**Resolution No. AC/II/(23-24).2.RPS6**

# S. P. Mandali's

# Ramnarain Ruia Autonomous College

***(Affiliated to University of Mumbai)***

## Syllabus for MSc Computer Science

## Program: M.Sc.

## Program Code: RPSCS

As per the guidelines of NEP2020
Academic year 2024-25

## GRADUATE ATTRIBUTE

S. P. Mandali's Ramnarain Ruia Autonomous College has adopted the Outcome Based Education model to make its science graduates globally competent and capable of advancing in their careers. The Bachelors Program in Science also encourages students to reflect on the broader purpose of their education.

| GA | GA Description<br>A student completing Master's Degree in Science program will be able to: |
|---|---|
| GA 1 | Demonstrate in depth understanding in the relevant science discipline. Recall, explain, extrapolate and organize conceptual scientific knowledge for execution and application and also to evaluate its relevance. |
| GA 2 | Critically evaluate, analyze and comprehend a scientific problem. Think creatively, experiment and generate a solution independently, check and validate it and modify if necessary. |
| GA 3 | Access, evaluate, understand and compare digital information from various sources and apply it for scientific knowledge acquisition as well as scientific data analysis and presentation. |
| GA 4 | Articulate scientific ideas, put forth a hypothesis, design and execute testing tools and draw relevant inferences. Communicate the research work in appropriate scientific language. |
| GA 5 | Demonstrate initiative, competence and tenacity at the workplace. Successfully plan and execute tasks independently as well as with team members. Effectively communicate and present complex information accurately and appropriately to different groups. |
| GA 6 | Use an objective, unbiased and non-manipulative approach in collection and interpretation of scientific data and avoid plagiarism and violation of Intellectual Property Rights. Appreciate and be sensitive to environmental and sustainability issues and understand its scientific significance and global relevance |
| GA 7 | Translate academic research into innovation and creatively design scientific solutions to problems. Exemplify project plans, use management skills, and lead a team for planning and execution of a task. |
| GA 8 | Understand cross disciplinary relevance of scientific developments and relearn and reskill to adapt to technological advancements. |

## PROGRAM OUTCOMES

| PO | Description<br>A student completing Master's Degree in Science program in the subject of Computer Science will be able to: |
|---|---|
| **PO 1** | Develop a keen interest in the emerging technologies in the industry |
| **PO 2** | Analyze, innovate, and solve real-life case studies using technology |
| **PO 3** | Work in teams with various disciplines; working on an interdisciplinary project |
| **PO 4** | Understand work culture in the industry and attain skills to become a successful entrepreneur. |
| **PO 5** | Develop a skillset to analyze, describe, and innovate various methodologies to solve a given problem |
| **PO 6** | Understand the philosophy of the subject to apply to various fields of research. |
| **PO 7** | Work in an industrial environment under expert supervision and develop expertise in various technologies |
| **PO 8** | Effective utilization of available resources to overcome challenging tasks |

## PROGRAM OUTLINE

| YEAR | SEM | COURSE CODE | TYPE OF COURSE | COURSE TITLE | CREDITS |
|---|---|---|---|---|---|
| MSc COMPUTER SCIENCE PART II - SEMESTER III | | | | | |
| M.Sc. CS Part II | III | RPSCSO601 | Discipline Specific Core I | Deep Learning | 3 |
| | | RPSCSOP601 | Practical DSC I | Practical for Deep Learning | 1 |
| | | RPSCSO602 | Discipline Specific Core II | Advanced Web Technologies | 3 |
| | | RPSCSOP602 | Practical DSC II | Practical for Advanced Web Technologies | 1 |
| | | RPSCSO603 | Discipline Specific Core III | Big Data Analytics | 3 |
| | | RPSCSOP603 | Practical DSC III | Practical for Big Data Analytics | 1 |
| | | RPSRPCSO605 | | Research Project | 6 |
| | | RPSECSO604 - I | Discipline Specific Elective-I | Bioinformatics | 3 |
| | | RPSECSPO604 - I | Practical on DSE-I | Practical for Bioinformatics | 1 |
| | | RPSECSO604 - II | Discipline Specific Elective-II | Digital image Processing | 3 |
| | | RPSECSPO604 - II | Practical on DSE-II | Practical for Digital image Processing | 1 |
| MSc COMPUTER SCIENCE PART II - SEMESTER IV | | | | | |
| M.Sc. CS Part II | IV | RPSCSE611 | Discipline Specific Core I | Generative AI | 3 |
| | | RPSCSPE611 | Practical DSC I | Practical of Generative AI | 1 |
| | | RPSCSE612 | Discipline Specific Core II | Human Computer Interaction | 3 |
| | | RPSCSPE612 | Practical DSC II | Practical of Human Computer Interaction | 1 |
| | | RPSINTCSE614 | | OJT / Internship | 10 |
| | | RPSECSE613 - I | Discipline Specific Elective-I | Advanced Data Modelling | 3 |
| | | RPSECSPE613 - I | Practical of DSE-I | Practical of Advanced Data Modelling | 1 |
| | | RPSECSE613 - II | Discipline Specific Elective-II | Software Design Patterns | 3 |
| | | RPSECSPE613 - II | Practical of DSE-II | Practical of Software Design Patterns | 1 |

