Autonomous Program Structure
B.Tech in Instrumentation and Control
with **Honors Degree Programme** in
Industrial Measurement and Automation
Academic Year: 2022-2023 Onwards

Course Code	Semester	Course Title	Teaching Scheme Hours /Week			Examination Scheme				Marks	Credit
			Lecture	Tutorial	Practical	In Semester	End Semester	Oral	Practical		
20HIA501	TY Sem I	Sensor Technology	3	0	0	50	50	0	0	100	3
20HIA502	TY Sem I	Field Instrumentation	3	0	0	50	50	0	0	100	3
20HIA502 L	TY Sem I	Field Instrumentation Lab	0	0	2	0	0	0	50	50	1
20HIA601	TY Sem II	Industrial IoT	3	0	0	50	50	0	0	100	3
20HIA602	TY Sem II	Machine Vision for Automation	3	0	0	50	50	0	0	100	3
20HIA602 L	TY Sem II	Machine Vision for Automation Lab	0	0	2	25	0	0	25	50	1
20HIA801	Final Year Sem II	Batch Automation	3	0	0	50	50	0	0	100	3
20HIA801 L	Final Year Sem II	Batch Automation Lab	0	0	2	25	0	25	0	50	1
		Total	**15**	**0**	**6**	**300**	**250**	**25**	**75**	**650**	**18**
		Grand Total	**21**			**650**					

20HIA501 Sensor Technology

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
In sem: 50 Marks
End sem: 50 Marks
Credit: 3

Prerequisites: Sensors and Transducers, Industrial Instrumentation

Course Objectives:
1. To acquire the knowledge of basic principles of sensing various parameters
2. To study principles, working, mathematical relation characteristics, advantages and limitations of various sensors
3. To select appropriate transducer for the particular application

Course Outcomes: The students will be able to
1. Identify various steps involved in sensor design
2. Compare to select various sensors for the given application
3. Design the transducer using appropriate modeling technique
4. Prepare the testing and calibration documents of sensor

Unit 1: Introduction to sensor design **(06)**
Common types of sensors and actuators, Overview of analog and digital interfaces, amplifiers, sensor noise

Unit 2: Design considerations and selection criterion **(06)**
Sensor fabrication techniques, process details, and latest trends in sensor fabrication, fiber optics sensors, electromechanical sensors, Solid state chemical sensors, Bio-sensors, Piezo-resistive sensors, characterization of sensors, effect of sensors on process identification, signal conditioning techniques.

Unit 3: Modeling methods **(08)**
Modeling methods of transducer design, developing first principle model, and empirical model based on the data, describe the effect of variables which are related to manufacturing tolerances and environmental effects.

Unit 4: Standards **(06)**
Standards for testing the transducers and calibration procedure and documentation for the calibration process - Case Studies.

Unit 5: Case studies related to **(06)**
Chemical sensors, bio sensors, gas sensors
Discussion on Nano sensors and MEMS applications

Reference Books:
1. E.O. Doebelin, "Measurement Systems", McGraw Hill, Fourth ed., 1990.
2. Sabrie Soloman, "Sensors Handbook", McGraw Hill Publication, First ed., 1998.
3. Smart materials and new technologies, Addington, M. ,Schodek, Daniel L. Architectural Press, 2005.
4. Smart Sensors and Systems, Lin, Y.-L., Kyung, C.-M., Yasuura, H., Liu, Y. [Springer]

20HIA502 Field Instrumentation

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
In sem: 50 Marks
End sem: 50 Marks
Credit: 3

Pre-requisites: Sensors and transducers, Linear Integrated Circuits, Digital Techniques, Industrial drives and Control

Course Objectives:
1. Compare the working of electrical, hydraulic, pneumatic field devices.
2. Develop signal conditioning circuits
3. Develop electrical, pneumatic hydraulic circuits for given application using various field devices
4. Interfacing of field devices

Course Outcomes: The students will be able to
1. Design process field indicators, process control devices.
2. Select different types of field devices for process control and safety components for the control panel.
3. Interface the field devices to the controller using appropriate components and connections.
4. Develop various motor control circuits, hydraulic, pneumatic circuits for the given application.

Unit 1: Motor control circuits using field devices (06)
Concept of sequencing & interlocking. Motor control circuits like Starting, Stopping, Emergency shutdown, starters, reversing direction of rotation, braking, starting with variable speeds, jogging/Inching.

Unit 2: Design of field indicators (06)
Design of Process parameter indicators like level indicator, temperature indicator pressure indicator, speed indicator weight measurement etc. Design of temperature measuring circuit for RTD, thermocouple with cold junction compensation.

Unit 3: Design of process control field devices (06)
Design of process transmitters, process switches (level, temperature etc), process converters like F/V, current isolator/repeaters, P to I converters, I to PWM, distributors, Pulse I/O converters etc

Unit 4: Interfacing of field devices to PLC and control of actuators (06)
Digital (manual switches (PB, toggle, rotary switch, slide switch, proximity switches), process switches (temperature, pressure, level switches), outputs(solenoid, relay, contactors, lamp, hooter, DCV)), analog, special, remote, IoT enabled field devices. Interfacing PLC to pneumatic circuits. Driving circuits for servomotor, stepper motor

Unit 5: Control panel Instrumentation (06)

Control panel basics, panel safety instruments, panel wiring, electrical power and instrument power requirements and their distribution. Earthing scheme, panel ventilation, cooling and illumination. Wiring accessories- ferrules, lugs, etc.codes and standards used for panel

Unit 6: Process automation using pneumatics and hydraulics (06)

Case studies of process automation using pneumatics and hydraulics components like Job stamping, sorting according to its dimension, box transfer on conveyor belt, sequencing of cylinders, Speed control of pneumatic motor, Can sealing mechanism, etc.

Text Books:

1. Petruzella, "Industrial Electronics", McGraw-Hill
2. Majumdhar, "Pneumatic Instrumentation", TMH
3. Andrew Parr, "Hydraulics and pneumatics: A Technician's and Engineer's guide", Butterworth Heinemann Ltd
4. Dan Sheingold, Editor, Transducer Interfacing Handbook, Analog Devices, Inc., 1980.
5. Manabendra Bhuyan, Intelligent Instrumentation: Principles and Applications, CRC Press Taylor & Francis Group, 2010.
6. "Applied instrumentation in process industries", Andrew & Williams, Gulf Publications.

Reference Books:

1. Pneumatics, Festo Didactic
2. Ramon Pallás Areny, John G. Webster, Sensors and Signal Conditioning, 2nd Edition, John Wiley and Sons, 2000.
3. Thomas L. Floyd, David Buchla, Fundamentals of analog circuits, 2002- Prentice Hall.
4. Ernest O. Doebelin; Measurement System Application and Design; Mc-Graw Hill; 5th Edition,2003.
5. "Instrument Installation Project Management", ISA Publications.
6. "Process control Instrument Engineers Handbook", B. G. Liptak, CRC Press.

20HIA502L Field Instrumentation Lab

Teaching Scheme:
Practical: 2 hrs/week

Examination Scheme:
Practical: 50 Marks
Credit: 1

Pre-requisites: Sensors and transducers, Linear Integrated Circuits, Digital Techniques, Industrial drives and Control

Course Outcomes: The students will be able to
1. Implement the designed process field indicators, process control devices
2. Select different types of field devices for to solve the given problem
3. Interface the field devices to the controller using appropriate components and connections
4. Implement the developed various motor control circuits, hydraulic, pneumatic circuits for the given application.

List of Practical Assignments:
1. Implementation of motor control circuits
2. Design of level indicator
3. Design of temperature measuring circuit with RTD
4. Design of temperature measuring circuit with thermocouple with cold junction compensation
5. Design of process transmitter
6. Design of process converters
7. Interfacing PLC to field devices
8. Interfacing PLC to Pneumatic circuits
9. Implementation of Pneumatic circuits
10. Implementation of hydraulic circuits
11. Study control panel components.
12. Field Visit

Or similar type of practical assignments based on the course contents

20HIA601 Industrial Internet of Things

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
In sem: 50 Marks
End sem: 50 Marks
Credit: 3

Prerequisites: Basics of IoT, its protocols and networks

Course Objectives:
1. To understand building blocks and components of IIoT
2. To understand various technologies used in IIoT
3. To understand the role of platforms and security in IIoT

Course Outcomes: The students will be able to
1. Identify components and business models of IIoT
2. Compare Technologies used in IIoT
3. Select and justify the method/ protocol for a given application
4. Propose solutions for given problem statement

Unit 1: Introduction to IIoT
Introduction, History, The Fourth Revolution, LEAN Production Systems, Smart and Connected Business Perspective, Smart Factories
Components of IIOT - Sensors, Interface, Networks, Business Models and Reference Architecture, People & Process, Hype cycle, IOT Market, Trends & future, Real life examples

Unit 2: IIoT and Cyber Manufacturing Systems:
Introduction to Cyber Manufacturing Systems and Cyber Physical Systems, it's concept, architecture, design principles, modeling, challenges, interoperability in Smart Automation of CPS, examples and case studies in various domains

Unit 3: IIoT and Blockchain Technology:
Introduction to Blockchain technology, concept, need, types, architecture, elements, connectivity, challenges and concerns, platforms, applications in FinTech, Supply Chain, Identity Management, military and equivalent.

Unit 4: IIoT and M2M Communication:
Introduction to M2M, concept, need, architecture, models, challenges and concerns, various approaches, applications in Automotive, Smart Telemetry, Building Automation, Industrial Automation, surveillance and equivalent.

Unit 5: Supporting Technologies and platforms for IIoT:
Augmented Reality and Virtual Reality, Artificial Intelligence, Big Data and Advanced Analysis, Digital Twin Technologies and Applications IIOT cloud platforms : Overview of cots cloud platforms, predix, thingworks, azure and

equivalent. Case Studies of implementing Industrial IoT solutions with AWS/ Google Cloud/ Azure/ equivalent. Fog Computing: architecture, models, role in Industrial IoT

Unit 6: Privacy, Security and Governance

Security Basics - Risk, Threat & Vulnerability, Risk Assessment, IIoT Security Framework based on IIC, Basic understanding of various IIoT security standards like NIST 82, IEC 62443, NERC, NIC etc., Hardware based Security

Text Books:

1. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", ISBN: 978-1-118-47347-4, Wiley Publications
2. Bernd Scholz-Reiter, Florian , Michahelles, "Architecting the Internet of Things", ISBN 978-3- 642-19156-5 e-ISBN 978-3-642-19157-2, Springer

Reference Books:

1. Hakima Chaouchi, "The Internet of Things Connecting Objects to the Web" ISBN : 978-1- 84821-140-7, Wiley Publications
4. Olivier Hersent, David Boswarthick, Omar Elloumi, The Internet of Things: Key Applications and Protocols, ISBN: 978-1-119-99435-0, 2nd Edition, Wiley Publications
5. Inside the Internet of Things (IoT), Deloitte University Press
6. Internet of Things- From Research and Innovation to Market Deployment; By Ovidiu & Peter; River Publishers Series
7. Five thoughts from the Father of the Internet of Things; by By Phil Wainewright - Kevin Ashton
8. How Protocol Conversion Addresses IIoT Challenges: White Paper By RedLion.
9. The Internet of Things in the Industrial Sector, Mahmood, Zaigham (Ed.) (Springer Publication)
10. Industrial Internet of Things: Cyber manufacturing System, Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat (Springer Publication)
11. Industrial IoT Challenges, Design Principles, Applications, and Security by Ismail Butun (editor)

20HIA602 Machine Vision for Automation

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
In sem: 50 Marks
End sem: 50 Marks
Credit: 3

Pre-requisites: Sensors and transducers, Industrial drives and Control, Digital Signal Processing

Course Objectives:
1. Describe the fundamentals of image formation.
2. Compare image processing techniques for computer vision for shape and region analysis.
3. Develop an appreciation for various issues in the design of computer vision and object recognition systems
4. Provide the student with programming experience from implementing computer vision and object recognition applications.

Course Outcomes: The students will be able to
1. Identify fundamental steps in image processing.
2. Apply various image enhancement and restoration techniques.
3. Apply image segmentation and representation techniques.
4. Interpret the techniques for image feature extraction.
5. Develop machine vision systems using image processing and image analysis techniques for given applications.

Unit 1: Fundamentals of Machine Vision System (06)
Introduction: Digital Image- Steps of Digital Image Processing Systems-Elements of Visual Perception - Connectivity and Relations between Pixels. Simple Operations- Arithmetic, Logical, Geometric Operations. Mathematical Preliminaries - 2D Linear Space Invariant Systems - 2D Convolution - Correlation 2D Random Sequence - 2D Spectrum.

Unit 2: Image transforms and enhancement (06)
Introduction to the Fourier Transform, The Discrete Fourier Transform, Some properties of the Two Dimensional Fourier Transform, The Fast Fourier Transform, Other Separable Transforms, and The Hotelling Transforms.
Image Enhancement:- Histogram Equalization Technique Background, Enhancement by Point Processing, Spatial Filtering, Enhancement in the Frequency Domain, Generation of Spatial Mask from Frequency Domain Specification, Color Image processing.

Unit 3: Image restoration and construction (06)
Degradation Model, Diagonalization of Circulant and Block Circulant Matrices, Algebraic approach to Restoration, Inverse Filtering, Least Mean Square (Wiener) Filter, Constrained Least Squares Restoration, Interactive Restoration, Restoration in the Spatial Domain, Geometric Transformations.

Unit 4: Image Analysis (06)

Segmentation, detection of discontinuities, edge linking and boundary detection, thresholding, region -oriented segmentation, Representation and description: Representation schemes, descriptors, regional descriptors, pattern and pattern classes, Classifiers.

Unit 5: Image Compression **(06)**

Redundancies, image compression models, elements of information theory, error free compression variable length coding, bit plane coding, lossless predictive coding, lossy compression, predictive coding, transform coding, video compression, image compression standards- JPEG, MPEG.

Unit 6: Applications of Machine Vision **(06)**

Applications of machine vision in Automotive Industries, Manufacturing, Electronics, Printing, Pharmaceutical, Biomedical, Robotics, Agricultural Applications.

Text Books:

1. Gonzalez and Woods, "Digital Image Processing with Matlab", Pearson Education,

Reference Books:

1. Machine Vision: Theory, Algorithms, Practicalities (Signal Processing and its Applications) Hardcover by E. R. Davies
2. Arthur Weeks Jr., "Fundamentals of Digital Image Processing", Prentice-Hall International.
3. Madhuri Joshi, "Digital Image Processing", Prentice-Hall International. ‘
4. A. K. Jain, Fundamentals of Digital Image Processing, Prentice Hall of India.
5. K. R. Castleman, Digital Image Processing, Prentice-Hall International.
6. Pratt William, "Digital Image Processing", John Wiley & Sons
7. Alexander Hornberg, Handbook on Machine Vision (2006), Wiley.
8. Milan Sonka, Vaclav Hlavac, Roger Boyle, Image Processing Analysis and machine Vision (2014), Cengage Learning.

