Curriculum for PG Degree Course in MTech. Computer Engineering

(Academic Year: 2024-25 Onwards)

First Year | Semester-II

Course Code	Course Title	Teaching Scheme Hours / Week			Cr	Examination Scheme			Total Marks
		L	T	P		ISE	ESE	Pr/Or	
24PCMCE201	Cross Platform Application Development	3	0	0	3	50	50	0	100
24PCMCE202	Advanced Algorithms	3	0	0	4	50	50	0	100
24PCMCE203	Deep Learning Architectures and Design	3	0	0	3	50	50	0	100
24PEMCE201	Programme Elective-II	3	0	0	3	50	50	0	100
24PEMCE202	Programme Elective-III	3	0	0	3	50	50	0	100
24PCMCE201L	Cross Platform Application Development Laboratory	0	0	2	1	25	0	0	25
24PCMCE202L	Advanced Algorithms Laboratory	0	0	2	1	25	0	0	25
24PCMCE203L	Deep Learning Architectures and Design Laboratory	0	0	4	2	25	0	25	50
24PEMCE201L	Programme Elective-II Laboratory	0	0	2	1	25	0	25	50
	Total	**15**	**0**	**10**	**20**	**325**	**250**	**50**	**650**

24PEMCE201 Programme Elective-II	24PEMCE202 Programme Elective-III
A. Cyber Physical Systems B. High Performance Computing C. Immersive Technologies	A. Blockchain Technology B. Generative AI C. e-Business

- **Students who exit at the end of 1st year shall be awarded a Postgraduate Diploma.**

APPROVED BY
Secretary Academic Council
MKSSS's Cummins College of Engineering
For Women, Pune-411052

M.K.S.S.S. Cummins college of Engg. for Women KARVENAGAR Pune -52

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MKSSS's Cummins College of Engineering
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Curriculum for PG Degree Course in MTech. Computer Engineering
(Academic Year: 2024-25 Onwards)
First Year | Semester-II

24PCMCE201 CROSS PLATFORM APPLICATION DEVELOPMENT

Teaching Scheme
Lecture: 3 Hrs/week

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

Course Objectives
To facilitate the learner to

1. Understand and appreciate the need for cross platform-based application development in today's world.
2. Learn the basic constructs of Dart programming language.
3. Gain knowledge about the Flutter framework for cross platform-based application development in practice.
4. Get exposure to modern applications and emerging trends in real world application development.

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

1. Examine various facets of typical end-to-end application development, tools and technologies to understand the need for cross platform-based solutions.
2. Utilize various constructs of Dart programming language in building applications.
3. Make use of various concepts of Flutter framework for application development.
4. Examine various types of modern applications and emerging trends to realize cross platform-based development and deployment.

UNIT I: End-to-end Application Development

Platforms, Native applications, Cross platform applications -Advantages and Challenges, Typical end-to-end application structure, Application needs/dependencies, Technologies, Tools; Android and iOS platform architecture characteristics, Frameworks for cross platform application development, Introduction to Dart and Flutter.

UNIT II: Dart Programming

Variables and data types, Control flow and functions, Classes, Inheritance and exceptions, Collections, Asynchronous programming, Streams, Various Coding principles.

UNIT III: Flutter Framework

Architecture of the framework, Platform channel, Hot reload, Widgets and States, Builds,
User Interfaces (UIs) - Material, Forms, Layouts, themes; State management, Routes and navigation.

UNIT IV: Backend for Flutter

Local data persistence with JSON, HTTP requests and REST API calls.
Flutter and Node.js, Flutter and MongoDB.

UNIT V: Modern Applications and Trends

Web applications, Mobile applications, Cross platform applications, Cloud native applications, Serverless applications, Microservices architecture and containers, DevOps, Serverless architecture, Cloud based architecture, Case studies.

Text books:

1. Alberto Miola, 'Flutter Complete Reference', (2020), ISBN 979-8691939952
2. Sam Newman, 'Building Microservices -Designing fine grained systems', O'Reilly, (2021), ISBN: 9781492034025

Reference books:

1. Marko Nepoli, 'Beginning Flutter: A Hands On Guide to App Development', Wiley, (2019), ISBN 978-1-119-55082-2
2. Eric Windmill, 'Flutter in Action', Manning, (2019), ISBN: 978-1617296147

Web References:

1. https://www.techtarget.com/searchmobilecomputing/definition/cross-platform-mobile-development
2. https://fullscale.io/blog/what-is-cross-platform-app-development/

3. https://docs.flutter.dev/
4. https://www.ibm.com/blog/four-architecture-choices-for-application-development/
5. https://www.mongodb.com/compatibility/flutter-and-mongodb

24PCMCE201L CROSS PLATFORM APPLICATION DEVELOPMENT LABORATORY

Teaching Scheme
Practical: 2 Hrs/week

Examination Scheme
In Semester: 25 marks
Credits: 1

Course Objectives
To facilitate the learner to

1. Understand the Installation and Configuration setting related aspects of, integrated development environments (IDEs), various frameworks and libraries in the development of cross platform-based applications.
2. Understand the role of various cross platform technologies used for real-life application development.
3. Learn the basic concepts of Flutter framework and Dart programming language.
4. Gain knowledge about the Node.js and MongoDB for cross platform-based application development in practice.

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

1. Make use of Flutter framework and Dart programming for User Interface (UI) development of an application.
2. Experiment with a platform channel to connect with the native application.
3. Make use of REST APIs in Flutter to integrate with the server.
4. Experiment with cross-platform technologies and tools like Node.js and MongoDB for application development.