## COURSE CODE: RPSCSO601
## COURSE TITLE: DEEP LEARNING

| Course Outcomes | After Completing this course student will be able to : |
|---|---|
| CO 1 | Understand fundamental concepts in deep learning. |
| CO 2 | Compare popular deep learning frameworks such as TensorFlow, PyTorch, or Keras to develop and train deep learning models. |
| CO 3 | Apply deep learning techniques to various real-world applications. |
| CO4 | Solve real-world problems and work on deep learning projects, including problem formulation, data collection, model development |

| UNITS | DEEP LEARNING | CREDITS 3 HOURS 45 |
|---|---|---|
| I | Deep Learning: Deep forward Networks: Gradient-Based Learning, Hidden Unit, Back-Propagation and Other Differentiation Algorithms. Regularization of Deep Learning: Parameter Norm Penalties, Norm Penalties as Constrained Optimization, Regularization and Under-Constrained Problems, Dataset Augmentation, Noise Robustness, Semi-Supervised Learning, Multi-Task Learning, Early Stopping, Parameter Tying and Parameter Sharing, Sparse Representations | 15 Hr |
| II | Convolution Networks: The Convolution Operation, Motivation, Pooling, Convolution and Pooling as an Infinitely Strong Prior, Variants of the Basic Convolution Function, Structured Outputs, Data Types, Efficient Convolution Algorithms, Random or Unsupervised Features, The Neuroscientific Basis for Convolutional Networks.<br><br>Sequence Modelling: Recurrent and Recursive Nets: Unfolding Computational Graphs, Recurrent Neural Networks, Bidirectional RNNs, Encoder-Decoder Sequence-to-Sequence Architectures, Deep Recurrent Networks, Recursive Neural Networks, The Challenge of Long-Term Dependencies, Echo State Networks. Applications: Large Scale Deep Learning, Computer Vision, Speech Recognition, Natural Language Processin | 15 Hrs |

| | | |
|---|---|---|
| III | Deep Learning Research- Linear Factor Models: Probabilistic PCA and Factor Analysis, Independent Component Analysis (ICA), Slow Feature Analysis, Sparse Coding, Manifold Interpretation of PCA. Structured Probabilistic Models for Deep Learning: The Challenge of Unstructured Modeling, Using Graphs to Describe Model Structure, Sampling from Graphical Models, Advantages of Structured Modeling, Learning about Dependencies, Inference and Approximate Inference, The Deep Learning Approach to Structured Probabilistic Models | 15 Hrs |

## COURSE CODE: RPSCSOP601
## COURSE TITLE: DEEP LEARNING

| Course Outcomes | After Completing this course student will be able to : |
|---|---|
| CO1 | Use popular deep learning frameworks such as TensorFlow, PyTorch |
| CO2 | Develop trained deep learning models into production environments. |
| CO2 | Evaluate the performance of deep learning models using appropriate evaluation metrics and techniques. |

| SR. NO. | PRACTICAL OF DEEP LEARNING | CREDITS 1<br>HOURS 5 |
|---|---|---|
| 1 | Demonstrate the deep feedforward networks. | |
| 2 | Demonstrate Convolution networks using a deep learning model. | |
| 3 | Demonstrate Stochastic gradient descent (SGD) with Nesterov momentum | |
| 4 | Demonstrate recursive neural networks | |
| 5. | Demonstrate deep learning application for NLP | |
| 6 | Demonstrate Echo state networks | |
| 7. | Demonstrate Independent component analysis | |
| 8. | Demonstrate sampling from graph models. | |

**Text book:**

1. Deep Learning Ian Goodfellow, Yoshua Bengio, Aaron Courville (Adaptive Computation and Machine Learning series) MIT Press

## COURSE CODE: RPSCSO602
## COURSE TITLE: ADVANCED WEB TECHNOLOGIES

| Course Outcomes | After Completing this course student will be able to : |
|---|---|
| CO 1 | Work with collaborative version control Deploy Web applications through container |
| CO 2 | Develop web applications using Node |
| CO 3 | Develop web applications with Typescript |
| CO4 | Explore webpack for creating web applications |

| UNITS | ADVANCED WEB TECHNOLOGIES | CREDITS 3 HOURS 45 |
|---|---|---|
| I | Node and NPM - Installation - Commands - Packaging - filesystem **Node js :** Introduction to Node js. Installing Node.js. The package .json File. The Node. js Event Loop. The I/O Cycle. The Anatomy of a Node js Module. Creating Node Modules. Exploring the Node.js HTTP Module. Creating an HTTP Webserver with Node js. Responding to HTTP. Requests. Routing in Node. js. Creating a Sample Node js Application. **MongoDB:** Introduction to MongoDB. Installing MongoDB. Using MongoDB Compass. Using Mongo Shell Interface. Connecting to MongoDB. Creating Schemas and Models. Querying Documents. Inserting Documents. Updating Documents. Deleting Documents. | 15 Hrs |
| II | **Front End** **React js:** Introduction to React.JS, Writing different components , Form Validation, Saving Data Using React.JS, Creation using React.JS. | 15 Hrs |
| III | **Back End** Typescript - Programming structures - Boolean - Arrays - Tuples - function Classes - Inheritance - Interfaces - Namespaces - Modules - Decorators - Debugging Typescript apps - development of a simple web application with typescript | 15 Hrs |

## COURSE CODE: RPSCSOP602
## COURSE TITLE: ADVANCED WEB TECHNOLOGIES

| Course Outcomes | After Completing this course student will be able to : |
|---|---|
| CO1 | Demonstrate the working of Node Js |
| CO2 | Apply MVC pattern in the programs |
| CO2 | Classify code based on React, Node & modify based on database. |

| RPSCSOP602 | PRACTICAL OF ADVANCED WEB TECHNOLOGIES | CREDITS 1<br>HOURS 15 |
|---|---|---|
| 1 | **Write a program to implement MongoDB data models** | |
| 2 | Develop a simple CRUD (Create, Read, Update, Delete) application using Node.js and a MongoDB database | |
| 3 | Demonstrate how to send various HTTP status codes and response headers in Node.js. | |
| 4 | Explain the concept of the event loop and its role in managing asynchronous tasks in Node.js. | |
| 5. | Create React First app & display Hello world with the help of components | |
| 6 | Using components to display set of data together on screen. Also create a CSS for the same. | |
| 7. | Creating a form in react js using components properties & state | |
| 8. | Programming with different data structures and functions using Typescript | |
| 9 | Programming with classes and inheritance | |
| 10 | Development of a full stack web application with a combination of all | |