20HIA602L Machine Vision for Automation Lab

Teaching Scheme:
Practical: 2 hrs/week

Examination Scheme:
In sem: 25 Marks
Practical: 25 Marks
Credit: 1

Pre-requisites: Sensors and transducers, Industrial drives and Control, Digital Signal Processing

Course Outcomes: The students will be able to
1. Apply various image filtering techniques including median filtering, and Gaussian smoothing.
2. Implement various image segmentation techniques and edge detection.
3. Classify the given image based on feature extraction.
4. Develop and implement machine vision systems using image processing and image analysis techniques for given applications.

List of Practical Assignments:
Students are expected to perform Minimum Eight Experiments

1. Point-to-point transformation- Thresholding an image and the evaluation of its histogram.
2. Enhance an image using image arithmetic and logical operations
3. Geometric transformations- Image rotation, scaling, and translation. Two-dimensional Fourier transform.
4. Two-dimensional Fourier Transform. Harmonic content of an image using the discrete Fourier transform (DFT) and masking with DFT.
5. Ideal filters in the frequency domain- Effects of filtering low and high frequencies in an image.
6. Non-Linear filtering using convolutional masks- Effects of a median filter on an image corrupted with impulsive noise.
7. Entropy as a compression measure- Entropy as a compression measurement to the DPCM compression measure.
8. Edge detection- Edge detectors and their operation in noisy images
9. Open ended assignment: Develop any one Machine Vision System for

i. Tool wear measurement using Machine vision
ii. Inspection system in production line for checking the level of liquid in bottle
iii. Sorting of color pencils
iv. Printed Circuit Board Inspection using Template Matching
v. Implementing polka yoke using machine vision system
vi. Online inspection using machine vision camera

Or similar type of practical assignments based on the course contents

20HIA801 Batch Automation

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
In sem: 50 Marks
End sem: 50 Marks
Credit: 3

Prerequisite: Process Instrumentation and Control, Industrial Automation

Course Objective:

1. Understand the basics of Batch control system
2. Learn the International standards used for Batch processes
3. Describe the various stages involved in Batch process control

Course Outcomes: The students will be able to

1. Identify the requirements for a batch control system.
2. Define procedural elements that can be effectively used with the equipment entities.
3. Develop phase logic that executes in equipment and that can deal with both normal and abnormal operations
4. Recognize the various control languages that are available
5. Identify the alternative architectures for PLC, DCS and PC-based control systems

Unit 1: Introduction to batch control system **(06)**

Introduction to batch control system, batch control system terminology, characteristics of batch processes, hierarchical batch model, control structure for batch systems.

Unit 2: ISA Standard for batch **(06)**

ANSI/ISA S88 standard: introduction: Scope, definitions, Batch process and equipment: process model (Entity relationship diagram for different levels), physical model, equipment module or control module, enterprise level, Types of control.

Unit 3: Recipe Management system **(06)**

Recipes: Definition, contents, types: General, Site, Master. Procedures, Procedural element relationships, Control recipe procedure/equipment control separation. Recipe management.

Unit 4: Planning and scheduling **(06)**

Production plans and schedules, Production information, mechanisms for allocating resources, Batch history, Batch reports, Modes and states.

Unit 5: Batch Control **(06)**

Batch control activities and functions: Control activities, Control activity model, Information handling, Security, Availability, Archival, Reference tracking, Process and control engineering.

Unit 6: Batch Management system (06)

Batch process management: Manage batches, manage process cell resources, Collection of batch and process cell information, unit supervision, manage unit resources, Execute equipment phases, Personnel and environmental protection

Reference Books:

1. Jim Parshall and L. B. Lamb , Applying S88: Batch Control from a User's Perspective, ISA, 2000.
2. ANSI/ISA–88.01–1995, Batch Control Part 1: Models and Terminology, ISA
3. William M. Hawkins, Thomas G. Fisher, Batch Control Systems: Design, Application, and Implementation, ISA

20HIA801L Batch Automation Process Lab

Teaching Scheme:
Practical: 2 Hrs/week

Examination Scheme:
In sem: 25 Marks
Oral: 25 Marks
Credit: 1

Course Outcomes: The student will be able to
1. Identify various features of DeltaV for Batch process control
2. Identify the alternative architectures for PLC, DCS and PC-based control systems
3. Design sequential logic for batch process control
4. Implement the Batch control logic using SFC programming

List of Practical Assignments:
1. Introduction to DeltaV batch suite
2. Introduction to SFC programming module
3. Design a sequence of operation for given process using SFC
4. Introduction to Phase Logic Module (PLM)
5. Design a sequence of operation for given process using PLM
6. Design a plant hierarchy for a given process
7. Case study of Recipe management system
8. Case study of Batch Process Management

Or similar type of practical assignments based on the course contents

20PEIN501LC Advanced Microcontroller Techniques Lab

Teaching Scheme:
Practical: 2 Hrs/Week

Examination Scheme:
In Semester: 25 marks
Oral: 25 Marks
Credit: 1

Course Outcomes: The students will be able to
1. Program microcontroller for given application
2. Select integrated peripheral for given application
3. Configure the peripherals in different modes
4. Debug the developed program / given problem statement

List of Practical Assignments:
Part A: (any 5)
1. Introduction and familiarization with programming environment of ARM
2. Display interfacing and Programming using ARM
3. Wave generation using ARM
4. Introduction and familiarization with programming environment of STM32
5. Port configuration and programming for input/ output devices
6. Analog input measurement using ADC
7. Communication interface configuration and programming

Part B:
System development using STM32 microcontroller for given problem statement

Or similar type of practical assignments based on the course contents

20PEIN501C Advanced Microcontroller Techniques

Teaching Scheme:
Lectures: 3 Hrs/week

Examination Scheme:
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

Prerequisites:
1. Concepts of Microprocessors and Microcontrollers
2. Logic building concepts and programming microcontrollers in C

Course Objectives:
1. To introduce the architecture and features of high-capacity microcontrollers
2. To provide an understanding of integrated peripherals and its configuration
3. To design system for specified application

Course Outcomes: The students will be able to
1. Select appropriate features of microcontroller for given application.
2. Identify detailed hardware structure and software model of the microcontroller for the given application.
3. Develop configuration of integrated peripherals.
4. Design system for given application using microcontrollers

Unit 1: Introduction to ARM Cortex (07)
Architecture, Block Diagram, Programmer's Model, Registers and Memory Management, CPU operating modes, Pipeline, Thumb instructions set, Reset circuit and Sequence. Development Tools, Tool chains, Libraries and Software for programming

Unit 2: The ARM Cortex Processor (08)
Buses, System Timing, Interrupt handling and NVIC, Power management, Clock, comparison with ARM7 and ARM10

Unit 3: Introduction to STM32 microcontrollers (08)
Overview and Features of STM32 Microcontrollers, Advantages, Drawbacks and Subfamilies, Low Power operation and reset sources

Unit 4: Integrated Peripherals of STM32 microcontrollers-I (07)
General Purpose I/O, External Interrupts, ADC and Timers, DMA

Unit 5: Integrated Peripherals of STM32 microcontrollers-II (06)

SPI, I2C, USART, CAN and USB

Unit 6: Small System Design with STM32 microcontrollers (06)

System design for specified applications using integrated peripherals and external components necessary for the same.

Books:

1. Discovering the STM32 Microcontroller, Geoffrey Brown
2. The Insider's Guide To The STM32 ARM Based Microcontroller, Trevor Martin, Published by Hitex (UK) Ltd.
3. Mastering STM32, Carmine Noviello, Lean Publishing, 2016
4. The Definitive Guide to ARM Cortex®-M0 and Cortex-M0+ Processors, Joseph Yiu, Second Edition, Elsevier

20HDM601L Advanced Machine Learning Laboratory

Teaching Scheme:
Practical: 2 hrs/week

Examination Scheme:
In sem: 25 Marks
Oral: 25 Marks
Credit: 1

Course Objectives:	
To facilitate the learner to	
1.	Implement Support vector machine (SVM), Naive bayes algorithms on the dataset.
2.	Implement decision tree algorithm, random forest algorithm of machine learning.
3.	Implement Ensemble techniques such as bagging, boosting on the given dataset..
4.	Implement artificial neural networks back propagation algorithm for XOR.
5.	Implement a small machine learning application and evaluate the performance of the designed machine learning model.
Course Outcomes:	
After completion of the course, students will be able to	
1.	Implement the Support vector machine (SVM), Naive bayes algorithms of supervised machine learning on the dataset.
2.	Implement the decision tree algorithm, random forest algorithm of machine learning to solve the given problem.
3.	Implement various Ensemble techniques such as bagging, boosting on the given dataset.
4.	Implement the artificial neural network technique for non linearly separable data.
5.	Develop small machine learning applications using different techniques on the dataset.

The large part of Advanced Machine Learning Techniques laboratory course conduction is to

develop small case studies, mini projects using built in free datasets from kaggle, data.gov.in, ncbi.nlm.nih.gov, imagenet, etc, analyze and represent the results and data using different tools and technologies. Data will be used in a progressive way i.e. data cleaning/transformation/integration/reduction done in earlier lab will be subsequently used to build ML Model and model comparison/evaluation will also be done. Build models can be utilized in the decision making process through business intelligence. Students will be encouraged to publish their findings in the form of research papers. The large part of the laboratory component will be devoted to implement the advanced concepts of Machine learning and data science along with the real world applications.

Faculty members are encouraged to expand problems with variations and increased complexities. Assignments can be framed and expanded in such a way that it explores concepts, logic of solution and real life applications. Students will be encouraged to solve open problems in different domain

Suggestive List of Assignments

Implementation of the following Machine Learning algorithms using Tensorflow and Keras/R/python library on previously cleaned and integrated dataset and also evaluate the performance of the implemented ML Model.

Reference Data sets which can be used are (from Indian datasets such as https://data.gov.in/, https://www.ncbi.nlm.nih.gov/, https://dbie.rbi.org.in/, https://data.uidai.gov.in/, http://mospi.nic.in/, https://bhuvan-app3.nrsc.gov.in/, https://www.india.gov.in/, https://surveyofindia.gov.in/, https://www.meteoblue.com/en/weather/archive/export/india_el-salvador_3585481, https://www.icegate.gov.in/, https://www.gbif.org/dataset/9e7ea106-0bf8-4087-bb61-dfe4f29e0f17)

--Support vector machine for data classification using IRIS or breast cancer dataset as example.

--Naive Bayes algorithm such as gaussian naive bayes, bernoulli naive bayes, multinomial naive bayes etc using Purchase/shopping data set as example.

--Expectation Maximization (EM) algorithm.

--Decision tree algorithm using birth weight data set as example.

--Random Forest algorithm using IRIS data set as example.

--Ensemble techniques such as bagging, boosting on breast cancer dataset as example..

--Back propagation algorithm for XOR logic gate or using any non linear separable data.

--Develop a mini project using data science and Machine learning for readily available dataset using the advanced machine learning and statistical analysis techniques studied.

Text Books

1. “Hands-On Machine Learning with Scikit-Learn and TensorFlow”, Aurélien Géron, O’Reilly Media, 2nd edition, ISBN 9781492032649, 2019
2. “Machine learning”, Peter Flach, cambridge university press, 6th edition, ISBN 978-1-316-50611-0, 2018
3. “Machine learning using python”, Pradhan, U. Dinesh Kumar, Wiley publication, 1st edition, ISBN 978-81-265-7990-7, 2019
4. “Machine learning”, S. Sridhar, M.Vijayalakshmi, 1st Edition, Oxford university press, 2021, ISBN 978-0-19-012727-5

Reference Books:

1. “Introduction to machine learning”, Ethem Alpaydın, MIT press, 3rd edition, ISBN 978-81-203-5078-6, 2014
2. “Machine learning in python”, Michael Bowlers, Wiley publication, 1st edition, ISBN 978-81-265-5592-5, 2015
3. “Practical Machine Learning with Python”:A Problem-Solver’s Guide to Building Real-World Intelligent Systems, Dipanjan Sarkar, Raghav Bali, Tushar Sharma, Apress publication, ISBN: 978-1-4842-3206-4, 2018
4. Jiawei Han, Micheline Kamber, Jian Pei, “Data Mining: Concepts and Techniques”, 3 rd Edition, 2012, Morgan Kaufmann publishing, ISBN: 978-0-12-381479-1

20HDM602 Data Visualization and Business Intelligence

Teaching Scheme
Lectures: 3 Hours / Week

Examination Scheme
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

Course Objectives:

1. Develop familiarity with Business Intelligence concepts
2. Gain knowledge about analysis of data and visualization
3. Get exposure to latest trends and case studies in BI

Course Outcomes: At the end of this course, students will be able to

1. Apply decision making knowledge to a application from business perspective
2. Analyze the data and generate appropriate representation
3. Visualize the given data by following ethical guidelines
4. Make use of latest trends and case studies in BI to a given scenario

Section I: Business intelligence

Decision making and Decision Support Systems, Business Intelligence Concepts, BI life cycle, Business Performance Management Systems, BI and data science

Section II: Data Visualization

Design principles of data visualization, best practices, choosing an effective visual, managing clutter, dissecting model visuals, Popular tools, data visualization using tools like R, Tableau, Importance of ethics in data visualization, ethical dimensions and general guidelines about visualization, Data visualization in business.

Section III: Case studies and trends

Case studies related to storytelling with data, Geographic visualizations (eg.Uber), Demographic comparison (eg. Voters and their inclinations), visualization of Urban data , self-service BI, Predictive /Advanced analytics, Mobile BI

In class hands-on / demonstrations:

-Hands on previously explored datasets for visualization using open source BI tools such as Jaspersoft, BIRT (Business intelligence and Reporting tools)

Text Books:

1. "Storytelling with data" , cole nussbaumer knaflic, Wiley Publications , 2019, ISBN 978-1119621492
2. "Data science for Business", Foster Provost et al., O'reilly Publications, 2013,ISBN 978-1449361327
3. "Decision Support And Business Intelligence Systems",Turban, Sharda, Pearson Publications, 2013, ISBN 978-8131761090

Reference Books:

1. "Business analytics for managers" , Laursen G.H.N. , Thorlund J., 2nd Edition, Wiley publication, 2016, ISBN: 978-1-119-29858-8
2. "Business Intelligence for Dummies" Swain Schepus, Wiley Publication, 2008, ISBN 978-0-470-12723-0
3. "Decision Support Systems in the 21st Century", George Marakas, 2002, ISBN-978-8120323766
4. "Real-World Decision Support Systems Case Studies", Jason Papathanasiou et al., Springer, 2016, ISBN 978-3-319-43916-7

T1 Evaluation
20HDM 602 Data Visualization and Business Intelligence
2022-23

Rubrics for Evaluation:

The students will be working in a group of 2.
The evaluation can be done on following points:

Sr. No.	CO	Evaluation point	Marks	BL Section	
1.	4	Select a free/ open source BI tool, download it and investigate BI components present.	06	L4 S3	A
2.	3	Select a dataset and analyze the data visualization techniques available in selected tool	06	L4 S2	M
3.	4	Analyze different BI characteristics and components available in selected tool. Compare it with other tools.	08	L4 S1, S3	D
4.	1	Analyze the decision making process available in selected tool	05	L4 S1	M
		Total marks	**25**		

- The students can select or create a data set.
- Presentation along with live demonstration of BI tool is preferred.
- The students will submit their presentation along with a brief write-up to the course teacher on-line.

