Rajiv Gandhi Proudyogiki Vishwavidyalaya Bhopal
M.Tech (*IoT and Sensor System*)
Third Semester Syllabus

MTIN 301(A)-Deep Learning

Course Objectives:
The objective of this course is to impart adequate knowledge on deep learning frameworks and their applications to solving engineering problems

Unit I Neural Networks- ANN as a technique for regression and classification, structure of an artificial neuron, activation functions- linear activation, sigmoid andsoftmax. Feedforward neural networks- shallow modelsingle layer perceptron,multi-layer perceptron as complex decision classifier- learning XOR-Gradient based learning, Backpropagation algorithm, risk minimization, loss function, regularization, heuristics for faster training and avoiding local minima.

Unit II Deep Feed Forward Neural Networks- Feed forward neural networks- deep model- output units and hidden units, training deep modelshyper parameters and validation sets-cross validation, capacity, overfitting and under fitting, bias vs variance trade off, cross validation - vanishing gradient problem, new optimization methods (adagrad, adadelta, rmsprop, adam), regularization methods (dropout, batch normalization, dataset augmentation), early stopping.

Unit III Convolutional Neural Network- Convolution operation- kernel and feature map, sparse connectivity, equivariance through parameter sharing, pooling function for invariant representation, convolution and pooling as strong prior, convolution with stride, effect of zero padding, single-channel and multi-channel data types used in ConvNet, variants of basic convolution- locally connected, tiled ConvNet- spatial separable and depthwise separable convolutions, fully connected layers, ConvNet architecture- layer patterns, layer sizing parameters,case studies- LeNet, AlexNet

Unit IV Recurrent Neural Networks- Sequence learning with neural nets, unrolling the recurrence, training RNN- Backpropagation through time (BPTT), vanishing gradient problem, Gated recurrent unit (GRU), Long short term memory (LSTM), Bidirectional LSTMs, bidirectional RNNs

Unit V Deep Learning Tools and Applications-Tools:TensorFlow, Keras, PyTorch, Caffe, Theano, MXNet. Applications: Object detection with RCNN - YOLO, SSD. Speech recognition with RNN

References:

1. Bengio, Yoshua, Ian J. Goodfellow, and Aaron Courville. "Deep learning" 2015, MIT Press
2. Josh Patterson and Adam Gibson, “Deep Learning- A Practitioner’s Approach” O’Reilly Media Inc., 2017, USA.
3. Bengio, Yoshua. "Learning deep architectures for AI- Foundations and trends in Machine Learning, 2(1)- 2009
4. Bishop, C. ,M., Pattern Recognition and Machine Learning, Springer, 2011

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

1. Understand the differences between shallow neural networks and deep neural networks for supervised and unsupervised learning
2. Develop and train neural networks for classification, regression and clustering.
3. Understand the foundations of neural networks, how to build neural networks and learn how to lead successful machine learning projects
4. Identify the deep feed forward, convolution and recurrent neural networks which are more appropriate for various types of learning tasks in various domains
5. Implement deep learning algorithm and solve real world problems

MTIN 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.

MTIN 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

MTIN 302(A)-Robotics

Course Objectives:
The objective of this course is to impart knowledge about industrial robots for their control and design.

Unit I Introduction to Robotics:
Types and components of a robot, Classification of robots, closed-loop and open-loop control systems; Kinematics systems: Definition of mechanisms and manipulators, Social issues and safety

Unit II Robot Kinematics and Dynamics:
Kinematic Modelling: Translation and Rotation Representation, Coordinate transformation, DH parameters, Jacobian, Singularity, and Statics;
Dynamic Modelling: Equations of motion: Euler-Lagrange formulation

Unit III Sensors and Vision System:
Sensor: Contact and Proximity, Position, Velocity, Force, Tactile etc.
Introduction to Cameras, Camera calibration, Geometry of Image formation, Euclidean/Similarity/Affine/Projective transformations, Vision applications in robotics.

Unit IV Robot Control:
Basics of control: Transfer functions, Control laws: P, PD, PID, Non-linear and advanced controls
Robot Actuation Systems: Actuators: Electric, Hydraulic and Pneumatic; Transmission: Gears, Timing Belts and Bearings, Parameters for selection of actuators.

Unit V Control Hardware and Interfacing:
Embedded systems: Architecture and integration with sensors, actuators, components, Programming for Robot Applications

References:

1. Saha, S.K., "Introduction to Robotics, 2nd Edition, McGraw-Hill Higher Education, New Delhi, 2014.
2. Ghosal, A., "Robotics", Oxford, New Delhi, 2006.
3. Niku Saeed B., "Introduction to Robotics: Analysis, Systems, Applications", PHI, New Delhi.
4. Mittal R.K. and Nagrath I.J., "Robotics and Control", Tata McGraw Hill.
5. Mukherjee S., "Robotics and Automation", Khanna Publishing House, Delhi.
6. Craig, J.J., "Introduction to Robotics: Mechanics and Control", Pearson, New Delhi, 2009
7. Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, "Robot Modelling and Control", John Wiley and Sons Inc, 2005
8. Steve Heath, "Embedded System Design", 2nd Edition, Newnes, Burlington, 2003
9. Merzouki R., Samantaray A.K., Phathak P.M. and Bouamama B. Ould, "Intelligent Mechatronic System: Modeling, Control and Diagnosis", Springer.

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

1. Understand robot mechanism
2. Perform kinematic and dynamic analyses with simulation
3. Design control laws for a robot
4. Integrate mechanical and electrical hardware for a real prototype of robotic device
5. Select a robotic system for given application

MTIN 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.

MTIN 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