Suggestive List of Assignments:

Students will design and develop a typical web/mobile application (Mini project) using Flutter User Interface (UI) framework, Node.js and MongoDB. Students will be encouraged to broadly implement the following set of assignments incrementally which will eventually result into the integrated end-to-end sample application.

1. Setting up of an environment: IDEs like Visual Studio (VS) code, Software Development Kits (SDKs), Libraries.

2. Develop user interface using various widgets such as Forms and buttons with Flutter and Dart.
3. Implement Navigation aspects to connect various pages/screens in Flutter.
4. Design and implement Layout for various pages/screens in Flutter.
5. Implement Platform channel to integrate Flutter UI with backend Java Android app.
6. Implement REST API in Flutter to send/retrieve data to/from the server.
7. Implement server-side logic using Node.js and server-side java script.
8. Create database in MongoDB and integrate it with Flutter to add, retrieve, update and delete data.

24PCMCE202 ADVANCED ALGORITHMS

Teaching Scheme
Lecture: 3 Hrs/Week

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

Course Objectives
To facilitate the learners to

1. Understand significance of analysis of algorithms.
2. Learn and apply algorithmic strategies for designing the algorithms.
3. Learn and apply the concept of advanced algorithms for various application domains.
4. Get acquainted with computational complexity of advanced algorithms.

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

1. Utilize the knowledge of algorithm analysis for performance measurement.
2. Choose standard algorithm design techniques for problem solving.
3. Make use of advanced algorithm concepts for sorting, policy making.
4. Examine the complexity of real-world problems with respect to algorithmic efficiency.

UNIT I : Introduction to Algorithms Design Paradigms

Overview and importance of algorithms, Stages of algorithm development, identifying suitable algorithms design paradigm - Greedy, Divide and Conquer technique, Dynamic programming, Backtracking, Brand and Bound technique

UNIT II : Information Retrieval Algorithms

Terminologies and concepts of Information Retrieval, Retrieval models - Boolean, Vector space, Probabilistic models, Citation/Link analysis models. Latent semantic indexing. Retrieval algorithms: inverted index; TF-IDF, (Term Frequency-Inverse Document Frequency) stopping and stemming.

UNIT III : Geometric Algorithms and Randomized Algorithm

Significance of Geometric algorithms. Convex Hull finding Algorithms, Graham's Scan, Jarvis March Algorithms, Randomized quick sort algorithms, Complexities of Geometric algorithms, Applications of Geometric and Randomized Algorithm in Geometric Information System and Robotics

UNIT IV : Global Optimization Algorithms

Introduction of Global optimization, Gradient Descent, Simulated Annealing, Genetic Algorithms, Particle Swarm Optimization.

UNIT V : Reinforcement learning based Algorithms

Policy based Algorithms, Evaluating agent performance by a reward function, Value based Algorithms for managing trade off between exploration and exploitation, Time complexity and Applications of Reinforcement learning algorithms

Text Books:

1. Thomas H Cormen and Charles E.L Leiserson, "Introduction to Algorithm", 3rd edition, 2009, PHI
2. Christopher D. Manning, Prabhakar Raghavan and Hinrich Schütze, Introduction to Information Retrieval, Cambridge University Press. 2008.
3. Mahmoud Parsian, "Data Algorithms", O'Reilly, ISBN: 10 1491906189
4. R. Horst, P.M. Pardalos and N.V. Thoai, "Introduction to Global Optimization", Kluwer Academic Publishers, 2001, ISBN: 0-7923-6756-1 (2nd edition).

Reference Books:

1. David Edward Goldberg," Genetic Algorithms in Search, Optimization and Machine Learning", Addison-Wesley, 0201157675, 9780201157673
2. Rajiv Motwani, Prabhakar Raghvan,"Randomized Algorithms", Cambridge university Press, ISBN - 978-0521474658

Web References :

1. https://smartlabai.medium.com/reinforcement-learning-algorithms-an-intuitive-overview-904e2dff5bbc
2. https://tfocs.iiitb.ac.in/2021/Intro%20to%20Online.pdf
3. https://assets.cambridge.org/97810093/49185/frontmatter/9781009349185_frontmatter.pdf

24PCMCE202L ADVANCED ALGORITHMS LABORATORY

Teaching Scheme
Practical: 2 Hrs/week

Examination Scheme
In Semester: 25 marks
Credits: 1

Prerequisite: Algorithm Fundamentals

Course Objectives
To facilitate the learners to

1. Learn, apply and analyze algorithmic techniques required for problem solving.
2. Develop the practical skills of advanced algorithms design paradigms
3. Understand the processes of applying advanced algorithms with the help of suitable applications.
4. Learn the skills required for analysis of problems belonging to diversified domains

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

1. Experiment with various algorithmic techniques
2. Solve problems involving advanced algorithms design paradigms
3. Make use of advanced algorithm concepts for finding solutions to problems
4. Examine the complexity of real-world problems with respect to algorithmic efficiency.

There have been several notable advancements and trends in advanced algorithms that are shaping various fields and benefiting engineering post graduate students. These advancements are helping engineering students by providing them with the tools and techniques to tackle complex problems across various domains. By learning and applying these algorithms, students can develop innovative solutions, enhance computational efficiency, and drive advancements in technology and science. Additionally, understanding advanced algorithms equips students with valuable skills sought after by industries ranging from tech giants to startups across the globe.

Suggestive List for Laboratory Assignments:

1. Implement the solutions for the given problems using suitable algorithmic strategies
    1. Knapsack problem
    2. Traveling salesman problem
    3. Queens placement problem
2. Given two vectors - Document and Query, Calculate cosine similarity angle between two vectors.