**References:**


1. Beginning Node.JS, Basarat Ali Khan, Apress.
2. Practical Node.JS Building Real-world Scalable Web Apps, Azat Mardan. Apress.
3. MERN Quickstart Guide - Build web applications with MongoDB, Express.js, React, and Node, Eddy Wilson Iriarte Koroliova, Packt.
4. The Complete Beginner's Guide to React, Kristen Dyrr.
5. Nodes, MongoDB and Angular Web Development: The definitive guide to using the MEAN stack to build web anolications bv Brad Davlev. Brendan Davlev Caleb Davlev Pearson 2018
6. Full Stack Javascript Development with Mean - MongoDB, Express, AngularJS, and Node.JS by Adam Bretz, Colin J Ihrig, Shroff/SitePoint, 2015
7. Frank Zammetti, Modern Full-Stack Development Using TypeScript, React, Node.js, Webpack, and Docker, Apress, First Edition, 2020

8. David Choi, Full-Stack React, TypeScript, and Node, Packt Publications, 2020
9. Vasan Subramanian, Pro MERN Stack, Full Stack Web App Development with Mongo, Express, React, and Node, A Press Publisher, Second Edition 2019.

## COURSE CODE: RPSCSO603
## COURSE TITLE: BIG DATA ANALYTICS

| Course Outcomes | After Completing this course student will be able to : |
|---|---|
| CO 1 | Understand various Big Data Technologies |
| CO 2 | Design the prototype and give solutions for the real world problems. |
| CO 3 | Develop smart applications with the help of smart devices. |
| CO4 | Demonstrate the implementation of IoT based applications in the Cloud. |
| CO5 | Propose and apply automation in industry. |

| UNITS | BIG DATA ANALYTICS | CREDITS 3 HOURS 45 |
|---|---|---|
| I | Introduction to Hadoop, Hadoop Distributed File System, MapReduce framework, YARN, Other changes, Installing Hadoop 3. Overview of Big Data Analytics: Introduction to data analytics, Introduction to big data, Distributed computing using Apache Hadoop | 15 Hrs |
| II | The MapReduce framework, Hive, Apache Spark, Visualisation using Tableau. Big Data Processing with MapReduce, The MapReduce framework, MapReduce job types, MapReduce patterns. Scientific Computing and Big Data Analysis with Python and Hadoop, Scientific Computing and Big Data Analysis with Python and Hadoop, Data analysis. Statistical Big Data Computing with R and Hadoop: Introduction, Methods of integrating R and Hadoop, Data analytics. | 15 Hrs |

| | | |
|---|---|---|
| III | Batch Analytics with Apache Spark: SparkSQL and DataFrames, DataFrame APIs and the SQL API, Schema – the structure of data, Loading datasets, Saving datasets, Aggregations, Joins. Real-Time Analytics with Apache Spark Streaming, Spark Streaming, file Stream, Transformations Checkpointing, Driver failure recovery. Visualizing Big Data: Introduction, Tableau, Chart types, Using Python to visualise data, Using R to visualise data, Big data visualisation tools<br><br>Importing and Exporting Data from Various DBs: Learning about data files as the database, Understanding MySQL, Understanding Excel, Understanding MongoDB, Understanding SQLite, Understanding PostgreSQL, Understanding Hive, Understanding HBase | 15 Hrs |

## COURSE CODE:RPSCSOP603
## COURSE TITLE: PRACTICAL OF BIG DATA ANALYTICS

| Course Outcomes | After Completing this course student will be able to : |
|---|---|
| CO1 | Use tools of Big data technologies |
| CO2 | Demonstrate techniques used in data analytics |
| CO2 | Apply Data visualisation techniques |

| RPSCSOP603 | PRACTICAL OF BIG DATA ANALYTICS | CREDITS 1<br>HOURS 15 |
|---|---|---|
| 1 | Demonstrate usage of HIVE in Hadoop | |
| 2 | Demonstrate queries on streams with Apache Spark | |
| 3 | Implement Mapreduce for a case study | |
| 4 | Demonstrate an application in R to implement predictive methods in data analytics. | |
| 5. | Demonstrate the usage of HBase | |
| 6 | Extract data from various sources and load it in Hadoop | |
| 7. | Demonstrate the data visualisation using R | |
| 8. | Demonstrate the data visualisation by creating a dashboard in R | |
| 9 | Demonstrate usage of HIVE in Hadoop | |

**Text book:**

1. Big Data, Black Book: Covers Hadoop 2, MapReduce, Hive, YARN, Pig, R and Data Visualization
2. Hadoop: The Definitive Guide by Tom White 5th Edith O'Reilly.

## COURSE CODE: RPSRPCSO605
## COURSE TITLE: RESEARCH PROJECT

| Course Outcomes | After Completing this course student will be able to : |
|---|---|
| CO 1 | Formulate research problem of real world |
| CO 2 | Excel critical thinking skills to solve problems. |
| CO 3 | Develop research quotient to bring new ideas |
| CO 4 | Apply technical knowledge to innovate optimise solution |

| COURSE CODE<br>RPSRPCSO605 | COURSE NAME<br>RESEARCH PROJECT | CREDITS<br>6 |
|---|---|---|
| The syllabus proposes project implementation as part of the semester–IV. The student is expected to give a presentation of the project proposed and get verified and sanctioned by the project guide. In addition, experimental setup, analysis of results, comparison with results of related works, conclusion and future prospects will be part of the project implementation. A student is expected to make a project implementation report and appear for a project viva. He or she needs to spend around 200-250 hours on the project implementation for which the student will be awarded 6 credits. | | |