Dr. Madhuri Tasgaonkar
DVBI Course Chairman

20HDM601 Advanced Machine Learning

Teaching Scheme
Lectures: 3 Hours / Week

Examination Scheme
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

Prerequisite: 20CE404 Machine Learning

Course Objectives:

1. To be familiar with Tensorflow/keras/python and advanced machine learning algorithms.
2. To gain advanced knowledge of support vector machines, naive bayes, decision tree algorithms.
3. To get exposure to applying Artificial neural networks for non linearly separable patterns.
4. To apply methods of ensemble learning.

Course Outcomes:

At the end of this course, students will be able to

1. Make use of basic functions of tensorflow/keras/python for machine learning algorithms and design of support vector machine
2. Apply Naive bayes classification algorithm for given problem
3. Experiment with methods of ensemble learning and advanced decision tree for given data.
4. Solve non linearly separable problems using artificial neural networks.

Course Contents:

Section 1: TensorFlow, Keras and Support vector machine

ML using TensorFlow , keras/ Basic functions. Installation of TensorFlow/keras and its features. Introduction to Support Vector Machines(SVM), Optimal Hyperplane for Linearly Separable and Nonseparable Patterns, Maximizing margin, Non linear pattern classification, Kernel trick, Design of Support Vector Machines.

Section 2: Naive Bayes Classification

Introduction to Naive Bayes, Bayes theorem, Bayes theorem and concept learning, ML for predicting probabilities, Naive Bayes classifier, Types of bayesian classifier, Bayesian belief networks, Expectation Maximization (EM) algorithm.

Section 3: Ensemble learning

Introduction, Decision Tree, Entropy, Information gain, Gini Index , Different types of ensemble learning methods, bagging , boosting, stacking, Random Forests.

Section 4: Advanced Artificial neural networks

Artificial neural networks, Non linear separability, XOR problem, back propagation algorithm.

Text Books

1. "Hands-On Machine Learning with Scikit-Learn and TensorFlow", Aurélien Géron, O'Reilly Media, 2nd edition, ISBN 9781492032649, 2019
2. "Machine learning", Peter Flach, cambridge university press, 6th edition, ISBN 978-1-316-50611-0, 2018
3. "Machine learning using python", Pradhan, U. Dinesh Kumar, Wiley publication, 1st edition, ISBN 978-81-265-7990-7, 2019
4. "Machine learning", S. Sridhar, M.Vijayalakshmi, 1st Edition, Oxford university press, 2021, ISBN 978-0-19-012727-5

Reference Books:

1. "Introduction to machine learning", Ethem Alpaydın, MIT press, 3rd edition, ISBN 978-81-203-5078-6, 2014
2. "Machine learning in python", Michael Bowlers, Wiley publication, 1st edition, ISBN 978-81-265-5592-5, 2015
3. "Practical Machine Learning with Python":A Problem-Solver's Guide to Building Real-World Intelligent Systems, Dipanjan Sarkar, Raghav Bali, Tushar Sharma, Apress publication, ISBN: 978-1-4842-3206-4, 2018
4. Jiawei Han, Micheline Kamber, Jian Pei, "Data Mining: Concepts and Techniques", 3 rd Edition, 2012, Morgan Kaufmann publishing, ISBN: 978-0-12-381479-1

20OE601 GAMIFICATION

Teaching Scheme Examination Scheme Lectures: 3 Hours / Week In Semester: 50 Marks End Semester: 50 Marks

Credits: 3

Course Objectives:

To facilitate the learner to

1. To develop problem solving abilities using gamification.
2. To identify the various methods of Gamification.
3. To apply gamifications mechanics to solve a problem.
4. To make use of gamifications tools to solve a problem .

Course Outcomes:

After completion of the course, students will be able to

1. To apply steps of problem solving using gamification.
2. To analyze player motivation and counter gamification.
3. To analyze games using gamification mechanics.
4. To apply tools of gamification to real life applications.

Unit I: Gaming Foundations (6) Introduction, Resetting Behavior, Replaying History, Gaming foundations: Fun Quotient, Evolution by loyalty, status at the wheel, the House always wins.

Unit II: Player Motivation (7) Powerful Human Motivators, Why People Play, Player types, Social Games, Intrinsic verses Extrinsic Motivation, Progression to Mastery, Case studies for Thinking: Tower of Hanoi,Concepts Applied to Video games and Gamification,

Unit III: Counter Moves in Gamification (8) Reclaiming Opposition: Counter gamification, Gamed Agencies: Affectively Modulating Our Screen-and App-Based Digital Futures, Remodeling design, Designing for Engagement, Case study of Maze Problem.

Unit IV: Game Design (8) Game Mechanics and Dynamics: Feedback and Re-enforcement, Game Mechanics in depth, Putting it together, Case study of 8 queens problem.

Unit V: Game Mechanics and Applications (6) Gamification case Studies, Coding basic game Mechanics,Gamification Applications : Education,Healthcare,Marketing,Gamification for Machine Learning

Unit VI: Gamification Platforms (6) Instant Gamification Platforms, Mambo.io(Ref:http://mambi.io), Installation and use of BigDoor (Open Source http://bigdoor.com),ngageoint/gamification-server(ref: https://github.com/ngageoint/gamification-server)

Text Books:

1. Mathias Fuchs, Sonia Fizek,Paolo Ruffino, Niklas Schrape, Rethinking Gamification, Meson Press,2014, ISBN: 978-3-95796-000.
2. Gabe Zechermann, Christopher Cunningham, Gamification by Design, Oreilly,August 2015, ISBN: 978-1-449-397678.

Reference Books:

1. B. Burke, Gamify: How Gamification Motivates People to Do Extraordinary Things, Gartner 2014,ISBN:1937134857.

2. Stieglitz, S.Lattemann, C.Robra-Bissantz, S.Zarnekow, R.Brockmann,Gamification :Using Game Elements in Serious Contexts,2016,ISBN: 978-3-319-45557.

OE 4201 : e-Business

(Open Elective-III)

Teaching Scheme
Lectures : 3 Hrs / week

Examination Scheme
In Semester : 50 Marks
End semester : 50 marks
Credits : 3

Prerequisites : No Prerequisites

Course Objectives :

To facilitate the learners to -

1. Understand the technological, economic and social phenomena behind rapid changes in the e-businesses
2. Have a good working knowledge of e-business concepts, applications and technologies
3. Understand the e-business models and infrastructure
4. learn how e-business concepts are applied to different fields, such as: education, banking, tourism and so on
5. Inspire with online business ideas and motivate them to apply in the real life.
6. Study the new trends in e-business, e-commerce

Course Outcome :

By the end of this course, students should be able to -

1. Explain the concepts of e-business and e-business models
2. Apply suitable principles and practices of designing and developing e-business website
3. Apply necessary back end system components required for successful e-business implementations
4. Outline the meaning of e-business security and how it impacts the business
5. Relate e-business, BI and KM to fulfil modern e-business trends

Unit I: Introduction **(07)**

E-commerce and e-business, advantages of e-business in growth of a business, Transition from traditional business to e-business, features of e-business technology, e-business models, IT Infrastructure requirements of e-business **Case Study :** Various e-business models

Unit II : Building e-business Websites **(7)**

Issues involved in designing a website, designing in-house websites, steps involved in website development, e-business and website development solutions, Advantages of using an e-business solution, selection of a suitable e-business solution, security issues involved in websites, tracking and analysing website traffic data. Digital Marketing **Case Study**

Unit III : e-Business Infrastruture / Back end Systems (7)

Back end system support requirements - security, scalability, availability, adaptability, manageability, maintainability, assurance, interoperability, load balancing; internet technology, World Wide Web, Internet software; Content management, **Case Study**

Unit IV : e-security & online payment systems (7)

e-Business security policy, risks and risk assessment, practice guidelines to e-security, legal framework and enforcement, ethical, social and political issues in e-business

Performance characteristics of online payment systems, online payment methods, security and risk handling in online payments, fraud detection in online payments, IT Act 2000, digital signatures, digital certificates, and PKI; **Case Study**

Unit V : Knowledge management & BI for strategic e-business (8)

From information processing to knowledge world, aligning knowledge with business, knowledge management platforms, state of knowledge and measuring parameters; knowledge industry, knowledge strategy, and knowledge workers

Business and Intelligence - applications and importance of business intelligence, implementation of intelligence, building BI systems, selecting BI tools, integrating BI and KM, decision-making and BI, **Case Study**

Unit VI : Launching an e-Business and e-business trends (6)

Launching a successful e-business – requirement analysis, managing Web site development, search engine optimization, Evaluate Web sites on design criteria.

Future and next generation of enterprise e-business, challenges and new trends, ethical and regulatory issues

References

Text Books	
1	Papazoglou, Michael and Pieter Ribbers, “E-Business : Organizational and Technical Foundations”, John Wiley, 2nd Edition (Sept 2011)
2	Parag Kulkarni, Sunita Jahirabadkar, Pradeep Chande, “E-Business”, Oxford University Press (May 2012)
Reference Books	
1	Daniel Amor, “The E-business (R)evolution”, Prentice Hall PTR (2000)
2	Kenneth Laudon, Carol Guercio, “E-commerce : Business, Technology, Society”, Prentice Hall, 4th Edition (January 2008)
3	Kalakota Ravi, Marcia Robinson, “E-Business 2.0 – Roadmap for Success”, Pearson Education, 2nd Edition (2004)

VERITAS

PECE 3201Data Management, Protection and Governance

PECE 3201 Data Management, Protection and Governance

Teaching Scheme

Lectures: 3 Hrs/Week

Examination Scheme

In Semester: 50 marks

End Semester: 50 marks

Credits: 3

Course Objectives:

To facilitate the learner to –

1. Get acquainted with the high-level phases of data life cycle management.
2. Acquire knowledge about the various aspects of data storage, data availability, data protection.
3. Gain exposure to various solutions/reference architectures for various use-cases.
4. Understand the technical capabilities and business benefits of data protection.

Course Outcomes:

By taking this course, the learner will be able to –

1. Understand the data management world, challenges and best practices.
2. Compare various concepts and technologies for enabling data storage and high availability.
3. Illustrate various types of data threats and approaches to ensure data center security.
4. Explain the various concepts related to data protection.
5. Outline different standards for compliance and governance of data.
6. Understand various approaches for designing data intensive enterprise applications and industry standard solutions in data management.

Unit 1: Introduction to data life cycle management (DLM) (06)

- Goals of data life cycle management
- Challenges involved
    - Volume of data source
    - Ubiquity of data locations
    - User demand for access
- Stages of data life cycle - creation, storage, usage, archival, destruction
- Risks involved without DLM, benefits, best practices

Unit 2: Data storage and data availability (08)

- Storage technology
    - Hard Disk Device (HDD), Solid State Devices (SSD), memory devices
    - Data access - block, files, object
    - Data center End to End View – overview of complete stack including storage, network, host, cluster, applications, virtual machines, cloud storage
    - Storage virtualization technologies - RAID level, storage pooling, storage provisioning
    - Advance topics in storage virtualization – storage provisioning, thin-provisioning
    - Cloud storage – S3, glacier, storage tiering
- High Availability
    - Introduction to high availability
    - clustering, failover, parallel access

Unit 3: Data Threats and Data center security **(07)**

- Type of Threats
  - Denial of Service (DoS), man in the middle attacks
  - Unintentional data loss
  - Repudiation
  - Malicious attacks to steal data
- Introduction to Ransomware
- Understanding, Identification and Threat modelling tools
- Security
  - Authorization and authentication - access control, Transport Layer Security (TLS), key management, security in cloud
  - Design and architecture considerations for security

Unit 4: Introduction to data protection **(08)**

- Introduction
  - Need for data protection
  - basic of back-up/restore
- Snapshots for data protection, copy-data management (cloning, DevOps)
- De-duplication
- Replication
- Long Term Retention - LTR
- Archival
- Design considerations
  - System recovery
  - Solution architecture
  - Backup v/s Archival
  - media considerations and management (tapes, disks, cloud)
  - challenges with new edge technology (cloud, containers)

Unit 5: Data regulation, compliance and governance (06)

- Regulations requirements and Privacy Regulations
  - The Health Insurance Portability and Privacy Act of 1996 (HIPPA)
  - PII (Personally Identifiable Information)
  - General Data Protection Regulation (GDPR)
- Information Governance
  - Auditing
  - Legal Hold
  - Data classification and tagging (Natural Language Processing)
- India's Personal Data Protection bill

Unit 6: Applications uninterrupted (07)

- Understand data management aspects of traditional and new edge applications
- Reference architecture/best practices *(pick 2-3 case studies from below topics)*
  - Transactional Databases (Oracle, MySQL, DB2)
  - NoSQL Databases (MongoDB, Cassandra)
  - Distributed applications (micro service architectures)
  - Cloud applications – Platform as Service (PaaS), Software as Service (SaaS), Kubernetes
  - Multi-Tiered applications
  - ETL workloads
  - Data analytics (AI/ML)

Textbooks:

1. Robert Spalding, **'Storage Networks: The complete Reference'**.
2. Vic (J.R.) Winkler, **'Securing The Cloud: Cloud Computing Security Techniques and Tactics'**, Syngress/Elsevier - 978-1-59749-592-9

Reference Books:

1. Martin Kleppmann, **'Designing Data-Intensive Applications'** , O'Reilly

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Web References:

https://www.enterprisestorageforum.com/storage-hardware/storage-virtualization.html

https://searchstorage.techtarget.com/definition/data-life-cycle-management

https://www.hitechnectar.com/blogs/three-goals-data-lifecycle-management/

https://www.bmc.com/blogs/data-lifecycle-management/

https://www.dataworks.ie/5-stages-in-the-data-management-lifecycle-process/

https://medium.com/jagoanhosting/what-is-data-lifecycle-management-and-what-phases-would-it-pass-through-94dbd207ff54

https://www.spirion.com/data-lifecycle-management/

https://www.bloomberg.com/professional/blog/7-phases-of-a-data-life-cycle/

https://www.datacore.com/storage-virtualization/

https://www.veritas.com/content/dam/Veritas/docs/solution-overviews/V0907_SB_InfoScale-Software-Defined-Infrastructure.pdf

https://www.veritas.com/solution/digital-compliance

https://www.veritas.com/solution/data-protection

https://www.veritas.com/gdpr

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20PECE 601C Deep Learning

Teaching Scheme
Lectures: 3 Hours / Week

Examination Scheme
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

Course Objectives:

To facilitate the learner to

1. Understand building blocks of Deep Neural Networks.
2. Understand various optimization algorithms used for training Deep Neural Networks.
3. Understand the working of CNN, RNN
4. Have knowledge of Deep Architectures for solving various applications.