3. A 2-D Convex Hull Problem Convex Hull Problem: Given: A set of points P in the plane. Find the smallest, convex polygon containing all points in P using
    1. Divide and Conquer algorithm
    2. Jarvis' Algorithm (Wrapping)
    3. Graham Scan (Sorting counter-clockwise wrt to leftmost point) algorithm

    Compare the algorithmic complexity of these algorithms.
4. Implementing the Random Quick Sort algorithm to efficiently sort a given array of integers in non-decreasing order.
5. Implement Combinatorial Optimization Strategies for
    1. Traveling Salesman Problem
    2. Job Scheduling Problem
    3. Knapsack Problem

    Compare the algorithmic complexity of these algorithms.

24PCMCE203 DEEP LEARNING ARCHITECTURES AND DESIGN

Teaching Scheme
Lectures: 3 Hrs / Week

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

Prerequisites: Python Programming, Machine Learning concepts.

Course Objectives
To facilitate the learners to

1. Understand Artificial Neural Network and its models
2. Understand Convolutional and Recurrent Neural Networks architecture and applications
3. Understand Deep Reinforcement Learning and Transformer models to real time problems
4. Understand use of Deep Learning techniques for selected objectives

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

1. Construct Artificial Neural Network models for prediction.
2. Make use of various concepts of Deep Learning models to solve simple problems
3. Analyze varied data using Deep Learning models
4. Compare Artificial Neural Network and Deep Learning techniques for selected objectives

UNIT I : Artificial Neural Network

Biological Neuron, McCulloch-Pitts Neuron, Perceptron Training and testing, Classification and regression models, Multiclass Perceptron model, Multi layer Perceptron(MLP), back Propagation in MLP, Autoencoder, Applications, Case study: Classification, Regression

UNIT II: Convolutional Neural Networks

Deep Learning and Deep Neural Networks, Convolutional Neural Networks (CNN), CNN Backpropagation, AlexNet, ZFNet, VGG, GoogLeNet, ResNet, Applications of CNN: Image Classification, Object Localization, Content-Based Image Retrieval, Case study: Image Classification and Segmentation

UNIT III : Recurrent Neural Networks

Working with Text data, Recurrent Neural Networks(RNN), Backpropagation Through Time(BPTT), Bidirectional RNN, Multilayer RNN, Long Short-Term Memory (LSTM), Gated Recurrent Units (GRUs), Applications of RNN/LSTM/GRU: Sentence-Level Classification / Time-Series Forecasting and Prediction. Case study: Automatic Image Captioning

UNIT IV: Deep Reinforcement Learning

Introduction to Reinforcement Learning (RL), Framework of RL, Markov Decision Processes (MDP), Neural Network for RL, Q-Learning and Deep Q-Networks, Applications of RL and Deep RL, Case study: Game designing using RL and Deep RL

UNIT V: Advances in Deep Learning

Introduction to Generative Adversarial Networks (GANs), Attention-based models, Auto-encoders, Transformer, Transformer Architectures, Transformer Architecture for Tabular Data, Applications: Using GANs for Generating Image Data, Transformers for Computer Vision, Regression and Classification for Tabular Data, Case study: BERT/ GPT

Text Books:

1. Charu C. Aggarwal, "Neural Networks and Deep Learning", ISBN 978-3-319-94462-3 ISBN 978-3-319-94463-0 (eBook) https://doi.org/10.1007/978-3-319-94463-0, Springer International Publishing
2. Shekhar Khandelwal, "Deep Learning for Data Architects", ISBN: 9789355515391 BPB Publication, eISBN: 9789355515292, Publishing Date: 16th Aug 2023,
3. Valentino Zocca, Gianmario Spacagna, Daniel Slater, Peter Roelants, "Python Deep Learning", Packt Publishing, ISBN 9781786460660, 2017

Reference Books:

1. Nikhil Baduma, Nicholas Locascio, "Fundamentals of Deep Learning: Designing Next Generation intelligence Alogrithms", O'Reilly Publication, ISBN 10: 9352135601 , ISBN 13: 978- 9352135608, 2017
2. Josh Patterson and Adam Gibson, "Deep Learning – A Practitioner's approach", O'Reilly Publication, 1st edition, ISBN : 9789352136049, 2017
3. S.N. Sivanandam, "Principles of Soft Computing", Wiley India- ISBN- 9788126527410, 2008, Second Edition,
4. Mohan Kumar Silaparasetty, "Beginning with Deep Learning using TensorFlow", BPB Publication, ISBN: 9789355510471, eISBN: 9789355510488, Publishing Date: February 2022

5. Ivan Gridin, "Practical Deep Reinforcement Learning with Python", ISBN: 9789355512055, eISBN: 9789355512062, BPB Publication, Publishing Date: 15th July 2022
6. Ian Goodfellow and Yoshua Bengio and Aaron Courville, "Deep Learning", MIT Press Ltd. ISBN:9780262035613, 0262035618, 2016
7. François Chollet, "Deep Learning with Python", Manning Publications Co., ISBN 9781617294433, 2017

Online/Web/Other References:

1. Transformer model architecture
   The Ultimate Guide to Transformer Deep Learning (turing.com)
2. NPTEL: Deep Learning - IIT Ropar
3. Building a Tic-Tac-Toe Game with Reinforcement Learning in Python: A Step-by-Step Tutorial (plainenglish.io)

24PCMCE203L DEEP LEARNING ARCHITECTURES AND DESIGN LABORATORY

Teaching Scheme
Practical: 4 Hrs/ Week

Examination Scheme
In Semester: 25 Marks
End Semester: 25 Marks
Credits: 2

Course Objectives
To facilitate the learners to

1. Understand tensorflow/ Keras libraries Deep Neural Networks
2. Demonstrate Convolutional and Recurrent Neural Networks architecture for selected applications
3. Understand Deep Reinforcement Learning and Transformer models for selected problems
4. Choose appropriate Deep Learning techniques for selected objectives

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

1. Apply tensorflow constructs to simple mathematical problems and Artificial Neural Network models for small toy problems
2. Build Artificial Neural Network and Deep Neural Network models
3. Analyze Artificial Neural Network and Deep Neural Network models for selected data
4. Compare accuracy and behaviour of Deep Learning models for selected objectives

Suggested List of Laboratory assignments:

Implement at least 8 assignments that will cover Deep Learning models that you have studied .