## COURSE CODE:RPSECSO604
## COURSE TITLE: BIOINFORMATICS

| Course Outcomes | After Completing this course student will be able to : |
|---|---|
| CO 1 | Adapt basic knowledge on various techniques and areas of application |
| CO 2 | Analyze common problem in bioinformatics |
| CO 3 | Computing & Understanding Data through visulaization |
| CO4 | Understanding ethical issues & evolutionary modelling |

| UNITS | BIOINFORMATICS | CREDITS 3<br>HOURS 45 |
|---|---|---|
| I | **Biological Data Analysis**<br>**Biological Foundations:** Introduction to molecular biology concepts and terminology, DNA, RNA, and protein structure and function, Genetic variation and mutation<br>**Introduction to Bioinformatics:** Overview of bioinformatics and its applications in biology and medicine, Introduction to biological databases and data formats, Introduction to sequence analysis, structure analysis<br>**Sequence Analysis:** Sequence alignment algorithms (pairwise and multiple sequence alignment), Sequence database searching (BLAST, FASTA), Hidden Markov Models (HMMs) for sequence analysis, Phylogenetic analysis and evolutionary tree construction | 15 Hrs |
| II | **Structure Analysis:** Protein structure prediction methods (homology modeling, ab initio methods), Protein structure visualization and analysis tools, Drug discovery<br>**Computational Tools and Methods**<br>**Genomics and Transcriptomics:** Analyzing and manipulating genomic sequences, working with genome annotations and gene features, Analyzing gene expression data (RNA-Seq, microarray), Identifying differentially expressed genes<br>**Data Visualization and Reporting**: Visualizing bioinformatics data, Creating interactive visualizations of biological data | 15 Hrs |
| III | **Machine Learning and Data Mining in Bioinformatics:** Introduction to machine learning algorithms and techniques, Feature selection and dimensionality reduction in biological data, Predictive modeling for biological data (classification, regression).<br>**Ethical, Legal, and Social Implications:** Ethical considerations in bioinformatics research, Privacy and data security in genomic data, social and policy issues in bioinformatics and personalized medicine | 15 Hrs |

**COURSE CODE: RPSECSPO604**
**COURSE TITLE: BIOINFORMATICS**

| Course Outcomes | After Completing this course student will be able to : |
|---|---|
| CO1 | Use basic knowledge on areas of application of bioinformatics |
| CO2 | Apply alignments techniques using various methods |
| CO2 | Demonstrate the use of tools for getting the sequences |

| RPSECSPO604 | PRACTICAL OF BIOINFORMATICS | CREDITS 1<br>HOURS 15 |
|---|---|---|
| 1 | Sequence Manipulation<br>● Read and parse sequence data from files<br>● Perform basic sequence manipulations (e.g., reverse complement, translation) | |
| 2 | Sequence Alignment<br>● Perform pairwise sequence alignment using algorithms like NeedlemanWunsch or Smith-Waterman<br>● Implement multiple sequence alignment using methods such as ClustalW or MUSCLE | |
| 3 | Database Searching<br>● Perform sequence searches against databases (e.g., BLAST or FASTA)<br>● Retrieve and analyze search results | |
| 4 | Protein Structure Analysis<br>● Retrieve protein structures from databases like PDB<br>● Calculate structural properties (e.g., secondary structure, solvent accessibility)<br>● Perform structure visualization and analysis | |
| 5. | Genomic Data Analysis<br>● Retrieve genomic data from databases (e.g., NCBI)<br>● Analyze gene annotations, promoter regions, or regulatory elements | |

| | | |
|---|---|---|
| | ● Perform genomic variant analysis | |
| 6 | Data Preprocessing<br><br>● Cleaning and preprocessing biological data (e.g., gene expression data, DNA sequences)<br><br>● Handling missing values, outliers, and normalization of data ● Feature selection and dimensionality reduction techniques | |
| 7. | Classification<br><br>● Applying machine learning algorithms (e.g., decision trees, random forests, support vector machines) to classify biological samples or sequences<br><br>● Evaluating model performance using metrics such as accuracy, precision, recall, and F1-score | |
| 8. | Regression<br><br>● Building regression models to predict quantitative biological properties (e.g., protein structure, gene expression levels)<br><br>● Assessing model performance using metrics such as mean squared error or R-squared | |
| 9 | Clustering<br>● Applying clustering algorithms (e.g., k-means, hierarchical clustering) to group similar biological samples or sequences<br>● Assessing clustering quality using metrics such as silhouette coefficient or Rand index | |
| 10 | Visualising clusters and analysing their biological significance<br><br>● Data Visualization:<br><br>● Generate plots, graphs, and figures to visualise bioinformatics results<br><br>● Use libraries like Matplotlib, Seaborn, or ggplot in Python or R for visualisation<br><br>● Create interactive visualisations using tools like D3.js or Plotly | |

**Text Books:**

1. Bioinformatics: Sequence and Genome Analysis by David W. Mount Publisher: Cold Spring Harbor Laboratory Press Publication (4th edition), 2021,

2. Python for Bioinformatics by Tiago Antao, Packt Publishing Publication, 2015 3. Python for Biologists: A complete programming course for beginners" by Martin Jones CreateSpace Independent Publishing Platform, 2013,

**Reference Books:**

1. Bioinformatics for Beginners: Genes, Genomes, Molecular Evolution, Databases, and Analytical Tools by SupratimChoudhuri, Academic Press Publication, 2014

2. Bioinformatics Programming Using Python: Practical Programming for Biological Data by Mitchell L. Model, O'Reilly Media, 2009