Course Outcomes:

After completion of the course, students will be able to

1. Apply mathematical concepts and Machine Learning Basics for understanding Deep Learning topics
2. Apply concepts of Feedforward Networks for understanding Deep Learning topics
3. Apply the basic concepts of CNN and RNN to real time problems
4. Apply available Deep Learning solutions to real time applications.

Unit I: Machine Learning and Deep Learning (07)

What Is Deep Learning and Machine Learning Work? Limitations of Machine Learning, History of Deep Learning, Advantages/ Challenges of Deep Learning, Bias Variance trade off, hyper- parameters, Regularization, Confusion matrix, Building a Machine Learning Algorithm, Deep Learning tools/frameworks.

Unit II: Deep Learning Basics (07)

Linear Algebra, Probabilities and Information theory, Linear Dependence and Span, Norms, Eigen decomposition, The Trace Operator, The Determinant, Principal Components Analysis, Activation Functions, Loss Functions, Perceptron, Sigmoid neurons.

Unit III: Feedforward Networks for Deep Learning (07)

Learning XOR, Gradient-Based Learning, Hidden Units, Architecture Design, Back-Propagation, Regularization and Under-Constrained Problems, Dataset Augmentation, Noise, Early Stopping, Parameter Tying and Parameter Sharing, Dropout, Introduction to Keras, TensorFlow, Theano, and CNTK, Setting up a deep-learning workstation.

Unit IV: Convolution Neural Network (CNN) (08)

Biological Inspiration and Motivation, The Convolution Operation, Pooling, Padding, Overview of CNN Architecture, Input Layers, Convolutional Layers, Pooling Layers, Fully Connected Layers, Back propagation in CNN, Applications of CNNs, Introduction to convnets.

Unit V: Recurrent Neural Network (RNN) (07)

Working with text data, One-hot encoding of words and characters, Using word embeddings, Wrom raw text to word embeddings, Wrapping up, Recurrent Neural Network (RNN), A recurrent layer in Keras, Understanding the LSTM and GRU, Advanced use of recurrent neural networks, A temperature-forecasting

Unit VI: Advanced Deep Learning (06)

Introduction to Deep Learning applications in Computer Vision / NLP / Text Mining, Understanding use of CNNs for classification, Semantic Segmentation, Image denoising, Object Detection. Introduction to Generative Adversarial Networks, Deep Reinforcement Learning, AlexNet/VGG Net/ResNet etc.

Text Books:

1. Deep Learning, Ian Goodfellow and Yoshua Bengio and Aaron Courville, MIT Press Ltd. ISBN:9780262035613, 0262035618, 2016
2. Deep Learning with Python, FRANÇOIS CHOLLET, Manning Publications Co., ISBN 9781617294433, 2017
3. Python Deep Learning,Valentino Zocca, Gianmario Spacagna, Daniel Slater, Peter Roelants, Packt Publishing, ISBN 9781786460660, 2017

Reference Books:

1. Fundamentals of Deep Learning: Designing Next Generation intelligence Alogrithms, Nikhil Baduma, Nicholas Locascio, O'Reilly Publication, ISBN 10: 9352135601 , ISBN 13: 978- 9352135608, 2017

2. Deep Learning – A Practitioner's approach, Josh Patterson and Adam Gibson, O'Reilly Publication, 1st edition, ISBN : 9789352136049, 2017
3. Deep Learning with PyTorch, ELI STEVENS, LUCA ANTIGA, AND THOMAS VIEHMANN, Manning Publications Co, ISBN 9781617295263, 2020

20PECE 601A DevOps Fundamentals

Teaching Scheme
Lectures: 3 Hours/Week

Examination Scheme
In Semester: 50 marks
End Semester: 50 marks
Credits: 3

Prerequisites: Software Design and Architecture (20CE 503)

Course Objectives:
To facilitate the learner to -

1. Understand and appreciate the need for the DevOps as a state-of-art software engineering practice.
2. Learn the basic concepts related to DevOps.
3. Get acquainted with the various tools which are used in different phases of DevOps model.
4. Get exposure to emerging trends in software development related to DevOps.

Course Outcomes:
By taking this course, the learner will be able to -

5. Apply the fundamental concepts and emerging trends of DevOps to software development.
6. Analyze the various concepts of application development such as agile software model, microservices to understand the need of DevOps based solution of a system.
7. Compare various concepts and tools of continuous integration, continuous delivery, continuous testing and monitoring for DevOps based realization of solution of a system.
8. Analyze the various deployment platforms as part of DevOps lifecycle.

Unit 1: Introduction to DevOps **(06)**

Overview, Features, Components, Why to use DevOps - Benefits, Business need for DevOps, Using DevOps to solve new challenges like enabling mobile applications, scaling agile and managing multitier applications; DevOps lifecycle - DevOps stages: Develop, Code/build, Test, Deploy; DevOps use cases DevOps techniques: Continuous improvement, Release planning, Continuous integration, Continuous delivery, Continuous testing, Continuous monitoring and feedback; DevOps tools.

Unit 2: Application Development **(07)**

Agile software development, User stories, Automating SDLC and DevOps, DevOps team. Serverless computing. Microservices and DevOps: Monolithic to microservices Project in terms of microservices, need/applicability of DevOps Microservices - what, characteristics, how are they used, nature in continuous release, architecture, services design.

Unit 3: Continuous Integration Continuous Delivery (CICD) Pipeline (08)

CICD pipeline - basics, Source code repository, Version control and source code management - GitHub, Git commands. Creating Automated build, Automated build frameworks like Maven, Ant for Java. Automated configuration and automated deployment, Configuration management with tools like Puppet and Chef, Ansible; Continuous integration with Jenkins.

Unit 4: Continuous testing and Continuous monitoring (08)

Continuous Unit testing and Integration testing, Test Driven Development (TDD), Release testing, Testing in development, Testing in production, Selenium: Introduction, Why to use, automating test cases for testing web elements, Creating test cases in Selenium WebDriver. Testing and Bug tracking Frameworks such as JUnit, TestNG and JIRA. Continuous monitoring and logging with tools like Nagios.

Unit 5: Deployment Platforms (07)

Containerization and DevOps: Virtualization, Application runtime environment, Application needs/dependencies, Containerization, Containerization Tools, Benefits of containers in enabling DevOps workflow.

Dockers for DevOps: Docker - Overview, Docker lifecycle, Docker Image, Docker file, Docker registry, Docker engine, Docker runtime container, Docker installation, commands, Namespaces, Docker layered approach, Docker applications/use cases. Container Orchestration: Kubernetes.

Unit 6: DevOps - Applications, Case studies and Trends (06)

Cloud's benefit to DevOps, Web Applications on Cloud Platform

Automation of infrastructure: Terraforms - Infrastructure as code (IaC) software tool.

DevSecOps: Agile security, DevOps and security, Low code solutions.

Text books:

1. Sanjeev Sharma and Bernie Coyne, 'DevOps for Dummies', IBM Limited Edition, John Wiley and Sons, Inc., ISBN- 978-1-119-04705-6, (2015).
2. Viktor Farcic, 'The DevOps 2.0 Toolkit: Automating the Continuous Deployment Pipeline with Containerized Microservices', CreateSpace Independent Pub, (2016).
3. Katrina Clokie, 'A Practical Guide to Testing in DevOps', Leanpub, (2017).

Reference books:

1. Bass, L., Weber, I.M., Zhu, L., 'DevOps: a software architect's perspective'. Pearson Education, ISBN: 9789332570375, (2016).
2. Davis J., Daniels K., 'Effective DevOps: Building a Culture of Collaboration, Affinity and Tooling at Scale', O'Reilly, ISBN- 9789352133765, (2018).

3. Farooqui S. M., 'Enterprise DevOps Framework: Transforming IT Operations', CA Press / Apress, ISBN- 9781484240618, (2019).
4. Sanjeev Sharma, 'The DevOps Adoption Playbook: A Guide to Adopting DevOps in a Multi-Speed IT Enterprise', Wiley, ISBN- 9788126569083, (2017).
5. Humble, J., Farley, D.: 'Continuous Delivery: Reliable Software Releases Through Build, Test, and Deployment Automation'. 1st edn. Addison-Wesley Professional (2010).

Web References:

1. https://devops.com/
2. https://docs.docker.com
3. https://www.bmc.com/blogs/devops-basics-introduction/
4. https://www.ibm.com/in-en/cloud/devops
5. https://aws.amazon.com/devops/what-is-devops/

20HS 601 Professional And Societal Awareness For Engineers

Teaching Scheme

Lectures: 3 Hours / Week

Examination Scheme

In Semester: 50 Marks

End Semester: 50 Marks

Credits: 3

Course Objectives:

To facilitate the learner to

1. Understand professional ethics, communication and practices
2. Relate Intellectual property concepts to various documents , products
3. Study Sustainability issues and green computing in environmental context
4. Study social issues in the computing world

Course Outcomes:

After completion of the course, students will be able to

1. Apply professional and computing ethics
2. Relate Intellectual property basics to information management, storage and sharing
3. Apply sustainability paradigms to various computing centric issues
4. Relate green computing basics to IT systems
5. Apply sustainability principles to new world

Unit I: Professional Ethics and communication (08)

Morals, values and Ethics, Integrity, Work ethic, Civic virtue, Valuing time, Cooperation, Commitment, Empathy, Self-confidence, stress management, Senses of Engineering Ethics, Kohlberg‟s theory, Gilligan‟s theory, Models of professional roles, Uses of Ethical Theories, Communicating professionally with stakeholders

Unit II: Intellectual Property (08)

Philosophical foundations of intellectual property, Intellectual property rights (cross-reference IM/Information Storage and Retrieval/intellectual property and protection) ,Intangible digital

intellectual property (IDIP), Copyrights, patents, trade secrets, trademarks, Plagiarism, non disclosure agreement

Unit III: Sustainability & CSR (09)

Basics of sustainability in IT and computing, Global social and environmental impacts of computer use and disposal, Business Ethics, Ethics Vs Social Responsibility, A view of corporate social responsibility (Legal, Ethical, Economic, Philanthropic) and its importance, ESG(Environmental, Social and Governance standards), Evolution of ESG from CSR

Unit IV: Green Computing (09)

Green IT Fundamentals: Business, IT, and the Environment , Green computing: carbon footprint, scoop on power, Green IT Strategies: Drivers, Dimensions, and Goals , Environmentally Responsible Business: Policies, Practices, and Metrics, Virtualization of IT systems, Role of electric utilities, Telecommuting, teleconferencing and teleporting , Materials recycling , Best ways for Green PC, Green Data center, Green Grid framework.

Unit V: Sustainability in Healthcare (08)

Basics, Societal expectations, Sustainability and Pharmaceutical products-Role in Human health, Sustainable Concerns All Along the Life Cycle of the Health-care Industry, Global corporate governance and IT

Text Books

1. Bhuvan Unhelkar, "Green IT Strategies and Applications-Using Environmental Intelligence", CRC Press, June 2014
2. Ming din, "Sustainable development for health care industry" , Springer
3. Niraja Pandey, Khushdeep Dharni, "Intellectual Property Rights", PHI
4. Caroline Whitbeck, "Ethics in Engineering Practice and Research", Cambridge Press, ISBN:978-1-107-66847-8

Reference books

1. Woody Leonhard and Katherine Murray, "Green IT for Dummies", Wiley Publications (2009),ISBN: 978-0-470-74349-2

Online resources

NPTEL on Professional Ethics :https://nptel.ac.in/courses/110/105/110105097/

20PECE 501B Java Full Stack Technologies

Teaching Scheme
Lectures: 3 Hrs/week

Examination Scheme
In Semester: 50 marks
End Semester: 50 marks
Credits: 3

Prerequisites: Data Structures (20CE 302)

Course Objectives:
To facilitate the learner to -

1. Get exposure to full stack development in Java technologies.
2. Develop familiarity with the client side Java technologies.
3. Gain comprehensive knowledge about Java server side technologies for enterprise application development in practice.
4. Get familiar with the web services based approach for real-life application development.
5. Get acquainted with the database development technologies in Java.

Course Outcomes:
By taking this course, the learner will be able to -

1. Choose suitable client side Java technologies.
2. Analyze Java server side technologies for enterprise application development.
3. Analyze the characteristics of web services paradigm.
4. Analyze the role of Java database development technologies to realize their suitability for application development.

Unit 1: Client Side Web Technologies **(07)**

n-tier architecture, HTTP request - response, Web browser, HTML, CSS, XML, JSON, JavaScript (JS), Document Object Model (DOM), Introduction to jQuery, Asynchronous JavaScript And XML (AJAX).

Unit 2: Server Side Java Web Technologies **(07)**

Introduction to server side technology, Common Gate Interface (CGI), Java Servlets, Java Server Pages (JSP), Session tracking, JSP tags, Java Beans, MVC architecture.

Unit 3: ReactJS **(06)**

Overview of ReactJS: Introduction, Features, Advantages, Comparison with AngularJS, Introduction to Nodejs; ReactJS concepts like components, virtual DOM, JSX and APIs.

Unit 4: Java 2 Enterprise Edition (J2EE) Technologies (08)

Introduction to J2EE technologies, Enterprise Java Beans (EJB), Java Messaging Service (JMS), Remote Method Invocation (RMI).

Unit 5: Java Web Services (07)

Web Services: Overview; Service Oriented Architecture (SOA), Java Web services based on SOAP and REST, Java Web services API for SOAP and REST based web services:
JAX-WS, JAX-RS.

Unit 6: Java Database Programming and Hibernate (07)

Java Database Connectivity (JDBC), Java Transaction API (JTA), Java Persistence API (JPA), Hibernate: Overview, architecture, Object Relational (OR) Mapping.

Text books:

1. Kogent Learning Solutions Inc., **'Web Technologies: HTML, JS, PHP, Java, JSP, ASP.NET, XML, AJAX, Black Book'**, *DreamTech Press*, ISBN: 978-81-7722-997-4, (2015).
2. Kogent Learning Solutions Inc., **'Java Sever Programming Java EE6 Black Book'**, *DreamTech Press*, ISBN: 978-81-7722-936-3, (2013).
3. Stoyan Stefanov, **'React - Up & Running: Building Web Applications',** *O'Reilly,* ISBN: 9781491931820, (2016).
4. William Crawford, Jim Farley, **'Java Enterprise in a Nutshell'**, *O'Reilly*, ISBN-13: 978-0596101428, 3rd Edition, (2005).

References books:

1. Mark Tielens Thomas, **'React in Action'**, *Manning Publications*, ISBN: 978-1617293856, (2018).
2. Kevin Mukhar, Chris Zelenak, James L. Weaver and Jim Crume, **'Beginning Java EE5: From Novice to Professional'**, *Apress*, ISBN-13: 978-8181284020, (2006).
3. Kirupa Chinnathambi, **'Learning React: A Hands-on Guide to Building Web Applications Using React and Redux',** *Addison Wesley,* (2016).
4. Jim Keogh, **'The Complete Reference J2EE'**, *McGraw Hill Education*, ISBN: 978-0-07-052912-0, (2012).