1. Experiment with Numpy, Pandas, reading writing data to and from different file formats, Pandas profiling
2. Build and analyze Neural Network model using one and two hidden layers for classification problems such as Digit classification
3. Develop Neural Network regression model predicting price of house and identify accuracy using confusion metrics
4. Implement Convolutional Neural Network(CNN) to classify handwritten digits images and evaluate the model using a confusion matrix.
5. Compare pre trained CNN models for Object detection for Animal Data set
6. Select suitable CNN model for Image segmentation using Data set such as Oxford-IIIT Pet) . validate model using Jaccard Index
7. Experiment with NLTK tokenizer, Word2Vec, character based embedding, downloading and preprocessing sequential data.

8. Implement simple RNN for a short sequence of characters and predict the next character. Find accuracy for the same.
9. Implement RNN / LSTM IMDB movie-review-classification problem. validate the model with precision, recall, and F1 score
10. Implement transformer model for selected application and validate it using ROUGE (Recall-Oriented Understudy for Gisting Evaluation) score.
11. Implement encoder-decoder model for image data/sequential data and compare the model performance with already implemented model
12. Implement Deep Learning model for selected application and compare the results with existing literature.

24PEMCE201A CYBER PHYSICAL SYSTEMS

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. Analyze the architecture and components of Cyber Physical System (CPS)
2. Design and develop CPS applications for different domains
3. Apply principles of real-time computing and control in CPS design
4. Develop an exposition of the challenges in implementing CPS from a computational perspective

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

1. Develop the ability to interact with CPS
2. Designing a CPS for given applications
3. Develop the ability to integrate CPS protocols
4. Analyse common methods used to secure CPS

UNIT I: Introduction to Cyber Physical Systems

Embedded Systems, Communications Model, Machine-to-Machine(M2M), IoT Terms and Basic Definitions, Characteristics Enabling Technologies in IoT, Sensors, Edge Devices, Wireless Sensor Networks, Cloud Computing, CPS in Real world, Basic Principle, Industry 4.0, IIoT, CPS System requirements, Design Recommendations

UNIT II: Cyber Physical System Platforms

Hardware platforms for CPS (Sensors/Actuators, Microprocessor/Microcontrollers), Technology Platforms in CPS, Wireless Technologies for CPS

UNIT III: Cyber Physical System – Models and Dynamic Behaviours

Control Systems - Feedback control systems, Open and Closed loop, Human in the loop predictive model-based control systems, Continuous dynamics, Discrete dynamics, Hybrid systems, Compare Embedded systems, Internet of Things, CPS

UNIT IV: Concurrent Models of Computation

Structure of models, Synchronous reactive models, Dataflow models of computation, Timed models of computation

UNIT V: Security and Privacy in Cyber Physical Systems

Security and Privacy Issues in CPS, Local Network Security for CPSs, Security and Privacy for Cloud-Interconnected CPSs, Case Studies-Smart Energy Grids, Automotive CPS, VANET, Automatic cruise control, Robot Interaction in a cloud environment, Healthcare applications of CPS, Cybersecurity in Digital Manufacturing/Industry 4.0.

Textbooks:

1. Rajeev Alur, "Principles of Cyber Physical Systems", MIT Press, 2015
2. E. A. Lee, Sanjit Seshia, "Introduction to Embedded Systems – A Cyber–Physical Systems Approach", Second Edition, MIT Press, 2017, ISBN: 978-0-262-53381-2.
3. Srinivasa K G, Siddesh G.M, Hanumantha Raju R, "Internet of Things", CENGAGE, 1st Edition, 2017

Reference Books:

1. Guido Dartmann, Houbing song, Anke Schmeink, "Big data analytics for Cyber Physical System", Elsevier, 2019.
2. Houbing song, Danda B Rawat, Sabina Jeschke, Christian Brecher, "Cyber Physical Systems Foundations, Principles and Applications", Elsevier, 2017.
3. Chong Li, Meikang Qiu, "Reinforcement Learning for Cyber Physical Systems with Cyber Securities Case Studies", CRC press, 2019
4. Houbing Song, Glenn A Fink, Sabina Jesche, "Security and Privacy in Cyber-Physical Systems: Foundations, Principles and Solutions", IEEE Press.

Online/Web/Other References:

1. Coursera course, Cyber Physical system modelling
   https://www.coursera.org/learn/cyber-physical-systems
2. https://onlinecourses.nptel.ac.in/noc23_cs62/preview

24PEMCE201AL CYBER PHYSICAL SYSTEMS LABORATORY

Teaching Scheme
Practicals: 2 Hours / Week

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

Course Objectives
To facilitate the learner to

1. Study the basic concepts, requirements, principles, and techniques in emerging Cyber Physical Systems (CPS)
2. Provide students hands-on experience in prototyping a CPS
3. Address real-world problems through CPS
4. Provide students of different disciplinary background with necessary knowledge to understand the fundamentals of CPS

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

1. Develop an interface between CPS Components
2. Design a CPS to realize a product in real life environment
3. Develop the ability to integrate CPS protocols
4. Analyse common methods used to secure CPS