## COURSE CODE:RPSECSO604
## COURSE TITLE: DIGITAL IMAGE PROCESSING

| Course Outcomes | After Completing this course student will be able to : |
|---|---|
| CO1 | Understand the relevant aspects of digital image representation and their practical implications. |
| CO2 | Design pointwise intensity transformations and spatial filtering to meet stated specifications. |
| CO3 | Apply alternative color spaces, and the design requirements leading to choices of color space and understand different mechanisms of image compression. |
| CO4 | Appreciate the basic image restoration and reconstruction techniques. |
| CO5 | Analyze and apply morphological image processing techniques |
| CO6 | Perform advanced image segmentation and feature extraction through various methods. |

| UNITS | DIGITAL IMAGE PROCESSING | CREDITS 3 HOURS 45 |
|---|---|---|

| | | |
|---|---|---|
| I | **Introduction:** Digital Image Processing, Origins of Digital Image Processing, Applications and Examples of Digital Image Processing, Fundamental Steps in Digital Image Processing, Components of an Image Processing System, **Digital Image Fundamentals:** Elements of Visual Perception, Light and the Electromagnetic Spectrum, Image Sensing and Acquisition, Image Sampling and Quantization, Basic Relationships Between Pixels, Basic Mathematical Tools Used in Digital Image Processing, **Intensity Transformations and Spatial Filtering:** Basics, Basic Intensity Transformation Functions, Basic Intensity Transformation Functions, Histogram Processing, Fundamentals of Spatial Filtering, Smoothing (Lowpass) Spatial Filters, Sharpening (Highpass) Spatial Filters, Highpass, Bandreject, and Bandpass Filters from Lowpass Filters, Combining Spatial Enhancement Methods, Using Fuzzy Techniques for Intensity Transformations and Spatial Filtering **Filtering in the Frequency Domain:** Background, Preliminary Concepts, Sampling and the Fourier Transform of Sampled Functions, The Discrete Fourier Transform of One Variable, Extensions to Functions of Two Variables, Properties of the 2-D DFT and IDFT, Basics of Filtering in the Frequency Domain, Image Smoothing Using Lowpass Frequency Domain Filters, Image Sharpening Using Highpass Filters, Selective Filtering, Fast Fourier Transform | 15 Hrs |
| II | **Image Restoration and Reconstruction**: A Model of the Image Degradation/Restoration Process, Noise Models, Restoration in the Presence of Noise Only-----Spatial Filtering, Periodic Noise Reduction Using Frequency Domain Filtering, Linear, PositionInvariant Degradations, Estimating the Degradation Function,Inverse Filtering, Minimum Mean Square Error (Wiener) Filtering, Constrained Least Squares Filtering, Geometric Mean Filter, Image Reconstruction from Projections **Wavelet and Other Image Transforms:** Preliminaries, Matrix - based Transforms, Correlation, Basis Functions in the Time - Frequency Plane, Basis Images, Fourier - Related Transforms, Walsh -Hadamard Transforms, Slant Transform, Haar Transform, Wavelet Transforms | 15 Hrs |

| | | |
|---|---|---|
| | **Color Image Processing:** Color Fundamentals, Color Models, Pseudocolor Image Processing, Full -Color Image Processing, Color Transformations, Color Image Smoothing and Sharpening, Using Color in Image Segmentation, Noise in Color Images, Color Image Compression. **Image Compression and Watermarking:** Fundamentals, Huffman Coding, Golomb Coding, Arithmetic Coding, LZW Coding, Run -length Coding, Symbol -based Coding, 8 Bit -plane Coding, Block Transform Coding, Predictive Coding, Wavelet Coding, Digital Image Watermarking, | |
| III | **Morphological Image Processing:** Preliminaries, Erosion and Dilation, Opening and Closing, The Hit -or -Miss Transform, Morphological Algorithms, Morphological Reconstruction¸ Morphological Operations on Binary Images, Grayscale Morphology<br>**Image Segmentation I: Edge Detection, Thresholding, and**<br>**Region Detection**: Fundamentals, Thresholding, Segmentation<br>by Region Growing and by Region Splitting and Merging, Region Segmentation Using Clustering and Superpixels, Region<br>Segmentation Using Graph Cuts, Segmentation Using Morphological Watersheds, Use of Motion in Segmentation<br>**Image Segmentation II:** Active Contours: Snakes and Level Sets: Background, Image Segmentation Using Snakes, Segmentation Using Level Sets.<br>**Feature Extraction:** Background, Boundary Preprocessing, Boundary Feature Descriptors, Region Feature Descriptors, Principal Components as Feature Descriptors, Whole<br>-Image Features, Scale<br>-Invariant Feature Transform (SIFT) | 15 Hrs |

## COURSE CODE: RPSECSOP604
## COURSE TITLE: PRACTICALS OF DIGITAL IMAGE PROCESSING

| Course Outcomes | After Completing this course student will be able to : |
|---|---|
| CO1 | Acquire and process digital images, correct defects, and enhance image quality. |
| CO2 | Apply segmentation,thresholding, and process binary images for feature recognition and classification. |
| CO3 | Analyze and visualize 3D images using advanced imaging techniques. |

| RPSECSOP604 | **PRACTICAL OF DIGITAL IMAGE PROCESSING** | **CREDITS** 1<br>**HOURS** 15 |
|---|---|---|
| 1 | Acquiring Images | |
| 2 | Correcting Image Defects | |
| 3 | Image Enhancement | |
| 4 | Segmentation | |
| 5. | Thresholding | |
| 6 | Processing Binary Images | |
| 7. | Feature Recognition | |
| 8. | Feature Classification | |
| 9. | 3D ImageAcquisition | |
| 10. | 3D Image Visualisation | |

**Text book:**


1. Digital Image Processing Gonzalez and Woods Pearson/Prentice Hall Fourth 2018
2. Fundamentals of Digital Image Processing A K. Jain PHI
3. . The Image Processing Handbook J. C. Russ CRC Fifth 2010