Web References:

1. https://learn.jquery.com
2. https://docs.oracle.com/javaee/7/tutorial/
3. https://reactjs.org

20PECE 501LB Java Full Stack Technologies Laboratory

Teaching Scheme
Practical: 2 Hrs/week

Examination Scheme
In Semester: 25 Marks
Oral : 25 Marks
Credits: 1

Course Objectives:
To facilitate the learners to -

1. Understand the Installation and Configuration setting related aspects of web server, integrated development environments and various frameworks, in the development of web applications.
2. Understand the role of various technologies used for real-life application development.
3. Get exposure to full stack development in Java which includes client side and server side technologies, web services and database development technologies.
4. Gain practical knowledge about the various client side and Java server side technologies for application development in practice.

Course Outcomes:
By taking this course, the learner will be able to -

1. Make use of suitable client side Java technologies.
2. Experiment with various Java server side technologies like Java Servlets, Java Server Pages, Web services and JPA for web application development.
3. Make use of Java Sockets library and Java RMI framework for the development of sample client-server applications.
4. Build a sample web application using suitable technologies at various tiers.

Preamble:

Development of web applications need technologies at various levels, which play different roles in the overall web architecture. The intent of Java Full Stack Technologies Laboratory is to enable the understanding of the role of various technologies in full stack development and implementation of some real world application scenarios using these technologies. Assignment statements are in brief and should be implemented with Java web technologies. Motivation here is that students should be able to develop the user interface, business logic and the database programming parts of a typical web application, using the APIs/libraries provided by various client side and server side Java technologies. Faculty members are encouraged to expand problem statements with variations. Assignments can be framed and expanded in such a way that it explores concepts, logic of solution and simple application. Students will be encouraged to build solutions for real world business scenarios in different domains, to fulfil the end-user requirements. Faculty will appropriately adopt assignments on similar lines as the examples shown here. Group A assignments are on applying various client side technologies and basic server side technologies. Group B assignments are on

exploring the use of technologies like EJB, Web services and Hibernate. Group C assignment is on the development of sample web application.

Suggestive List of Assignments:

Group A: (Mandatory)

1. Develop dynamic and interactive web client using HTML, CSS and JavaScript technologies. Make use of these technologies to develop suitable web forms, layout and to perform validation of form data, for this web client.

   Sample application scenario:
   Consider that a student needs to register for an online course portal. For this scenario, develop an HTML form for "Course Registration", make use of CSS for layout design of this form and perform validation on various fields of this form using JavaScript.

2. Develop dynamic and interactive web client using XML and AJAX technologies, to enable rich user experience.

   Sample application scenario for AJAX:
   Consider a web form for an administrator of an "Online Shopping Application". An administrator can select the name of a customer from the drop down list box on the web form. Then on the same page, the details of the customer such as shipping address should get displayed.

3. Develop dynamic and interactive web client using jQuery as a client side JavaScript library. For this web client, implement event handling and animation effects using jQuery.
4. Develop dynamic and interactive web client using ReactJS as a client side library. Make use of various features of ReactJS such as components, APIs etc.
5. Implement an application using Java RMI to understand distributed application environment. The remote object accesses database using JDBC.
6. Implement a sample web application scenario using Java Servlets, Java Server Pages and Java Beans as the server side dynamic content generation technologies. Make use of MVC architecture for this implementation and also show the appropriate usage of the various capabilities of these technologies such as session tracking, tag library, implicit objects, directives etc.

   Sample application scenario:
   Consider a simple web form where you give Student Roll number and get back Student Profile details from the database. Make use of MVC architecture, based on Java Servlet, JSP and Java Bean to implement this web based scenario.

Group B: (Any One)

1. Implement a sample EJB based scenario for any application like online movie ticket booking, online college admission portal, online railway reservation etc. Make use of various types of beans such as session beans and entity beans, for the implementation of business methods and persistence of data.
2. For a sample application scenario, implement and consume the suitable web services using SOAP or REST protocol.
3. Make use of JPA with Hibernate framework for performing the create, retrieve, update and delete (CRUD) operations on the backend database.

   Sample application scenario:
   Consider "Course Information Management" as a typical Database Application. This application may have database tables like Courses, Participants etc. Make use of JPA with Hibernate framework to access the data from the Courses table in this above application.

Group C:

1. Design and develop a typical web application like online cab booking, online food ordering application, online tours and travel portal etc. For the development of this application, choose the appropriate technologies for the client side aspects, server side business logic and database development.

Programme Elective-II
20PECE 502 (NPTEL / Swayam Course)

20PECE 502B Reinforcement Learning

Teaching Scheme
Lectures : 3 Hrs/Week

Examination Scheme
In Semester : 50 Marks
End Semester: 50 Marks
Credits: 3

Prerequisites :
Machine Learning (20CE404)

Course Objectives:
To facilitate the learners to -

1. Understand the need of Reinforcement Learning.
2. Understand the full reinforcement learning concepts and its techniques
3. Understand the basic mathematical foundations of reinforcement learning.
4. Understand the concepts of function approximation in reinforcement learning.
5. Have the knowledge of hierarchical reinforcement learning and applications.
6. Explore the current developments in the reinforcement learning field.

Course Outcomes:
By taking this course, the learner will be able to -

1. Apply the basic concepts of Reinforcement Learning in various domains/fields.
2. Make use of the techniques for full reinforcement learning.
3. Apply the fundamental mathematics for solving the problems of reinforcement learning.
4. Apply the knowledge of function approximation in reinforcement learning.
5. Apply the concepts of hierarchical reinforcement learning and its applications.
6. Interpret the recent advancements in the field of reinforcement learning.

- Introduction to RL
- RL Framework and Applications
- Introduction to Immediate RL
- Bandit Optimalities
- Value function based methods

- UCB 1
- Concentration Bounds
- UCB 1 theorem
- PAC bounds
- Median Elimination
- Thompson Sampling

- Policy Search
- REINFORCE
- Contextual Bandits
- Full RL Introduction
- Returns, value functions and MDPs
- MDP modeling

- Bellman Equation
- Bellman Optimality Equation
- Cauchy sequence and Green's equation
- Banach Fixed Point equation
- convergence proofs

- Lpi Convergence
- Value Iteration
- Policy Iteration
- Dynamic Programming
- Monte Carlo
- Control in Monte Carlo

- Off Policy MC
- UCT
- TD (0)
- TD (0) control
- Q-learning
- Afterstate

- Eligibility Traces
- Backwards view of Eligibility Traces
- Eligibility Trace control
- Thompson sampling Recap

- Function Approximation
- Linear Parameterization
- State Aggregation methods
- Function Approximation and Eligibility Traces
- LSTD and LSTDQ
- LSPI and Fitted Q

- DQN and fitted Q Iteration
- Policy Gradient Approach
- Actor critic and REINFORCE
- Theorem-1
- Policy Gradient Approaches with Function Approximation

- Hierarchical Reinforcement Learning
- Types of Optimality
- Semi Markov Decision Processes
- Options
- Learning with Options
- Hierarchical Abstract Machines

- MAXQ
- MAXQ value Function Decomposition
- Option Recovery

- Solving PODMP.

Textbook:
R. S. Sutton and A. G. Barto. Reinforcement Learning - An Introduction. MIT Press. 1998.

Course Link:
https://onlinecourses.nptel.ac.in/noc22_cs75/preview

Video Download link:
https://archive.nptel.ac.in/courses/106/106/106106143/

Transcript link:
https://archive.nptel.ac.in/courses/106/106/106106143/

20PEEC601LD DEEP LEARNING LAB

Teaching Scheme
Practical: 2 Hours /Week

Examination Scheme
In Semester : 25Marks
Practical: 25 Marks
Credits: 1

Course Objectives:

1. To implement Artificial Neural Networks (ANN), Convolutional Neural Networks (CNN) and Recurrent Neural Networks (RNN)
2. To get familiar with deep learning frameworks and Python libraries used for Deep Learning
3. To apply ANN, CNN and RNN algorithms to solve real-world problems

Course Outcomes:

After completion of the course, students will be able to-

CO1	Apply neural network learning methods and transfer learning for classification/regression applications
CO2	Select a suitable Convolutional Neural Network architecture and hyperparameters to solve real-world image classification, object recognition problems
CO3	Develop an algorithm for text processing and time series prediction using Recurrent Neural Networks and Long Short-Term Memory
CO4	Analyze performance of Deep Learning models based on different evaluation metrics

List of Experiments:

1. Introduction to Python libraries (Keras, TensorFlow) for deep learning.
2. Write a program to implement a Perceptron learning algorithm.
3. Write a program to perform classification (on Kaggle dataset) using Backpropagation.
4. Develop an algorithm and write a program for image classification using Convolutional Neural Network.
5. Write a program to implement image recognition using transfer learning.
6. Develop an algorithm and write a program for object detection using Convolutional Neural Network.
7. Develop an algorithm and write a program to predict the stock prices based on historic data using Long Short-Term Memory/ Gated Recurrent Unit.
8. Develop an algorithm and write a program for text preprocessing and text summarization using Recurrent Neural Network.

20PEEC601LB BIOMEDICAL ELECTRONICS LAB

Teaching Scheme
Practical: 2 Hours / Week

Examination Scheme
In Semester : 25Marks
Practical: 25 Marks
Credits: 1

Course Objectives:

1. To understand signal acquisition of some of the bio signals
2. To explore and select appropriate signal conditioning techniques
3. To study different AI/ML techniques for analysis and automatic classification

Course Outcomes:

After completion of the course, students will be able to

CO1 Compare the performances of different sensors used in Biomedical Applications
CO2 Select and Apply appropriate signal conditioning techniques to the different biomedical signals
CO3 Implement spectral analysis techniques on Biomedical signals
CO4 Develop a microcontroller based system to acquire the real life biosignal and perform analysis of the same

List of Experiments:

1. Temperature measurement using AD590 / LM35/Digital sensor
2. Measure ECG and Heart rate (photoelectric transducers/ finger plethysmography) : Normal and after exercise, Raw signal and after signal conditioning
3. Measure EMG for different muscles while performing any actions
4. Measurement of unknown resistance by using a Strain Gauge/Load cell in the Wheatstone bridge and finding the sensitivity of the bridge
5. Measurement of blood pressure using sphygmomanometer and automatic digital BP instrument (Test points on a Trainer kit). Finding the systolic and diastolic values and calculate Mean Arterial Pressure (MAP)
6. Use of AI/ML techniques for analyzing the spectrum of ECG/EEG/PCG signals
7. Open ended assignment

20OE601K MULTIMEDIA SYSTEMS

Teaching Scheme
Lectures: 3 Hours / Week

Examination Scheme
ISE: 50 Marks
ESE: 50 Marks
Credits: 3

Prerequisite:20EC402 Analog and Digital Communication

Course Objectives:

1. To introduce basic concepts and design of Colour TV and Digital TV
2. To explain advanced TV technologies like HDTV, CATV, CCTV, DTH, CAS and case study for live telecast
3. To introduce multimedia compression techniques, standards and multimedia over the internet
4. To familiarize the students with digital recording and playback systems, acoustic design, microphones and loudspeakers

Course Outcomes:

After completion of the course, students will be able to

CO1 Explain the concepts of colour TV design, systems and Digital TV
CO2 Discuss and compare advanced TV systems like CATV, CCTV, DTH, HDTV, CAS, Wi-fi TV, 3DTV and different display technologies
CO3 Apply and analyze multimedia compression standards for text, audio, image and video and explain multimedia over the internet
CO4 Compare optical recording techniques, microphones and loudspeakers
CO5 Design acoustics and PA system for auditorium, public meeting, debating hall, football stadium and college classrooms

Unit I: Colour and Digital TV (11)

Resolution, interlaced scanning, BW, CVS, Color TV systems, frequency interleaving, colour difference signals, colour TV receiver, NTSC, PAL, SECAM encoders and decoders, Introduction to Digital TV, Digital TV signals and parameters, Digital TV Transmitters and receivers.

Unit II: Advanced TV Systems (10)

HDTV standards and systems, HDTV transmitter and receiver, CCTV, CATV, Direct to Home TV (DTH), Set top box, Conditional Access System (CAS), 3D TV systems, Case study (Cricket match, Marathon, Football match), Wi-Fi TV, Video door phone systems, Display devices: LED, LCD, Plasma.

Unit III: Multimedia Compression and Multimedia over Internet (11)

Introduction, Overview, Concept of Multimedia, Multimedia Applications, Text: Types, Compression, Hypertext, Image Compression techniques: JPEG, Multimedia Audio: MIDI, MP3, Video: MPEG, Animation: Introduction, types, 3D animation, Virtual reality, Multimedia over Internet**:** Introduction to Multimedia Services, Transmission of Multimedia over the Internet, IP Multicasting, Explaining VOIP.

Unit IV: Acoustics and Digital Audio Video (10)

Optical recording, noise, CD, DVD, dual layer DVD, rewritable DVD, Blu Ray DVD, Studio acoustics and reverberation, acoustic chambers, PA system for : auditorium, public meeting, debating hall, football stadium, college hall, Advanced PA systems, Different types of speakers and microphones.

Text Books:

1. R. R. Gulati, **"Modern Television Practice",** *New Age International*, (5th Edition), (2015).
2. Ralf Steinmetz, Klara Nahrstedt, **"Multimedia: Computing, Communication and Applications"**, *Pearson Publication*, (8th Edition), (2011).
3. R.G. Gupta, **"Audio and Video Systems"**, *Tata Mcgraw Hills*, (2nd Edition), (2020).
4. Robert D. Finch, **"Introduction To Acoustics",** *PHI*, (2nd Edition), (2007).
5. Dayanand Ambawade, Dr. Deven shah, Prof. Mahendra Mehra, "**Advance Computer Network"**, *Wiley*, (2nd Edition), (2014).

Reference Books:

1. A. M. Dhake, "**Television and Video Engineering**", *Tata Mcgraw Hills*, (2nd Edition), (2003).
2. Ranjan Parekh, **"Principles of Multimedia**", *Tata Mcgraw Hills*, (2nd Edition), (2013).
3. Alec Nisbett , "**The Sound Studio**", *Focal Press*, (5th Edition) , (1993).

Online Resources:

NPTEL Course " Multimedia Systems"

1. https://nptel.ac.in/courses/117/105/117105083/

20OE601E COMPUTER VISION

Teaching Scheme
Lectures: 3 Hours / Week

Examination Scheme
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

Prerequisite:20EC501 Digital Signal Processing

Course Objectives:

1. To introduce major ideas, methods and techniques of Computer Vision algorithms
2. To introduce fundamentals of Image formation
3. To explain concepts of Camera Calibration and Stereo Imaging
4. To explain different Background Subtraction techniques and Motion tracking algorithms

Course Outcomes:

After completion of the course, students will be able to

CO1 Explain the fundamentals of Image formation, Camera calibration parameters and Stereo Imaging

CO2 Apply camera calibration concepts to calculate intrinsic and extrinsic parameters of camera

CO3 Explain different Background Subtraction techniques and Calculate the Performance measures of it.