Suggested List of Assignments:

1. Setting up Raspberry-pi and Arduino interface for building a CPS
2. Working with sensors through an I/O Interface
3. Building a CPS model for maintaining room temperature
4. Hands on exercises using simulation tools to model simple CPS scenarios, such as traffic light control systems
5. Building a CPS model for Adaptive cruise control in vehicle
6. Building an effective security system for a CPS
7. Building IoT based communication model for connecting devices
8. Application development and cloud interface for building a CPS

9. Building a CPS Model using Matlab
10. Building Line-follower robot using Raspberry-pi

24PEMCE201B HIGH PERFORMANCE COMPUTING

Teaching Scheme
Lecture: 3 Hrs/week

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

Prerequisites: Operating Systems, Microprocessor Architecture

Course Objectives
To facilitate the learners to

1. Understand the various aspects of parallel processing.
2. Familiarize with concepts of Shared Address Space , Accelerating Memory and learn programming using OpenMp,CUDA programming
3. Understand the communication paradigms in distributed address space using MPI.
4. Apply the parallel programming concepts to various algorithms
5. Understand the advanced trends and techniques in High Performance Computing.

Course Outcome
By taking this course, students will be able to

1. Make use of various parallel programming paradigms to design solutions.
2. Make use of parallel programming constructs for Shared Address Space Platform.
3. Make use of parallel programming constructs for Message Passing.
4. Apply parallel programming concepts to various algorithms.
5. Summarize the advanced techniques in Parallel Computing.

UNIT I : Introduction to Parallelism

Need of High performance computing(HPC), Parallel Processing Concepts, HPC Cluster Architecture, Processor Architecture, HPC Topologies, Parallelization Paradigms, Levels of parallelism, Performance Metrics and Benchmarking

UNIT II: Shared Memory Programming Model

Shared Address Memory model, OpenMP Programming Model, OpenMP- Scope of data variables, Work sharing loops, Synchronization Constructs, sections, "sentinels" and pragmas; ; PyOMP constructs

UNIT III : Parallel Communication

Basic communication operations, Point-to-point Communication, Collective communication, Topologies and embeddings, Groups and Computators, Parallel IO ; SLURM batch system

UNIT IV: Accelerating Memory Computation

GPGPU introduction, CUDA Architecture, Managing GPU memory, Synchronization, Optimizing CUDA applications, Profiling;
Introduction to OpenACC, Data Management, Loop Optimizations with OpenACC

UNIT V : Designing Parallel Algorithm

Fundamental Design Issues in Parallel Computing, Fundamental Limitations Facing in Parallel Computing; Dense matrix algorithms, Quick Sort, Graph algorithms, Dijkstra's algorithm, Linear equations

UNIT VI :Recent Trends in Parallel Processing

HPC applications, Exascale computing, Quantum Computing; Grid Computing, Case study of Supercomputer - Param Utkarsh

Text books:

1. Peter Pancheco, "An Introduction to Parallel Programming",Elsevier (2011) *Morgan Kaufmann Publishers(First edition)(2019) ISBN:*
2. Ananth Grama, Anshul Gupta, George Karypis, and Vipin Kumar, "Introduction to Parallel Computing", *Addison-Wesley (India)(Second edition)(2003)*, ISBN: 0-201-64865-2.

Reference Books:

1. David Culler Jaswinder Pal Singh, 'Parallel Computer Architecture: A hardware/Software Approach', *Morgan Kaufmann Publishers (India)(1999)*, ISBN 978-1-55860-343-1.
2. Kai Hwang, 'Scalable Parallel Computing', *McGraw Hill (1998)*, ISBN:0070317984.

3. Shane Cook, 'CUDA Programming: A Developer's Guide to Parallel Computing with GPUs', *Morgan Kaufmann Publishers Inc.(2013)* ISBN: 9780124159884.
4. Jason sanders, Edward Kandrot, 'CUDA by Example', *Addison-Wesley*, ISBN-13: 978-0-13-138768-3.

Web references:

1. https://onlinecourses.nptel.ac.in/noc20_cs41/preview
2. https://nptel.ac.in/courses/106108055
3. https://www.digimat.in/nptel/courses/video/106104120/L01.html
4. https://paramutkarsh.cdac.in/wp-content/uploads/2022/05/PARAM_Utkarsh_User_Manual-v3.0-1.pdf

24PEMCE201BL HIGH PERFORMANCE COMPUTING LABORATORY

Teaching Scheme
Practicals: 2 Hrs/week

Examination Scheme
In semester: 25 marks
End Semester: 25 Marks
Credits: 1

Course Objectives
To facilitate the learners to

1. Implement concepts of Shared Address Space
2. Implement concepts of Accelerating Memory
3. Make use of the communication paradigms in distributed address space using MPI.
4. Apply the parallel programming concepts to various algorithms

Course Outcomes
By taking this course, students will be able to

1. Implement concepts of parallel computing on Shared Address Space using OpenMp.
2. Implement concepts of Accelerating Memory using CUDA and OpenACC programming
3. Implement concepts of Message passing for distributed memory using MPI
4. Develop parallel equivalents of serial algorithms.

Suggestive of Assignments:

1. Implement OpenMP program for computing matrix-matrix assignment using OpenMP constructs.
2. Implement Producer Consumer tasks using OpenMP synchronization constructs .
3. Implement program to find sum of n integers using MPI Consider processors are arranged in ring topology using MPI point-to-point blocking communication library calls
4. Implement parallel graph traversal program -Depth First Search using MPI
5. Implement parallel histogram calculation using MPI for image processing or data analysis.
6. Implement a program to find the sum of first N integers using any given number of processes. Use MPI and OpenMP constructs.
7. Parallel Implementation of the K Nearest Neighbors Classifier
8. Implement matrix multiplication using CUDA.
9. Implement parallel reduction algorithms, such as sum reduction or finding the maximum element in an array, using CUDA.
10. Provided a serial code (in C or Fortran) for solving the two-dimensional Laplace equation, parallelizing it using OpenACC directives. Then compare the performance between the serial code and the OpenACC code.