# SEMESTER IV

## COURSE CODE: RPSCSE611
## COURSE TITLE: GENERATIVE AI

| Course Outcomes | After Completing this course student will be able to : |
|---|---|
| CO 1 | Deploying Gen Ai Applications using GANs |
| CO 2 | Developing GenAi application responsibility with all ethics. |
| CO 3 | Developing applications using Variable autoencoders (VAEs) |
| CO4 | Optimised prompt engineering for effective use of LLMs |

| UNITS | GENERATIVE AI | CREDITS 3 HOURS 45 |
|---|---|---|
| I | Introduction to Generative AI and Ethics:<br>Privacy Concerns, Bias Concerns, Intellectual property concerns, ethical use of generative AI<br>Generative Adversarial networks(GANS): What are GANs? Applications of GANs, strengths of GANs, weaknesses of GANs, ethical concerns related to GANs, Responsibile use of GANs. | 15 Hrs |
| II | Variable Autoencoders(VAES): What are VAEs? Applications of VAEs, Strengths of VAEs, Weaknesses of VAEs, Ethical Concerns Related to VAEs, responsible use of VAEs<br>Flow-based models and normalizing flows, Style transfer and image to translation, music generation and audio sysnthesis, text generation and image captioning, GPT models and language generation, alethics, bias and fairness in AI, Tranparency and explainability in AI, privacy and security in AI,<br>Introduction to LLM | 15 Hrs |
| III | Prompt, creative AI applications: Introduction to prompts and creative AI<br>Language models and text generation, Art and Design generation, Music and audio generation, video and image generation, future of creative AI,AI in business and finance , AI in Healthcare and medicine, AI for education and learning, AI in energy and environment, AI in transportation and smart cities. | 15 Hrs |

## COURSE CODE: RPSCSEP611
## COURSE TITLE: PRACTICALS OF GENERATIVE AI

| Course Outcomes | After Completing this course student will be able to : |
|---|---|
| CO1 | Gain practical experience in implementing various generative AI models |
| CO2 | Apply generative AI techniques to real-world problems such as image generation, text generation, style transfer, and data augmentation. |
| CO2 | Develop small projects or applications that demonstrate the practical utility of generative AI models in various domains. |

| RPSCSEP611 | PRACTICAL OF GENERATIVE AI | CREDITS 1 HOURS 15 |
|---|---|---|
| 1 | Creative AI: Art and Music Generation | |
| 2 | Working with Generative Adversarial Networks (GANs) | |
| 3 | Implementing a VAE(Variational Autoencoders (VAEs)) to generate new data points in datasets like MNIST. | |
| 4 | Demostrate the use of GANs in Healthcare applicaiton | |
| 5. | Demonstrate use of GenAi in Educationals application | |
| 6 | AI in Video Generation and Editing | |
| 7. | Deepfakes and Their Detection | |
| 8. | Demonstrate optimized prompt engineering in education and learning | |
| 9 | AI for Personalized Marketing Campaigns | |
| 10 | Building AI Chatbots for Customer Service | |

**Text book:**


1. The Artificial Intelligence and Generative AI Bible: [5 in 1] The Most Updated and Complete Guide | From Understanding the Basics to Delving into GANs, NLP, Prompts, Deep Learning, and Ethics of AI by Alger Fraley 2024 Edition
2. Generative AI: How ChatGPT and Other AI Tools Will Revolutionize Business- Tom Taulli Monrovia, CA, USA
3. GENERATIVE AI AND PROMPT BASIS RULES FOR BEGINNERS- MICHAEL GORDON COHEN.
4. Dive into Deep Learning-Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola

## COURSE CODE:RPSCSE612
## COURSE TITLE: HUMAN COMPUTER INTERACTION

| Course Outcomes | After Completing this course student will be able to : |
|---|---|
| CO 1 | Define and explain the fundamental principles and theories of Human-Computer Interaction |
| CO 2 | Identify key concepts such as usability, accessibility, and user experience (UX) |
| CO 3 | Apply user-centered design methodologies in the development of interactive systems |
| CO4 | Design and evaluate user interfaces using appropriate design principles and guidelines |
| CO5 | Plan, conduct, and analyze usability testing sessions |

| UNITS | HUMAN COMPUTER INTERACTION | CREDITS 3 HOURS 45 |
|---|---|---|
| I | Introduction to HCI: Introduction to Human Factors, Cognitive Aspects, Paradigms, HCI in Software Process, Design Rules | 15 Hrs |
| II | Interaction Design: Interaction Design Basics, What is Interaction Design?, The Process of Interaction Design, Conceptualizing Interaction, Social Interaction, Emotional Interaction | 15 Hrs |
| III | Design in Practice & Evaluation: Data Gathering, Discovering Requirements, Design, Prototyping & Construction, Introducing Evaluation, Evaluation Studies: From controlled to natural settings, Evaluation: Inspection, Analytics and Models. | 15 Hrs |

## COURSE CODE: RPSCSPE612
## COURSE TITLE: PRACTICALS OF HUMAN COMPUTER INTERACTION

| Course Outcomes | After Completing this course student will be able to : |
|---|---|
| CO1 | Apply fundamentals principles of HCI in hands-on projects |
| CO2 | Conduct user research using various methods such as interviews, surveys, and observations |
| CO3 | Plan, conduct, and analyze usability testing sessions for various interfaces |
| CO4 | Develop creative and effective solutions to enhance user interaction and experience |

| RPSCSPE612 | PRACTICAL OF HUMAN COMPUTER INTERACTION | CREDITS 1 HOURS 15 |
|---|---|---|
| 1 | Usability testing | |
| 2 | Wireframing prototyping using tools such as Sketch, Adobe Xd, Figma | |
| 3 | Accessibility evaluation | |
| 4 | User persona development | |
| 5. | Evaluation of various interface | |
| 6 | Mobile App usability testing | |
| 7. | | |
| 8. | | |

**Text book:**

1. Interaction Design: Beyond Human Computer Interaction, Helen Sharp, Yvonne Rogers & Jennifer Preece, Wiley, 5th Edition
2. Human-Computer Interaction, Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, Pearson Education, 3rd Edition
3. An introduction to Human Factors Engineering, Wickens, Lee, Liu, and Gordon-Becker, Pearson Education, 2nd Edition.

