: Introduction, The dynamics of numbers, Linear and Nonlinear interpolation, the animation of objects, linear and non-linear translation, shape & object in betweening, free from deformation, particle system. Physical Simulation: Introduction, Objects falling in a gravitational field, Rotating wheels, Elastic collisions, projectiles, simple pendulum, springs, Flight dynamics of an aircraft.

**Unit IV** VR Hardware and Software- Human factors: Introduction, the eye, the ear, the somatic senses. VR Hardware: Introduction, sensor hardware, Head-coupled displays, Acoustic hardware, Integrated VR systems. VR Software: Introduction, Modeling virtual world, Physical simulation, VR toolkits, Introduction to VRML

**Unit V** Augmented and Mixed Reality- Taxonomy, Technology and features of augmented reality, difference between AR and VR, Challenges with AR, AR systems and functionality, Augmented reality methods, visualization techniques for augmented reality, wireless displays in educational augmented reality applications, mobile projection interfaces, marker-less tracking for augmented reality, enhancing interactivity in AR environments, evaluating AR systems.

**References:**


1. John Vince, “Virtual Reality Systems “, Pearson Education Asia, 2007.
2. Anand R., “Augmented and Virtual Reality”, Khanna Publishing House, Delhi.
3. Adams, “Visualizations of Virtual Reality”, Tata McGraw Hill, 2000.
4. Grigore C. Burdea, Philippe Coiffet , “Virtual Reality Technology”, Wiley Inter Science, 2 nd Edition, 2006.
5. William R. Sherman, Alan B. Craig, “Understanding Virtual Reality: Interface, Application and Design”, Morgan Kaufmann, 2008.
6. Alan B Craig, William R Sherman and Jeffrey D Will, Developing Virtual Reality Applications: Foundations of Effective Design, Morgan Kaufmann, 2009.
7. Gerard Jounghyun Kim, Designing Virtual Systems: The Structured Approach, 2005.
8. Alan B. Craig, Understanding Augmented Reality, Concepts and Applications, Morgan Kaufmann, 2013.


**Course Outcomes:**

After the completion of this course, the students will be able to:

1. Demonstrate knowledge of virtual reality and its applications
2. To describe the importance of viewing and projections.
3. Understand geometric modeling and Virtual environment.
4. Explain about virtual reality hardware and software
5. Develop Virtual Reality applications.

## MTIO 302(C)- Energy Harvesting Technologies and Power Management for IOT Devices

**Course Objective:**
The objective of this course is to enable the students to understand the energy harvesting systems in IoT and use its knowledge various applications of IoT

**Unit I**
Energy Harvesting Systems: Introduction – Energy sources – energy harvesting based sensor networks – photovoltaic cell technologies – generation of electric power in semiconductor PV cells– types

**Unit II**
Piezo-Electric Energy Harvesting and Electromechanical Modeling: Piezoelectric materials – transducers – harvesters – micro generators – strategies for enhancing the performance of energy harvesters. Electromechanical modeling of Lumped parameter model and coupled distributed parameter models and closed-form solutions

**Unit III**
Electromagnetic Energy Harvesting and Nonlinear Techniques: Basic principles – micro fabricated coils and magnetic materials – scaling – power maximations – micro and macro scale implementations. Non-linear techniques –vibration control & steady state cases

**Unit IV**
Energy Harvesting Wireless Sensors: Power sources for WSN – Power generation – conversion – examples – case studies. Harvesting microelectronic circuits – power conditioning and losses

**Unit V**
**Case Study:** Case studies for Implanted medical devices – Bio-MEMS based applications –harvesting for RF sensors and ID tags – powering wireless SHM sensor nodes

**References:**


1. Carlos Manuel Ferreira Carvalho, Nuno Filipe Silva Veríssimo Paulino, “CMOS Indoor Light Energy Harvesting System for Wireless Sensing Applications”, springer, 2016
2. Danick Briand, Eric Yeatman, Shad Roundy ,“Micro Energy Harvesting”, 2015


**Course Outcomes:**

After the completion of this course, the students will be able to:

1. Understand the energy harvesting systems in IoT
2. Apply strategies for enhancing the performance of energy harvesters
3. Learn various techniques of energy harvesting
4. Acquire knowledge of various power sources for wireless sensor networks
5. Build solutions for various applications by applying knowledge of case studies and examples