24PEMCE201C IMMERSIVE TECHNOLOGIES

Teaching Scheme
Lectures: 3 hrs/Week

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

Prerequisites:

1. Basic Mathematics
2. Basics of Python Programming

Course Objectives

To facilitate the learners to

1. To extend the computational knowledge to Virtual Reality (VR), Augmented Reality(AR) and Mixed Reality(XR).
2. To infer and analyze the tools and programming technologies used in immersive technologies.
3. To understand the concept of storytelling with immersive technologies.
4. To relate the use of deep learning methods for development of immersive environments.

Course Outcomes

By taking this course, the learner will be able to

1. Demonstrate the knowledge of Virtual Reality (VR), Augmented Reality(AR) and Mixed Reality (XR).
2. Make use of tools and programming technologies to design immersive applications.
3. Develop the concepts of user experience design in an immersive environment.
4. Utilize the knowledge of artificial intelligence and machine learning techniques for immersive applications.

UNIT I: Introduction To Immersive Technology

Virtual Reality (VR), Augmented Reality (AR) and Mixed Reality (XR), Immersive devices - headsets, sensors, controllers, and haptic devices, Aural devices, Telepresence, Cyber Presence, Morality, Ethics, Law, and Social Consequences in AR,VR, and XR

UNIT II: Virtual Reality

Geometry of virtual worlds, Moving from 2D to 3D, Visual Perception and Rendering, Elements of VR, Motion, Tracking, Interaction, Audio, Evaluating VR Systems and Experiences

UNIT III: Augmented Reality

Components and tracking in AR, Content and Abstract in AR, Marker based and Markerless AR, AR Interactions, Modeling and Annotations, AR Authoring, Mobile AR, Developing XR

UNIT IV: Tools And Technologies Used For Immersive Applications

Introduction to tools and technologies for immersive environments - WebXR, Unity, AR Frame, Unreal, Blender, Python based tools - venv, virtualenvs, Vizard, Demonstration of the tools / case studies

UNIT V: Interaction And Experience Design using Mixed Reality

Mixing real, virtual realities with interaction, Real time processing in XR, Gesture recognition, Ideation and Storyboarding using XR, Mixed Reality applications in areas like - mobile, marker based. markerless, speech,

UNIT VI: Recent Trends In Immersion

Applications of Artificial intelligence (AI), Machine Learning (ML) and Deep Learning in Immersive experience designs in - eLearning,Healthcare, eCommerce, etc., Metaverse

Text Books:

1. Steven M. LaValle, "VIRTUAL REALITY", Cambridge University Press, 2023.
2. Alan B. Craig, "Understanding Augmented Reality: Concepts and Applications", Focal Press, 2013
3. Dieter Schmalstieg and Tobias Hollerer, "Augmented Reality: Principles and Practice", Addison-Wesley, 2016
4. Alvin Albuero De Luna, "Introduction to Virtual Reality", Arcler Press, December 2021

Reference Books:

1. Edited by Erin Pangilinan, Steve Lukas, and Vasanth Mohan, "Creating Augmented and Virtual Realities Theory and Practice for Next-Generation Spatial Computing" , O'Reilly, April 2019
2. Samuel Greengard, "Virtual Reality", The MIT Press, Cambridge, 2019
3. Jerald,J., Morgan & Claypool, "The VR Book: Human-Centered Design for Virtual Reality", 2015
4. Zeynep Tacgin, "Virtual and Augmented Reality: An Educational Handbook", Cambridge Scholars Publishing, 2020
5. Tony Parisi, "Learning Virtual Reality", O' Reilly, October 2015
6. Burdea, G. C. and P. Coffet, "Virtual Reality Technology", Second Edition.Wiley‐IEEE Press, 2003/2006.
7. Alan Craig, William Sherman and Jeffrey Will, "Developing Virtual Reality Applications, Foundations of Effective Design", Morgan Kaufmann, 2009.
8. Branislav Sobota, Štefan Korečko, Marián Hudák and Martin Sivý, Book Chapter - "Mixed Reality: A known unknown", from edited book "Mixed Reality and Three-Dimensional Computer Graphics", Intech Open, October 2020

Web References:

1. NPTEL course https://nptel.ac.in/courses/106/106/106106138/ by Prof. Steven M. LaValle
2. WebXR Course - https://www.coursera.org/learn/develop-augmented-virtual-mixed-extended-reality-applications-webxr-unity-unreal
3. Peter Patterson, Mobile VR App Development with Unity, Unity Technologies, https://www.coursera.org/learn/mobile-vr-app-development-unity
4. Prof. Pat Hanrahan, Computer Graphics: Image Synthesis Techniques, Stanford University: https://graphics.stanford.edu/courses/cs348b-00/ 2.
5. Prof. Ravi Raviramamoorthi, Computer Graphics, University of California, San Diego, https://www.youtube.com/user/raviramamoorthi/videos.

24PEMCE201CL IMMERSIVE TECHNOLOGIES LABORATORY

Teaching Scheme
Practicals: 2 Hrs/Week

Examination Scheme
In Semester: 25 Marks
End-Semester: 25 Marks
Credit: 1

Prerequisite: Programming Fundamentals

Course Objectives
To facilitate the learners

1. To learn, apply and analyze tools and techniques used in immersive applications.
2. To develop the practical skills in immersive technologies that underpin extended reality experiences.
3. To understand the processes of content creation and delivery of immersive applications.
4. To learn multidisciplinary skills to create innovative immersive experiences.