**COURSE CODE:RPSINTCSE614**
**COURSE TITLE: OJT/ INTERNSHIP**

| Course Outcomes | After Completing this course student will be able to : |
|---|---|
| CO 1 | Apply theoretical knowledge gained from the academic course-work. |
| CO 2 | Develop professional skills required in a professional work environment. |
| CO 3 | Create a network with professionals in their field for future career opportunities. |
| CO 4 | Develop a professional portfolio enhancing their competitiveness in the market. |

| COURSE CODE RPSINTCSE614 | OJT / INTERNSHIP | CREDITS 10 HOURS 600 |
|---|---|---|
| The syllabus proposes an internship for about 600-650 hours to be done by a student. It is expected that a student chooses an IT or IT-related industry and formally works as a full time intern during the period. The student should give a presentation of the internship subject as the part of internship evaluation with proper documentation of the attendance and the type of work he or she has done in the chosen organization. Proper certification (as per the guidelines given) by the person, to whom the student was reporting, with the Organization's seal should be attached as part of the documentation. Students will be awarded 14 credits for the entire internship along with the final presentation in front of the examiners. | | |

## COURSE CODE:RPSECSE613
## COURSE TITLE: ADVANCED DATA MODELLING

| Course Outcomes | After Completing this course student will be able to : |
|---|---|
| CO 1 | Interpret different Data modelling Techniques for handling a variety of data. |
| CO 2 | Evaluate and Apply appropriate NoSQL database for a specific use case. |
| CO 3 | Analyze spatial data, relationships and metrics. |
| CO4 | Design and implement applications for semi-structured data. |

| UNITS | ADVANCED DATA MODELLING | CREDITS 3 HOURS 45 |
|---|---|---|
| I | Spatial data modelling: spatial data types, Raster, vector representation, topological spatial relationships, indexing, Geographical information systems: Data management, processing, referencing and analysis, visualization | 15 Hrs |
| II | Semi-structured data modelling:<br>Semi-structured data model, Hierarchical data model, DTD, XML documents and schema, XML documents and databases, XML querying | 15 Hrs |
| III | Nosql: Features,Managing different data types,consistency methods,Distributed scenario, Partitioning,Query model,Storage layout,Enterprise application Evaluating Nosql:Technical ,Business,issues<br>NoSQL data stores: features and use cases of key-value,graph data store, document database, columnar , search engines. | 15 Hrs |

**COURSE CODE:RPSECSPE613**
**COURSE TITLE: PRACTICALS OF ADVANCED DATA MODELLING**

| Course Outcomes | After Completing this course student will be able to : |
|---|---|
| CO1 | Demonstrate techniques of handling semi structured data |
| CO2 | Use NO-SQL database |
| CO2 | Apply mechanism with spatial data |

| Sr. No. | PRACTICAL OF ADVANCED DATA MODELLING | CREDITS 1 HOURS 15 |
|---|---|---|
| | Real-world Case studies based on the following single category of databases or a combination of multiple database | |
| 1 | Semi-structured data | |
| 2 | Spatial data | |
| 3 | GIS | |
| 4 | Nosql: Columnar data store | |
| 5 | NoSQL: Key-value datastore | |
| 6 | NoSQL: Graph datastore | |
| 7 | NoSQL: Document datastore | |
| 8 | NoSQL: Search engine | |

**Text book:**

1. NoSQL for Dummies by Adam Fowler published by Willey
2. NoSQL and SQL Data modelling By Ted Hills
3. Fundamentals of database systems Navathe
4. Principles of GIS, otto Huisman, Rolf A

## COURSE CODE:RPSECSE613
## COURSE TITLE: SOFTWARE DESIGN PATTERNS

| Course Outcomes | After Completing this course student will be able to : |
|---|---|
| CO 1 | Understand the concept of Design patterns and its importance |
| CO 2 | Relate the Creational, Structural & behavioral Design |
| CO 3 | Understand the problem & derive solutions. |
| CO4 | Apply the suitable design patterns to refine the basic design for given context. |

| UNITS | SOFTWARE DESIGN PATTERNS | CREDITS 3 HOURS 45 |
|---|---|---|
| I | What Is a Design Pattern?, Describing Design Pattern, How Design Patterns Solve Design Problems, How to Select a Design Pattern, How to Use a Design Pattern, What is UML? Why Use UML?, Class Diagram, Interaction(Sequence) Diagram | 15 Hrs |
| II | Why Study Design Pattens, Advantages of Studying Design Patterns, Types of Design Patterns: Creational Pattern, Structural Pattern, Behavioural Pattern. Creational Pattern - Abstract Factory, Builder, Factory Method, Prototype, Singleton, Structural Pattern - Adapter, Bridge, Composite, Decorator, Facade, Flyweight, Proxy | 15 Hrs |
| III | Behavioural Pattern: Chain of Responsibility, Command, Interpreter, Iterator, Mediator, Memento,Observer, State, Strategy, Template Method, Visitor. What to expect from a design pattern? Design Patten Encapsulates Implementation, Commonality Vs Variability Analysis, Decomposing Problem Domain into Responsibilities | 15 Hrs |