CO4 Select the appropriate feature extraction techniques according to the requirement of the applications

CO5 Analyze the appropriate Background Subtraction techniques and Object tracking algorithms according to the requirement of the applications

Unit I: Camera Calibration (07)

Geometrical primitives and transformations, 3D to 2D projections, Image Formation, Capture and Representation, Camera Calibration and parameters, Digital camera.

Unit II: Stereo Imaging (08)

Stereo Vision: Epipolar geometry, Rectification, Correspondence, triangulation, RANSAC algorithm, Dynamic programming.

Unit III: Visual Features and Representations (09)

Edge, Blobs, Corner Detection, SIFT, SURF, HoG.

Unit IV: Background Subtraction Techniques for Moving Object Detection (09)

Frame differencing, Mean and Median filtering, Gaussian Mixture Model (GMM), Kernel density estimation, Applications.

Unit V: Motion Tracking (09)

Motion tracking using Optical flow, blob tracking, Colour feature based mean shift, Kalman tracking, Applications.

Text Books:

1. D. Forsyth, J. Ponce**, "Computer Vision, A Modern Approach"**, *Prentice Hall*, (2nd Edition), (2003).

2. R. Szeliski, **"Computer vision algorithms and applications",** *Springer-Verlag*, (2nd Edition), (2010).

Reference Books:

1. L. G. Shapiro, George C. Stockman**, "Computer Vision"**, *Prentice Hall*, (1st Edition), (2001).
2. E. Trucco, A. Verri, **"Introductory Techniques for 3-D Computer Vision"**, *Prentice Hall*, (1st Edition), (1998)
3. D. H. Ballard, C. M. Brown, **"Computer Vision"**, Prentice Hall, (1st Edition), (1982).
4. M. Sonka, V. Hlavac, R. Boyle, **"Image Processing, Analysis, and Machine Vision",** *Thomson Press*, (3rd Edition), (2011).

Online Resources:

NPTEL Course **"Computer Vision"**

1. https://nptel.ac.in/courses/106/105/106105216/
2. http://www.ai.mit.edu/projects/vsam/Publications/stauffer_cvpr98_track.pdf
3. https://people.cs.rutgers.edu/~elgammal/pub/ieeeproc-paper-final.pdf
4. http://www.cs.cmu.edu/~16385/s15/lectures/Lecture24.pdf

20PEEC601D DEEP LEARNING

Teaching Scheme
Lectures: 3 Hours / Week

Examination Scheme
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

Prerequisite: 20EC403 Machine Learning with Python

Course Objectives:

1. To introduce basic concepts and learning algorithms of Artificial Neural Networks
2. To become familiar with feedforward and recurrent neural networks
3. To build CNN model and elaborate effects of hyperparameters on its performance
4. To get detailed insight of deep learning algorithms and their applications to solve real world problems

Course Outcomes: *

After completion of the course, students will be able to

CO1 Explain basic concepts of neural network and its learning algorithms
CO2 Calculate feature map dimensions and learnable parameters in Convolutional Neural Network (CNN)
CO3 Analyze effects of hyperparameter tuning on the performance of L-layer deep networks and interpret results
CO4 Solve image recognition and classification problems using pretrained CNN architectures
CO5 Compare recurrent neural networks, their types for sequence data processing and explain gradient issues
CO6 Design a deep neural network architecture to solve real-world problems

Unit I: Basics of Artificial Neural Network (09)

Biological neuron, McCulloch–Pitts unit and Thresholding logic, Linear Perceptron, Perceptron learning algorithm, Linear separability, Activation functions, Feedforward networks: Multilayer Perceptron, Gradient Descent, Backpropagation

Unit II: Deep Neural Networks (09)

Deep feedforward networks, Architecture design, Gradient based learning, Vanishing and exploding gradients, Regularization, Optimization methods (AdaGrad, AdaDelta, RMSProp, Adam, NAG) for training deep models, Hyperparameters.

Unit III: Convolutional Neural Networks (09)

Building blocks of Convolutional Neural Network (CNN), Convolution operation and layer, Kernels and Filters, Pooling layer, Stacking of layers, Cross-validation, Data augmentation, Transfer learning, Modern CNN architectures: AlexNet, VGGNet, GoogLeNet, ResNet, Autoencoder.

Unit IV: Sequence Modeling (09)

Recurrent Neural Network (RNN), Types of RNN, Bidirectional RNNs, Back propagation through time (BPTT), Vanishing Gradients with RNNs, Gated Recurrent Unit (GRU), Long Short-Term Memory (LSTM).

Unit V: Applications of Deep Learning (06)

Applications of CNN: Object recognition, Image classification.
Applications of RNN: Speech, language, and text processing.

Text Books:

1. Laurene Fausett, **"Fundamentals of Neural Networks: Architectures, Algorithms and Applications"**, *Pearson Education*, (1st Edition), (2008).
2. S. N. Sivanandan and S. N. Deepa, **"Principles of Soft Computing"**, *Wiley India*, (2nd Edition), (2011).
3. Ian Goodfellow, Yoshua Bengio and Aaron Courville, **"Deep Learning"**, *MIT Press*, (1st Edition), (2016).
4. Josh Patterson and Adam Gibson, **"Deep Learning- A Practitioner's Approach"**, *O'Reilly Media*, (1st Edition), (2017).

Reference Books:

1. Francois Chollet, **"Deep Learning with Python"**, *Manning Publications*, (1st Edition), (2018).
2. Phil Kim, **"MATLAB Deep Learning: With Machine Learning, Neural Networks and Artificial Intelligence"**, *Apress*, (1st Edition), (2017).

Online Resources:

1. NPTEL Course **"Fuzzy Logic and Neural Networks"**
   https://onlinecourses.nptel.ac.in/noc21_ge07/preview
2. NPTEL Course **"Deep Learning"**
   https://onlinecourses.nptel.ac.in/noc21_cs76/preview

20EC601 WAVE THEORY AND ANTENNA

Teaching Scheme
Lectures: 3 Hours / Week
Tutorial :1 Hours / Week

Examination Scheme
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 4

Prerequisite:20ES01 Basic Electrical and Electronics Engineering, 20BSEC301 Calculus and Probability

Course Objectives:
1. To study Electrostatic and Magnetostatic laws
2. To study Maxwell's equations and wave propagation in different media
3. To explain transmission line fundamentals and apply them to solve the problems using Smith chart
4. To study antenna fundamentals and analyze different types of antennas and antenna arrays

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

CO1	Apply the relevant laws for solving the problems of Electrostatics and Magnetostatics
CO2	Interpret Maxwell's equations for static and dynamic field and calculate the average power of Electromagnetic wave using Poynting theorem
CO3	Formulate the wave equation and solve it for uniform plane wave
CO4	Determine transmission line parameters using Smith chart
CO5	Analyze wire antenna and antenna arrays and identify the suitable antenna for a given communication system

Unit I: Fundamentals of Electrostatics and Magnetostatics (09)
Coulomb's law and Electric field intensity, Electric flux and flux density, Types of charge distributions and their Electric field, Gauss's law, Biot Savart law, Ampere Circuital law, Magnetic field intensity and flux density, Boundary conditions.

Unit II: Electromagnetic Waves (09)
Faraday's law, Maxwell Equations in point form and integral form, Wave Equation, Uniform Plane wavesin free space, dielectric, and conducting medium, Linear, Circular & Elliptical polarization, Reflection of plane waves, Normal incidence, Oblique incidence, Electromagnetic power and Poynting vector.

Unit III: Transmission Lines (08)
Types of transmission lines, Dissipation less line, Voltage and Current on a transmission line, Input impedance, Open and short-circuited transmission line, Impedance mismatch, Standing waves, EMI, EMC, Smith chart and applications.

Unit IV: Wire Antennas and Antenna Arrays (10)
Antenna fundamentals, Types of antennas, Near and far field, Radiation mechanism, Antenna parameters, Infinitesimal dipole, Small dipole, Finite length dipole, Half wavelength dipole, Small circular loop antenna, Antenna arrays, Two element array, Array factor, Pattern multiplication, N-element linear array: Uniform amplitude and spacing, Broad side and End-fire array, N-element linear array: Non-uniform amplitude and uniform spacing, Binomial and Dolph Chebyshev-array.

Unit V: LF to SHF Antennas (06)

Hertz & Marconi antennas, electrically short antennas, Beverage antenna, medium frequency antennas, Resonant & non-resonant antennas, VAntenna, Rhombic antenna, TW antennas, Loop antenna, Ferrite rod antenna, Whip antenna, Yagi Uda, Helical, Horn, Parabolic reflector, Microstrip patch antenna.

Text Books:

1. Mathew N. O Sadiku**, "Principles of Electromagnetics",** *Oxford University Press*, (4th Edition), (2009).
2. C.A. Balanis**, "Antenna Theory- Analysis and Design",** *John Wiley*, (4th Edition), (2016).

Reference Books:

1. John D Kraus, Ronald J Marhefka, Ahmad S Khan, **"Antennas for All Applications"**, *The McGraw Hill Companies*, (5rd Edition), (2017).
2. K. D. Prasad, **"Antenna and Wave Propagation"**, *Satya Prakashan New Delhi*, (2014).
3. John D Kraus, **"Antenna & Wave Propagation",** *McGraw Hill*, (4th Edition),(2010).

Online Resources:

1. Nptel Course **"Electromagnetic Theory"** https://nptel.ac.in/courses/108/104/108104087/
2. Nptel Course **"Antennas"** https://onlinecourses.nptel.ac.in/noc20_ee20/preview

20EC501LD INTRODUCTION TO IOT LAB

Teaching Scheme
Practical: 2 Hours / Week

Examination Scheme
ISE: 25 Marks
Practical:25 Marks
Credits: 1

Course Objectives

1. To learn use of sensors and actuators in IOT
2. To learn IOT devices and protocols
3. To build an IOT application

Course Outcome

After completion of the course, students will be able to

CO1 Select sensors and actuators in IOT application
CO2 Interface sensors and actuators with IoT development module
CO3 Develop a program to monitor and control by using web server
CO4 Develop an IOT system for given application

List of Experiments:

1. Introduction to various sensors and various actuators & its Application.
   a) PIR Motion Sensor.
   b) Float Sensor.
   c) Moisture Sensor.
   d) Temperature Sensor.
   e) Touch Sensor.
   f) Infrared Sensor.
   g) Servo Motor
   h) RFID Sensor
   i) Humidity sensor
2. Introduction to ESP32 and Arduino IDE/Visual Studio Code.
3. Write a program to measure sensor data and display on serial monitor.
4. Write a program to control Actuators.
5. Write a program to control Actuators based on real time sensor data.
6. Implement a standalone web server using of ESP32.
7. Develop a web application through ESP32.
8. Mini Project: Develop an IoT system for given application.

20PEEC501D INTRODUCTION TO INTERNET OF THINGS

Teaching Scheme
Lectures: 3 Hours / Week

Examination Scheme
In Semester: 50 Marks
End Semester: 50 Marks
Credits: 3

Prerequisite: 20EC404 Embedded Systems

Course Objectives:

1. To explore various components of Internet of Things such as Sensors, internetworking and cyber space
2. To design Internet of Things circuits and solutions

Course Outcomes:

After completion of the course, students will be able to

CO1 Apply concepts to explain Internet of Things (IoT) architecture, protocols, models and devices used to develop IoT systems
CO2 Identify appropriate protocols, models and devices to develop IoT system
CO3 Compare and contrast IoT and M2M, IoT physical devices, networking and protocols techniques
CO4 Design IoT system for the given application

Unit I: Introduction to Internet of Things (07)

Internet of Things fundamentals: Sensing, Actuation, Internet of Things (IOT) Architecture and protocols: Communication Protocols, Sensor Networks, IoT Definition, Characteristics. IoT Functional Blocks, Physical design of IoT, Logical design of IoT, Challenges in IOT, Communication models and APIs; IoT Enabling Technologies.

Unit II: Machine to Machine to Internet of Things (08)

The Vision-Introduction, From machine to machine (M2M) to Internet of Things (IoT), M2M towards IoT-the global context, Case study, Differing characteristics between M2M and IoT, Definitions, M2M Value Chains, Building architecture, Main design principles and needed capabilities, An IoT architecture outline, standards consideration, IoT Value Chains, Industrial IoT (IIoT).

Unit III: IOT Physical Devices and Objects (08)

Introduction to IoT tools, Implementation of IoT with Arduino and Raspberry-Pi, Cloud Computing, Fog Computing, Connected Vehicles, Data Aggregation for the IoT in Smart Cities, Privacy and Security Issues in IoT.

Unit IV: IOT Networking and Addressing techniques (07)

RFID technology, Wireless Sensor Networks, IPv6 Protocol Overview, comparison of IPv4 and IPv6, IPV6 tunneling, IPsec in IPv6, Quality of Service in IPv6

Unit V: IOT Protocols and Cloud offerings (07)

IoT Access Technologies: IEEE 802.15.4, IEEE 802.15.4g and 802.15.4e, IEEE 1901.2a, LoRaWAN, MQTT protocol, Introduction to cloud storage models and communication API's, web services for IoT.

Unit VI: Domain Specific Applications of Internet of Things (05)

Home automation - hardware approach - Industry applications, Surveillance applications.

Text Books:

1. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, **"From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence",** *Academic Press*, **(**1st Edition), (2014).
2. Vijay Madisetti and Arshdeep Bahga, **"Internet of Things (A Hands-on-Approach)",** *VPT* , (1st Edition), (2014).
3. Francis da Costa, **"Rethinking the Internet of Things: A Scalable Approach to Connecting Everything",** *Apress Publications*, (1st Edition), (2013).
4. Cuno Pfister, "**Getting Started with the Internet of Things**", *O'Reilly Media*, (1st Edition), (2011).

Reference Books:

1. Honbo Zhou, **"The Internet of Things in the Cloud: A Middleware Perspective",** *CRC Press*, (1st Edition), (2012)
2. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), **"Architecting the Internet of Things",** *Springer*, (1st Edition), (2011)
3. Olivier Hersent, David Boswarthick, Omar Elloumi , **"The Internet of Things – Key Applications and Protocols",** (1st Edition), *Wiley*, (2012)

Online Resources:

1. NPTEL Course "**Introduction to IOT"**
   https://nptel.ac.in/courses/106/105/106105166/

Course Name	System Dynamics – Modeling and Simulation	L	T	P
Course Code	20ME603	2	1	0
Pre-requisite	Analysis and Synthesis of Mechanisms, Machine Design, Power Train Design	Credit: 03		

Course Objectives:

1. To understand the methods to find natural frequency of system subjected to undamped free vibrations
2. To analyze the system subjected to vibrations with viscous/coulomb damping
3. To calculate the amplitude and phase difference for various cases of forced vibrations
4. To determine natural frequencies and mode shapes of multiple degree of freedom system
5. To explain the features and applications of various dynamic modeling techniques

Course Outcomes:

Upon completion of this course, the student will be able to,

1. evaluate the natural frequency of system subjected to undamped free vibrations
2. analyze the system subjected to vibrations with viscous/coulomb damping
3. calculate the amplitude and phase difference for various cases of forced vibrations
4. determine natural frequencies and mode shapes of multiple degree of freedom system
5. understand features and applications of various dynamic modeling techniques

Unit 1	Fundamentals of Dynamic System	4 hours	CO: 1

Elements of a vibratory system, S.H.M., degrees of freedom, modeling of a system, concept of linear and non-linear systems, equivalent spring, linear and torsional systems. Matrix Algebra

Unit 2	Single Degree of Freedom Systems – Free and Forced Vibrations	6 hours	CO: 2

Natural frequency by equilibrium and energy methods for longitudinal and torsional vibrations.
Forced vibrations of longitudinal and torsional systems, simple harmonic excitation, excitation due to reciprocating and rotating unbalance, base excitation, magnification factor and phase difference, force and motion transmissibility
Different types of damping, free vibrations with viscous damping - over damped, critically damped and under damped systems, dry friction damping.