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

1. Experiment with tools and techniques used in immersive experiences.
2. Build 3D VR content using visual perception, aural experiences.
3. Develop the AR content for immersive application.
4. Build a multidisciplinary real life application using suitable tools for immersive application.

Recent developments in sensors, devices, computer graphics and programming technology have given rise to a full suite of interactive tools that provide previously unheard-of opportunities to enhance or fully immerse people in virtual or physical surroundings. A whole new computing paradigm known as virtual reality (VR) and augmented reality (AR) is making its way into applications for business, healthcare, education, gaming and entertainment, among many other areas.

The main goal of this laboratory is to prepare professionals to create, implement, and assess VR and AR applications. It will offer interdisciplinary learning opportunities to engage in one of the most challenging cutting-edge technologies.

Suggestive List for Laboratory Assignments:

0. Install and get familiarized with WebXR, Unity & Visual Studio, AR Frame and Unreal, Blender, Python based tools - venv, Virtualenvs, and Vizard.
1. Develop a cube, plane, and/ or sphere, Apply transformations and audio to the game objects.
2. Apply menus and navigation techniques, object selection and manipulation in 3D application.
3. Develop a VR scene using Unity, or Unreal / Vizard or any other tool.
4. Develop a basic and immersive VR scene with WebXR using A-Frame.
5. Develop a Marker-based and marker-less scene to augment the environment for any application.
6. Perform 3D reconstruction, object recognition, and custom displays for AR.
7. Use Blender and Unity or Unreal Engine for creating animated films, visual effects, art, 3D-printed models, motion graphics, interactive 3D applications development.
8. Mini Project - Creating a VR App (Unity/Unreal Engine) / an AR App / XR App for any real life application.

24PEMCE202A BLOCKCHAIN TECHNOLOGY

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. Learn the underlying blockchain technology.
2. Understand use of cryptocurrency and consensus mechanism.
3. Learn blockchain frameworks and smart contracts to build Blockchain applications.
4. Understand security and legal regulations of blockchain for building applications in various domains.

Course Outcomes

By taking this course, the learner will be able to

1. Understand fundamental concepts of blockchain.
2. Make use of cryptocurrency and consensus mechanisms in real world applications.
3. Make use of blockchain frameworks and smart contracts to build Blockchain Decentralized Applications (DApp).
4. Examine emerging real world applications of Blockchain in various domains from security and legal regulation perspective.

UNIT I: Blockchain Fundamentals

Basics of Blockchain-Architecture, features, Types (Public, Private, Hybrid), working of blockchain, distributed ledger, wallets, Hash, Consensus mechanism and Mining, Smart contract, cryptocurrency.
Blockchain Technology: Applications, opportunity & challenges.

UNIT II: Cryptography And Consensus Mechanism

Use of Cryptography in Blockchain, symmetric key and asymmetric-key cryptography algorithms, hash functions, SHA-256, digital signature, merkel trees.
Importance of consensus in transactions, Consensus Mechanisms Proof of Work (PoW), Proof of Stake (PoS), PBFT(Practical Byzantine Fault Tolerance), DBFT(Delegated Byzantine Fault Tolerance).

UNIT III: Blockchain Frameworks And Smart Contract

Overview of Blockchain Platforms: Ethereum and Hyperledger. Setting Up Personal Ethereum Blockchain. Smart Contracts: Introduction, Working, Challenges. Types of Smart Contracts, Smart Contracts in Ethereum Blockchain. Ethereum Virtual Machine (EVM) and Gas Price.
Running and Debugging Smart Contracts in Remix IDE, Writing Smart Contracts using Solidity & JavaScript, and Deploying and Debugging Smart Contracts using Remix, Ganache, and Truffle.

UNIT IV: Cryptocurrency

Cryptocurrency Basics, Wallets, Types of Cryptocurrency. Crypto-economics and Cryptocurrency Transactions, Bitcoin, Cryptocurrency safety issues, Demonstration of Cryptocurrency wallet and a mock transaction, Cryptocurrency mining in a simulated environment.

UNIT V: Security And Legal Regulations In Blockchain

Security and Privacy Challenges of Blockchain, Security in Bitcoin, Identity Management, Authentication. Safeguarding Blockchain Smart Contract (DApp), Security in Hyperledger Fabric. Legal Regulation: Cryptocurrency Exchange, Black Market, Global Economy, Regulatory and Mitigating Illegal Behavior(s), Global Digital Assets Regulatory Trends.

UNIT VI: Blockchain Applications And Trends

Blockchain Applications like healthcare, Supply Chain Management, Finance, Digital ID's, Blockchain in Financial Service, use of Blockchain in Government services, Future trends in blockchain, impact of blockchain on Business.

Text Books:

1. Chandramouli Subramanian, Asha A George, Abhilash K A, Meena Karthikeyan, "Blockchain Technology", Universities Press 2020, ISBN 9789389211634
2. Melanie Swa, "Blockchain", O'Reilly, 2015, ISBN: 9781491920497

3. Bikramaditya Singhal, Gautam Dhameja, Priyanshu Sekhar Panda, "Beginning kchain",
Apress, First South Asian Edition 2018, ISBN 78-1-4842-3444-0.