Unit 3	Multiple Degree of Freedom Systems - Undamped Vibrations	6 hours	CO: 3

Free vibration of spring coupled systems – longitudinal and torsional, natural frequency and mode shapes. Eigen value and Eigen vector by Matrix method, Geared systems.

Unit 4	**Frequency Response and Vibration**	**6 hours**	**CO: 4**
Digital and Fast Fourier Transform, Frequency Response of first and second order Systems, Vibration Isolator and Vibration Absorption, Response to General Periodic Inputs			
Unit 5	**Dynamic Modeling and Simulation**	**6 hours**	**CO: 5**
Introduction to Laplace Method for Step input, impulse input to SDOF, Laplace Transform, Response for First Order Models, State Space system, Simulations using MATLAB and SIMULINK, Base Excitation, Rotating Imbalance			
	Total Lecture hours:	**28 hours**	

Text Books:	
1.	William J. Palm III, Modeling, Analysis, and Control of Dynamic Systems, Wiley,latest edition
2.	Rao S. S., „Mechanical Vibrations", Pearson Education Inc. Dorling Kindersley (India) Pvt. Ltd.
Reference Books:	
1.	William J. Palm III, System Dynamics, Mc-Graw Hill, latest edition
2.	Grover G. K., „Mechanical Vibrations", Nem Chand and Bros.
3.	Thomson, W. T., „Theory of Vibration with Applications", CBS Publishers and Distributors.
4.	V P Singh, „Mechanical Vibrations", Dhanpat Rai & Sons.
5.	Kelly S. G., „Mechanical Vibrations", Schaum„s outlines, Tata McGraw Hill Publishing Co. Ltd.
6.	Meirovitch, „Elements of Mechanical Vibrations", McGraw Hill.
7.	M.L.Munjal, „Noise and vibration control", Cambridge University Press India Private Limited.
8.	Bies, D. and Hansen, C., „Engineering Noise Control - Theory and Practice", Taylor and Francis.

T. Y. B. Tech. -- Semester-II

Course Code	Robotics and Control Systems	L	T	P
20ME601		3	0	0
Prerequisite	Basic Mathematics, Engineering Mechanics, Elements of Electrical and Electronics Engineering	Credit : 03		

Course Objectives:

To familiarize the students

1. Basics of Robotics
2. Robotic control and Actuation
3. Control Technology
4. System Modelling, Stability and Control actions.

Course Outcomes:

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

1. Identification of the basic Robotic systems components and performance parameters
2. Understand the fundamentals of Robotic sensory and actuation systems
3. Analyze the robotic kinematics
4. Identify the basic control systems and it"s classifications
5. Prepare the system model and can perform the stability analysis of the model
6. Analyze the different controller modes and perform the frequency domain analysis

Unit 1	Introduction to Robotics	5 hours	CO : 1

Basic concepts, Laws of Robotics, Classification, Structure of Robots, Point to point and continuous path control system, Robot performance measurement characteristics- accuracy, resolution, repeatability, precision, dexterity, Industrial Applications.

Unit 2	Robotic Sensors & Actuation	6 hours	CO : 2

Classification, Selection and application, Need for sensors and vision system is robotic control.
Sensors: Light,Soud,Temperature,Contact,Proximity,Distance,Pressure,Tilt,Navigation,Acceleration GPS, IMU, Vision, PVDF Tactile(Construction, working and selection)
Actuation: Selection of Drives, Actuators and transmission system of manipulator.

Machine Vision System: Vision system devices, image acquisition, Masking, Sampling and Quantization, Image processing techniques, Noise reduction, Edge detection, Segmentation.

Unit 3	**Robot Kinematics**	**6 hours**	**CO : 3**
Transformation matrices ,link and joint, Denavit- Hartenberg (D-H) parameters, kinematics redundancy, kinematics calibration, inverse kinematics Static force and velocity in manipulators, Motion of the manipulator links, Jacobians, Singularities, static forces, Jacobian in force domain.			
Unit 4	**Control System**	**6 hours**	**CO : 4**
Definition, Classification- open loop and closed loop control system, case studies, Feedback and Feed Forward Control System, Transfer Function, Block diagram reduction techniques, Signal flow Graphs-Mason's Gain Formula			
Unit 5	**System Modelling and Stability**	**7 hours**	**CO : 5**
Basic system Models: Thermal, Fluid, Hydraulic, Mechanical: Spring-Mass-Damper system equations Stability Analysis in S-Domain: The concept of stability , Poles and Zeros of system – Routh-Hurwitz‟s stability criterion – qualitative stability and conditional stability – Limitations of Routh-Hurwitz‟s stability. Root Locus Technique: Concept of root locus – Construction of root locus. Time domain Response analysis.			
Unit 6	**Controllers and Frequency Response Analysis**	**6 hours**	**CO : 6**
Controllers: On-Off,P,I,D,PI,PD and PID Controller working principle. **Frequency domain specifications**, Bode plot diagrams-Determination of Phase margin and Gain margin, Stability analysis from Bode plots, Polar plots.			
	Total Lecture hours:	**36 hours**	

Text Books:

1.	S.K.Saha, "Introduction to Robotics", 2nd edition, TataMcGraw Hill Publication,
2.	John J. Craig, "Introduction to Robotics: Mechanics & Control", 3rd edition, Pearson Education.
3.	Ogata K., "Modern Control Engineering" Prentice Hall of India
4.	Nagrath I.J., & Gopal M, "Control system Engineering." Wiley Eastern Reprint
5.	C D Johnson, "Process Control Instrumentation Technology", Prentice Hall of India, New Delhi

Reference Books:

1.	Handbook of design, manufacturing and Automation: R.C. Dorf, John Wiley and Sons
2.	W. Bolton: Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, Third Edition, Pearson Education (Low Price Edition)

20HEV602 EV Motor Drives and Power train

Pre-requisite Theory of Machines, Basics of Electrical Engineering

Course Objectives:

Course prepares students to

1. To calculate motor power ratings for an EV application
2. To select an appropriate type of motor
3. To design a control system for electric drive
4. To analyze and design components of a power train
5. To test and validate given power train

Course Outcomes:

Students will be able to

1. To calculate motor power ratings for an EV application
2. To select an appropriate type of motor
3. To design a control system for electric drive
4. To analyze and design components of a power train
5. To test and validate given power train

Unit 1 Fundamentals: 6

General architecture and requirement of EV, load characteristics, energy sources, principle of electromechanical energy conversion, motors and generator operation.

Unit 2 Types of Electric Drives: 6

DC motors, induction motors and synchronous motors, permanent magnet motors, BLDC, switched reluctance motors, Switched Reluctance Motors (SRM),Permanent Magnet Synchronous Motor (PMSM)

Unit 3 Control of Electric Drives: 8

Microcontrollers/DSP based control strategies, PI control, cascade control, scalar and vector control, power electronics-based control of electric motors

Unit 4 Components of Power Train: 8

Auxiliary Inverter, HV-LV DC-DC converter, Traction Inverter, Gear Trains, Integration of power train components

Unit 5 Simulation and Testing of Power Train: 8

Integrated clutch and electric motor design, Range extender system design, Vehicle system simulation (thermal, mechanical and control systems) using MATLAB, Testing of electrified powertrain vehicle systems, including regulatory tests, cold, hot, altitude, NHC, durability.

Total Lecture hours:36 hours

Text Books:

1. Chang Liang Xia,"Permanent Magnet Brushless Dc Motor Drives and Controls" Wiley 2012.
2. Rashid M.H., "Power Electronics Circuits, Devices and Applications", Prentice Hall India,

   Third Edition, New Delhi, 2011.
3. Bimal K Bose, " Modern Power Electronics and AC Drives", Pearson Education, Second

   Edition, 2003.
4. Dubey. G.K., " Thyristorised power controllers", New age International, New Delhi, 2002.
5. Bhimbhra P.S., " Power Electronics", Khanna Publishers, New Delhi, 2005
6. Miller. T. J. E., "Brushless Permanent Magnet and Reluctance Motor Drives", Clarendon

   Press, Oxford, 1989.
7. Kenjo. T and Nagamori. S, "Permanent Magnet and Brushless DC Motors", Clarendon Press,

   Oxford, 1989.
8. Kenjo. T, "Stepping Motors and their Microprocessor Control", Clarendon Press, Oxford,
9. Robert .L.Boylsted,and Louis Nashelsky, "Electronic Devices and Circuit Theory", Pearson Education,9th edition,2009.
10. David A Bell, "Fundamentals of Electronic Devices and Circuits", Oxford University Press, 2009.
11. Roy Choudhury and Shail Jain, "Linear Integrated Circuits", 2nd Edition, New Age

    International Publishers, 2003

20HEV601 Vehicles Dynamics and traction systems

Pre-requisite Rigid Body Dynamics, Theory of Machines, Applied Mechanics

Course Objectives:

Course prepares students to

1. To understand the dynamics of a vehicle
2. To analyze forces on tires and select tires
3. To analyze the stability of a vehicle
4. To apply principles of vibration to select a suspension system

Course Outcomes:

Students will be able to

1. To understand the dynamics of a vehicle
2. To analyze forces on tires and select tires
3. To analyze the stability of a vehicle
4. To apply principles of vibration to select a suspension system

Unit 1 Introduction to vehicle dynamics: 6

Dynamics of the motor vehicle, Vehicle fixed coordinates system; Earth fixed coordinates system, Details of vehicle systems, wheel angles, and Typical data of vehicles.

Unit 2 Tires - 8

Types, axis system, mechanics of pneumatic tires-tire forces Tire forces and moments, Tire structure, Longitudinal, and Lateral force at various slip angles, rolling resistance, Tractive and cornering property of tire. Ride property of tires. Conicity and Ply Steer, Tire models, Estimation of tire-road friction.

Unit 3 Longitudinal dynamics: 8

Forces and moments on the vehicle, Equation of motion, Tire forces, rolling resistance, weight distribution, Tractive effort and Power available from the engine, Calculation of Maximum acceleration Braking torque, Braking Force, Brake Proportioning, Braking Efficiency, Stopping Distance, Prediction of Vehicle performance. ABS, stability control, Traction control.

Unit 4 Lateral Dynamics: 6

Steering geometry, Types of steering systems, Fundamental condition for true Rolling, Development of lateral forces. Steady state handling characteristics. Yaw velocity, Lateral Acceleration, Curvature response & directional stability.

Unit 5 Vertical Dynamics - 8

Human response to vibrations, Sources of Vibration, Suspension systems, Functions of the suspension system. Body vibrations: Bouncing and pitching. Doubly conjugate points. Body rolling. Roll center and roll axis, Stability against body rolling.

Total Lecture hours: 36 hours

Text Books:

1. Thomas D. Gillespie, "Fundamentals of Vehicle Dynamics", 2013, Society of Automobile Engineers Inc., ISBN: 978-1560911999
2. J. Y. Woung , "Theory of Ground Vehicles", John Willey & Sons, NY.
3. Rajesh Rajamani , "Vehicle dynamics and control", Springer publication.
4. J. G. Giles , "Steering, Suspension & Tyres", Ilete Books Ltd., London.
5. W. Steed , "Mechanics of Road Vehicles", Ilete Books Ltd. London.
6. P. M. Heldt , "Automotive Chassis", Chilton Co. NK.
7. Reza N Jazar , "Vehicle Dynamics : Theory and Application", Springer publication.
8. Automobile Mechanics, "Crouse/Anglin",TATA Mcgraw-Hill.
9. William H. Crouse., "Automotive Mechanics", Tata McGraw Hill Publishing House
10. Joseph Heitner, "Automotive Mechanics", C.B.S Publishers And Distributors
11. Hans Hermann Braess, Ulrich Seiffen, "Handbook of Automotive Engineering ", SAE Publications

20HEV502 Energy Storage System for EV

Pre-requisite

Chemistry, Thermodynamics

Course Objectives:

Course prepares students to

1. To calculate energy storage requirements for vehicle application
2. To understand various battery chemistry
3. To select and design LI battery thermal management system
4. To analyze a supercapacitor storage system
5. To select hydrogen fuel cell for an application

Course Outcomes:

Students will be able to

1. To calculate energy storage requirements for vehicle application
2. To understand various battery chemistry
3. To select and design LI battery thermal management system
4. To analyze a supercapacitor storage system
5. To select hydrogen fuel cell for an application

Unit 1 Fundamental: 8

Energy storage requirements for vehicle applications, Storage technologies and metrics for comparison, Distribution of Energy, Storage Form of Energy, Intermediary Conversion, Control and Diagnostic, Ragone Chart, Theory of Ragone Plots. Ragone Plot of a Battery

Unit 2 Battery Chemistry: 8

Nickel-Iron Battery Nickel–Cadmium, Ni-MH, Accumulators with Nonaqueous Electrolyte Lithium-Metals, Lithium-Metal Polymer Cells, Lithium-Ion Accumulator Lithium–Iron Phosphate (LFP) Cells, Lithium-ion Polymer (Li-Po) Cells, Lithium–Titanate Cells (LTO), Large Size Accumulators, Sodium–Sulfur (NaS) Battery, Vanadium Redox Flow Battery (VRB), Chemical Reactions of the VRB Battery.

Unit 3 BMS, Packing and Charging: 7

Battery Management Systems (BMS), Lithium-Ion Batteries Aging Effects. Battery characterization and testing systems, Thermal management & Battery life cycle, Modular battery packs, packaging, thermal control, Changing Systems and Infrastructure

Unit 4 Supercapacitors: 7

Materials and Construction, Basic Model, Specific Behavior of Supercapacitors, Design of a Super-capacitive Bank, Series and Parallel Connections, Power Capability, Charging and Discharging Procedure of Supercapacitors, Energy Efficiency and Power Availability Thermal Aspects

Unit 5 Hydrogen Fuel Cells: 6

Hydrogen Generation and Storage of Hydrogen, Conversion from Hydrogen to Electricity, Low and Medium Temperature Fuel Cells: AFC, PEMFC, AND PAFC, High-Temperature Fuel Cells: MCFC AND SOFC.

Total Lecture hours: 36 hours

Text Books:

1. Energy Storage by Robert A. Huggins, Springer Publication
2. Energy storage (A new approach) by Ralph Zito Wiley Publication
3. Handbook of Energy Audit, Albert Thumann P.E. CEM, William J. Younger CEM, The Fairmont Press Inc., 7th Edition.
4. Energy Management Handbook, Wayne C. Turner, The Fairmont Press Inc., 5th Edition,Georgia
5. . Energy Storage Systems, Alfred Rufer, CRC Press

20HEV501 EV System Design, Architecture and Integration

Pre-requisite Basics of Electrical and Mechanical Engineering

Unit-I Introduction to hybrid and electric vehicles:
Engineering case, legislative push, incentives, market pull. EV : micro to mild to PHEV to HEV to REEV to EV - Hybrid-Electric Vehicle Power trains, Vehicle Energy Storage System Design, System and sub-systems, Modelling and design of EVs as a system, Motors & motive power spilting concepts, and interface within power train system;

Unit 2 Power train architecture - 6
Parallel, Series and Combined, Types of EVs, Vehicle layout and packaging options, Energy devices & combinations, Duty Cycles in Indian cities; performance, Sustainability assessment, Industry Activity and Market Reaction, HEV market drivers and technology trends, Customer related issues, HEV technology readiness levels. Vehicle Based HEV Performance specifications.

Unit 3 Modelling of electrical and mechanical sub systems: 8
Systems Modelling and Simulation, Modelling methodologies for HEV energy management. Control strategies for energy management and driveability. High voltage architecture options within HEVs and component selection.

Unit 4 EV Systems Integration: 8
Vehicle Development Process Overview, Hybrid Components, and Architectures: Major components in hybrid Power Train, Controls Integration, Component sizing, and integration tradeoffs, System Design and Development Considerations, Vehicle integration (ex. performance, drivability, NVH), Power Train integration,

Unit 5 Verification, Validation and Standards: 8
Component test considerations, System test considerations, Fleet testing, Hybrid and electric vehicle component characteristics and key design attributes, Various standards related to EV

Total Lecture hours: 36 hours

Text Books:

1. Iqbal Husain, Electric and Hybrid Vehicles –Design Fundamentals, CRC Press
2. Mehrdad Ehsani, Yimin Gao, Sebastian E.Gsay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Celll vehicles-Fundamentals - Theory and Design", CRC Press
3. Bosch' Automotive Handbook, 8 th Edition

20IT 603L Object Oriented Software Engineering Laboratory

Teaching Scheme:
Practical: 2 hours/week
Tutorial: -

Examination Scheme:
In-Semester: 25 marks
Oral: 25 marks
Credits: 1

Prerequisites: Object oriented analysis and design laboratory

Course Objectives:
Familiarize students with

1. Various Object Oriented concepts along with their applicability contexts using agile development approach.
2. Various domain objects, their properties and relationships among them for given problem domain.
3. Modeling techniques to model different perspectives of object-oriented software design (UML)
4. Object oriented design solutions for the recurring problems

Course Outcomes:
Students should be able to

1. Identify use cases from project requirements.
2. Identify potential classes from use case specifications.
3. Design models using the UML notations.
4. Produce industry standard documentation from requirements analysis and design through testing and verification

Software engineering diagrams will be drawn based on some problem statement (Agile Approach)

1. Use-case Diagrams
2. Class Diagrams
3. Sequence Diagram
4. Activity Diagrams
5. Package Diagrams
6. Component Diagrams
7. Deployment diagrams
8. State Machine Diagrams

Text Books:

1. Bernd Bruegge & Allen H. Dutoit, "Object-Oriented Software Engineering", Third edition, Prentice Hall.

Reference Books:

1. Chris Sims and Hillary Louise Johnson, "Scrum: a Breathtakingly Brief and Agile Introduction", Dymaxicon. ISBN-13: 978-1937965044

20OE 601F Open Elective II: Design Thinking

Teaching Scheme:
Lectures: 3 hours/week
Tutorial: -

Examination Scheme:
In-Semester: 50 marks
End-Semester: 50 marks
Credits: 3

Prerequisites: -

Course Objectives:
Familiarize students with

1. Design thinking process
2. User centric approach for designing a solution
3. Problem analysis with various methods
4. Applications of Design Thinking

Course Outcomes:
Students should be able to

1. Analyze problems with various methods
2. Recommend a solution based on empathy, ideation, prototyping, and playful testing
3. Apply design thinking methods to generate innovative and user centric solutions
4. Test designed prototypes to reduce risks and accelerate organizational learning

Unit – I: Design and Design Problems **8 Hours**

What is Design? The components of design problems; measurement, criteria and judgement in design

A model of design problems – Defining problems: Selecting goals and diverse teams, creating a unified vision and scope, mapping stakeholders and personas; Analysing design problems, generators of design problems, roles of generators, design constraints

Unit II: Design Solutions **8 Hours**

Solutions to Design Problems: Designer's response: procrastination, non-committal design and throw away design, design problems and solutions

Design Process: define, search, ideate, prototype, select, implement, learn, Refresher and restate the challenge, getting inspiration, understanding innovation ambition, Solution ideation, Narrowing solution choice, Solution evaluation, Road map

Unit III: Design Thinking **9 Hours**

Types and Styles of Thinking – theories of design, types of thinking; creative thinking - what is creativity? creativity in design, Principles of design thinking

Unit IV: Design Philosophies and Strategies **9 Hours**

Theory and practice, three early phases of working on the same problem

Prototype Creation: Choosing a prototype approach, user interface prototypes, applications vs custom build, reference architectures, prototype and solution evaluation

Unit V: Design Tactics and Traps **8 Hours**

Methods and Tactics, understanding the problem, the model of problems, One or many solutions? Common traps and ways of avoiding them

Text Books:

1. Bryan Lawson, "How designers think: The design process demystified", 2nd Edition, Butterworth Architecture
2. Nigel Cross, "Design Thinking", Berg Publishers - 2011

Reference Books:

1. Ben Crothers, "Design Thinking Fundamentals", O'Reily
2. Tim Brown, "Change by Design: How Design Thinking Transforms Organizations", HarperCollins – 2009

1. Susan Weins Chenk, "Hundred things every designer needs to know about people", New Riders Publication
2. Vijay Kumar, "101 Design Methods: A Structured Approach for Driving Innovation in Your Organization", Wiley Publication
3. Roger L. Martin, "Design of Business: Why Design Thinking is the Next Competitive Advantage" Harvard Business Press
4. Karl Ulrich, "Design: Creation of Artifacts in Society" - 2011
5. Bala Ramadurai, "Karmic Design Thinking"
6. T. Amabile, "How to kill creativity", SAGE Publication - 2006
7. William Lidwell, Kritina Holden, Jill Butler, "Universal principles of Design ", Rockport Publishers
8. Bella Martin, Bruce Hanignton, Bruce M Hanington "Universal methods of design", Rockport Publishers - 2012
9. Roman Kizanie, "Empathy: Why it matters, how to get it", TarcherPerigee Publishers
10. Karla McLaren, "The Art of Empathy: A complete Guide to life's most essential skill", Sounds True Publishers

20IT 603 Object Oriented Software Engineering

Teaching Scheme:
Lectures: 3 hours/week
Tutorial: 1 hour/week

Examination Scheme:
In-Semester: 50 marks
End-Semester: 50 marks
Credits: 4

Prerequisites: Object oriented analysis and design laboratory

Course Objectives:
Familiarize students with
1. Basic concepts of object oriented software engineering and process models.
2. Requirements elicitation and analysis activities.
3. Concepts of system and object design.
4. Software coding and testing techniques.

Course Outcomes:
Students should be able to
1. Choose appropriate software development process models for real life projects.
2. Analyze requirements with use cases.
3. Develop design models using the UML notations.
4. Apply appropriate coding and testing methods according to requirements.

Unit – I: Introduction to Software engineering **7 Hours**
Software life cycle, Processes and activities, Life cycle models: Sequential activity-centered models, Iterative activity-centered models, Entity centered models, Agile Process, Principles, Extreme programming, XP values, XP process, Industrial XP, Scrum

Unit – II: Requirements gathering and analysis **7 Hours**
Requirement elicitation, functional and nonfunctional requirements, Elicitation activities, identifying actors, scenarios, use-cases, refinement, Requirements analysis concept, Analysis Object Models and Dynamic Models, Entity, Boundary, and Control Objects, Generalization and Specialization, Analysis Activities: From Use Cases to Objects, Requirement Analysis document

Unit – III: System Design **7 Hours**
System Design Concept, Subsystem and classes, Services and Subsystem Interfaces, Coupling and Cohesion, Layers and Partitions, Architectural Styles, System Design Activities: From Objects to Subsystems, addressing design goals.

Unit – IV: Object Design **7 Hours**
Reuse concepts: Solution Objects, Inheritance, and Design Patterns, reuse activities: Selecting Design Patterns and Components, managing reuse, Specifying interface, interface specification, interface specification activities, managing object design.

Unit – V: Construction **7 Hours**
Mapping models to code, overview of mapping, mapping concept, Model transformatior Refactoring, Forward and reverse engineering, mapping activities, mapping implementation

Unit – VI: Software Testing **7 Hours**

Overview of testing, testing concepts, Faults, Erroneous States, and Failures, test cases, Test Stubs and Drivers, testing activities, component inspection, usability testing, unit testing, integration testing, system testing, managing testing

Text Books:

1. Bernd Bruegge & Allen H. Dutoit, 'Object-Oriented Software Engineering', Third edition, Prentice Hall.
2. Roger S. Pressman, 'Software Engineering: A practitioner's approach', McGraw Hill

Reference Books:

1. Pankaj Jalote, 'An integrated approach to Software Engineering', Springer/Narosa.
2. Ian Sommerville, 'Software Engineering', Addison-Wesley.
3. Schwaber, K. and Beedle, M. (2001)., 'Agile Software Development with SCRUM', New Jersey:Pearson. [ISBN - 9780130676344]

20IT 502L Design and Analysis of Algorithm Laboratory

Teaching Scheme:
Practical: 2 hours/week

Examination Scheme:
In Semester: 25 Marks
Practical: 25 marks
Credits: 1

Prerequisites: Data Structures

Course Objectives:
Familiarize students with
1. Basics of computational complexities.
2. The space and time requirements of the algorithms.
3. The various algorithmic design techniques.
4. The categorization of the given problem for finding an appropriate solution.

Course Outcomes:
Students should be able to
1. Apply algorithmic strategy for solving a given problem.
2. Develop the code for the algorithm such as sorting, minimum spanning tree, etc.
3. Analyze computational complexity of the algorithms.
4. Test the code for multiple inputs.

List of Laboratory Assignments (Minimum 4 assignments**)**

1. Write a program to implement an algorithm using Brute Force method or Exhaustive search approach.(For e.g Sorting techniques or Password cracking)
2. Write a program to implement a program using the Divide and Conquer approach (for e.g, Quick, Merge sort, Binary search, Strassen's method).
3. Write a program to implement an algorithm using Greedy method. (for e.g Prims, kruskals, knapsack problem).
4. Write a program to implement an algorithm using Dynamic Programming also verify the complexity. (for e.g Chain matrix multiplication, Bellman-Ford Algorithm, Multistage Graph problem, Optimal Binary Search Trees, Travelling Salesman Problem)
5. Write a recursive program to find the solution using Backtracking approach. (n queens, Graph coloring, Hamiltonian Cycle, 0/1 Knapsack Problem).
6. Write a program to find the solution using Branch and Bound approach (0/1 Knapsack problem – LC branch and bound and FIFO branch and bound solution, Traveling sales person problem, Job scheduling Problem).

Text Books:
1. Thomas H Cormen and Charles E.L Leiserson, Introduction to Algorithm, PHI, ISBN: 81-203-2141-3.
2. S. Sridhar, Design and Analysis of Algorithms, Oxford, ISBN 10: 0-19-809369-1.

Reference Books:

1. Horowitz and Sahani, Fundamentals of computer Algorithms, Galgotia, ISBN 81-7371-612-9.
2. R. C. T. Lee, SS Tseng, R C Chang, Y T Tsai, Introduction to Design and Analysis of Algorithms, A Strategic approach, Tata McGraw Hill, ISBN-13: 978-1-25-902582-2. ISBN-10: 1-25-902582-9.
3. Anany Levitin, Introduction to the Design & Analysis of Algorithm, Pearson, ISBN 81-7758-835-4.
4. Gilles Brassard, Paul Bratle, Fundamentals of Algorithms, Pearson, ISBN 978-81-317-1244-3.

20PEIT 502A Blockchain Architecture Design and Use Cases

Teaching Scheme:
Lectures: 3 hours/week

Examination Scheme:
In-Semester: 50 marks
End-Semester: 50 marks
Credits: 3

Prerequisites: Basics of programming, software engineering

Course Objectives:
Familiarize students with
1. Blockchain technology landscape
2. Bitcoin blockchain
3. Ethereum and smart contract
4. Hyperledger

Course Outcomes:
Students should be able to
1. Explain Blockchain technology landscape
2. Apply applications and implementation strategies of Blockchain
3. Make use of Blockchain in real life applications.
4. Evaluate security, privacy, and efficiency of a given blockchain system

Description:

The widespread popularity of digital cryptocurrencies has led the foundation of Blockchain, which is fundamentally a public digital ledger to share information in a trustworthy and secure way. The concept and applications of Blockchain have now spread from cryptocurrencies to various other domains, including business process management, smart contracts, IoT and so on. This course will cover both the conceptual as well as application aspects of Blockchain. This includes the fundamental design and architectural primitives of Blockchain, the system and the security aspects, along with various use cases from different application domains. us other domains, including business process management, smart contracts, IoT and so on.

The course will cover following topics:

Introduction to Blockchain, Basic Crypto Primitives, Bitcoin Basics Distributed Consensus, Consensus in Bitcoin, Permissioned Blockchain (Basics, Consensus, RAFT Consensus, Byzantine General Problem, Practical Byzantine Fault Tolerance), Blockchain for Enterprise – Overview, Blockchain Components and Concepts, Hyperledger Fabric – Transaction Flow, Hyperledger Fabric Details, Fabric – Membership and Identity Management, Hyperledger Fabric Network Setup, Fabric Demo on IBM Blockchain Cloud, Hyperledger Composer – Application Development, Network Administration, Blockchain in Financial Service, Revolutionizing Global Trade, Blockchain in Supply Chain, Blockchain in Government Blockchain Security, Comparing Ecosystems – Ethereum development tools and Quorum

Suggested Swayam Course:
"Blockchain Architecture Design and Use Cases", by Prof. Sandip Chakraborty, IIT, Guwahati
https://onlinecourses.nptel.ac.in/noc19_cs63/course

Reference Books:

1. Andreas M. Antonopoulos, "Mastering Bitcoin: Unlocking Digital Cryptocurrencies", 1st Edition
2. Melanie Swa, "Blockchain", O'Reilly
3. Bob Dill, David Smits, "Zero to Blockchain - An IBM Redbooks course"