Reference Books:

1. Narayanan, Bonneau, Felten, Miller and Goldfeder, "Bitcoin and Cryptocurrency Technologies – A Comprehensive Introduction", Princeton University Press, 2016, ISBN: 9780691171692
2. Thompson, 'Blockchain: The Blockchain for Beginnings, Guide to BlockchainTechnology Blockchain Programming', Create Space Independent Publishing Platform, 2017, ISBN: 1546772804
3. Tiana Laurence, Blockchain For Dummies, 2nd edition, Wiley, 2019, ISBN: 1-119-55513-1
4. Primavera De Filippi, Aaron Wright, "Blockchain and the Law", Harvard University Press, ISBN-13: 978-0674976429

Online/Web/Other References:

1. Hyperledger Fabric - https://www.hyperledger.org/projects/fabric
2. Zero to Blockchain - An IBM Redbooks course, by Bob Dill, David Smits https://www.redbooks.ibm.com/Redbooks.nsf/RedbookAbstracts/crse0401.html
3. Prof. Sandip Chakraborty, Dr. Praveen Jayachandran, "Blockchain Architecture Design And Use Cases"[MOOC], NPTEL: https://nptel.ac.in/courses/106/105/106105184/

24PEMCE202B Generative AI

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. Gain a solid understanding of generative AI, starting from the basics of neural networks and progressing to complex architectures like ChatGPT and Google Bard
2. Apply generative AI for text, image , video generation.
3. Gain an understanding of the tools and techniques used in generative AI.
4. Understand how generative AI can be applied across various industries, from healthcare and marketing to legal compliance through detailed use cases

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

1. Demonstrate the Generative AI principles, concepts and use cases.
2. Make use of Large Language Models, transformer model, generative pre-trained models for real world applications
3. Apply GAN architectures, Autoencoders to generate images.
4. Illustrate tools and techniques used for Generative video, images and codes.

UNIT I: Introduction to Generative AI

Generative AI: Definition, scope, Overview, Importance, and case studies highlighting successful implementations. Importance of Generative AI in various domains, Ethical considerations and Challenges of Generative AI

UNIT II: Generative Texts and Language Modelling

Evolution of Neural Networks to Large Language Models (LLMs), n-gram models, LLM architectures, Semantic searches with LLMs, BERT, Recurrent neural networks(RNNs), LSTMs, and Transformer models, Transformer architectures, Training LLMs for natural language processing, fine tuning, Parameter estimation and Evaluation
Implementing LLMs using Python
Generative Pre-trained Transformer: ChatGPT and its variants, ChatGPT Architecture
Practical Case studies of Generative texts, LLMs and transformer models

UNIT III: Generative Images

Role of AI in Image Generation, Image Sourcing Vs Image Generation, Diffusion Model and Generative AI for Images
GAN architectures: Vanilla GAN, CycleGAN, StyleGAN, PixelRNN, text-2-image, DiscoGAN, lsGAN
Autoencoders , Autoregressive models
Popular AI tools for Image Generation: Midjourney, Vivid AI, WOMBO etc
Practical Case studies of image generation.

UNIT IV: Generative Videos and Generative Codes

AI Tools for Video and code generation, Working of AI Video generation, Role of AI Tools in Programming, Copilot by Github, Working of Copilot, Copilot Compatibility, Advantages and Drawbacks of Copilot, GitHub Copilot Extension, Auto filling Repetitive Code using Copilot, Running Tests using Copilot, Navigating Unfamiliar Territory with Copilot, Creating an Application Entirely With Copilot
Practical Case studies of generative videos and generative codes.

Text Books:

1 Akshay Kulkarni, "Applied Generative AI for Beginners: Practical Knowledge on Diffusion Models, ChatGPT, and Other LLMs" , Apress, 2023,ISBN-10 : 1484299930, ISBN-13 : 978-1484299937
2 Amit Bahree, "Generative AI in action", ISBN 9781633436947, MEAP , 2023
3 Sinan Ozdemir, "Quick Start Guide to Large Language Models: Strategies and Best Practices for Using ChatGPT and Other LLMs", Addison-Wesley Data & Analytics Series, ISBN-13 978-0138199197, 2023
4 Denis Rothman , "Transformers for Natural Language Processing: Build innovative deep neural network architectures for NLP with Python, PyTorch, TensorFlow, BERT, RoBERTa, and more", Packt publication, 2021, ISBN-13 978-1800565791

Reference Books:

1. Ben Auffarth, "Generative AI with Long Chain", Packt publication, 2023, ISBN 9781835083468
2 David M. Patel, "Artificial Intelligence & Generative AI for Beginners: The Complete Guide (Generative AI & Chat GPT Mastery Series Book 1) ", Kindle Edition, ASIN : B0C8JM5MD9
3. David Foster, "Generative Deep learning", 2023, Wiley publication , ISBN-10 : 1098134184, ISBN - 13: 978-1098134181
4 Joseph Babcock, Raghav Bali, "Generative AI with Python and TensorFlow 2: Create images, text, and music with VAEs, GANs, LSTMs, Transformer models", Kindle Edition, Packt publication, ASIN : B0922PCNP

5 Jurafsky, David, James H. Martin,"Speech and Language Processing: An Introduction to Natural Language Processing,Computational Linguistics and Speech Recognition", Pearson Education Limited, Dorling Kindersley(India) Pvt. Ltd. Third Edition , ISBN: 987-93-325-1814-4.

24PEMCE202C e-Business

Teaching Scheme
Lectures : 3 Hrs / week

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

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 taking this course, the learner will 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 fulfill modern e-business trends

UNIT I: Introduction

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

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 analyzing website traffic data. Digital Marketing **Case Study**

UNIT III : e-Business Infrastructure / Back end Systems

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

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

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

Launching a successful e-business – requirement analysis, managing Web site development, search engine optimization, Evaluate Websites on design criteria.
Future and next generation of enterprise e-business, challenges and new trends, ethical and regulatory issues

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)