## COURSE CODE: RPSECSPE613
## COURSE TITLE: PRACTICALS OF SOFTWARE DESIGN PATTERNS

| Course Outcomes | After Completing this course student will be able to : |
|---|---|
| CO1 | Identify the appropriate design patterns to solve object oriented design problems. |
| CO2 | Develop design solutions using creational patterns. |
| CO2 | Apply structural patterns to solve design problems. |

| SR. NO. | PRACTICAL OF SOFTWARE DESIGN PATTERNS | CREDITS 1 HOURS 15 |
|---|---|---|
| 1 | Create a Class Diagram | |
| 2 | Create a Sequence Diagram | |
| 3 | Demonstrate Builder Pattern | |
| 4 | Demonstrate Factory Method Pattern | |
| 5. | Demonstrate Singleton Pattern | |
| 6 | Demonstrate Adapter Pattern | |
| 7. | Demonstrate Facade Pattern | |
| 8. | Demonstrate Observer Pattern | |
| 9 | Demonstrate Iterator Pattern | |
| 10 | Demonstrate how a design pattern is selected. | |

**Text book:**

1. "Design Patterns: Elements of Reusable Object-Oriented Software" by Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides

2. Design Patterns Explained: A New Perspective on Object-Oriented Design

3. "Head First Design Patterns" by Eric Freeman, Elisabeth Robson, Bert Bates, Kathy Sierra

4. Design Patterns - Refactoring Guru - https://refactoring.guru/design-patterns

# MODALITIES OF ASSESSMENT

## MODALITY OF ASSESSMENT - DSC/DSE (FOR 3 CREDITS)

**Theory Examination Pattern:**

**A) Internal Assessment (40%) - 30 Marks**

| Sr No | Evaluation type | Marks |
|---|---|---|
| 1 | Class Test | 20 |
| 2 | Class Test/ Project / Assignment / Presentation | 10 |
| | **TOTAL** | **30** |

**B) External Examination (Semester End 60%) - 45 Marks**
**Semester End Theory Examination:**

1. Duration – The duration for these examinations shall be of **two hours.**
2. Theory question paper pattern:

**Paper Pattern:**

| Questions | Options | Marks | Questions Based on |
|---|---|---|---|
| 1 | 3 questions of 5 M each from 4 Questions | 15 | Unit I |
| 2 | 3 questions of 5 M each from 4 Questions | 15 | Unit II |
| 3 | 3 questions of 5 M each from 4 Questions | 15 | Unit III |
| | **TOTAL** | **45** | |

**Practical Examination Pattern:**

**A) External Assessment Semester End - 50 Marks**

| Sr No | Evaluation type | Marks |
|---|---|---|
| 1 | Practical Implementation for the given question | 40 |
| 2 | Attendance, Punctuality and Lab discipline/Practice | 10 |
| | **TOTAL** | **50** |

## RESEARCH PROJECT EVALUATION -150 MARKS

**Internal evaluation - 60 Marks**

- Abstract submission & Literature Survey / sample data collection - 10 Marks
- Technology Implementation - 10 marks
- Mid-Term Presentation - 20 Marks
- Project Documentation- 20 marks

**External evaluation - 90 Marks**

- Project Quality - 20 Marks.
- Project Implementation - 40 Marks.
- Presentation - 30 Marks.

**A Student should submit a project implementation report with the following details:**

1. **Title:** Title of the project.
2. **Implementation details:** A description of how the project has been implemented. It shall be 2 to 4 pages.
3. **Experimental set-up and results:** A detailed explanation of how experiments were conducted, what software was used and the results obtained. Details like screenshots, tables and graphs can come here. It shall be 6 to 10 pages.
4. **Analysis of the results:** A description of what the results mean and how they have been arrived at. Different performing measures or statistical tools used etc may be part of this. It shall be 4 to 6 pages.
5. **Conclusion:** A conclusion of the project performed in terms of its outcome (Maybe half a page).
6. **Future enhancement:** A small description of what enhancement can be done when more time and resources are available (Maybe half a page).
7. **Program code:** The program code may be given as an appendix.

**Note:**

1. **Students have to acquire at least 40% marks in project evaluation.**
2. **Internal evaluation will be done by the Project guide allotted.**
3. **Timely submission on google classroom as per requirement is must, regularity will be determined based on that.**
4. **Attendance should be 75%.**

## INTERNSHIP EVALUATION - 250 MARKS

**Internal evaluation - 100 Marks**

**Following are the guidelines for evaluation:**

1. Job description: 20 Marks
2. Technical knowledge/skills: 20 Marks
3. Innovation & creativity: 20 Marks
4. Adherence to Schedule (weekly activity report): 20 Marks
5. Soft Skills (Communication, Teamwork, Resource Management, Leadership qualities): 20 Marks

**External evaluation - 150 Marks (50% by employer & 50% by the external examiner)**

On the basis of the detailed internship report submitted by the student duly signed by the employer and the internal faculty. A presentation is expected from the student for sharing his / her learning experience and work done at the internship.

**Following are the guidelines for evaluation:**

1. Internship Report: 30 Marks
2. Innovation and creativity: 30 Marks
3. Experience-based learning: 30 Marks
4. Viva: 20 Marks
5. Internship Genuineness: 10 Marks
6. Soft Skills: 10 Marks
7. Suitability & Clarity of material presented: 10 Marks
8. Quality of oral presentation: 10 Marks

**Note: - Students need to find an Internship by themselves. It's their responsibility.**

**The following things are expected to be completed by the student for the final evaluation.**

1. The syllabus proposes an internship for about 600 hours to be done by a student.
2. It is expected that a student chooses an IT or IT-related industry and formally works as a full-time intern during the period.
3. Evaluation will be done based on the feedback given by the employers about the student.
4. The student should subject himself/herself to an internship evaluation with proper documentation of the attendance and the type of work he or she has done in the chosen organization.

Following are the guidelines laid for the same

1. Internship joining Letter with the proper job description.
2. Weekly Report in Excel format to be shown every week to Internal In-charge
    - Start date
    - End date
    - Task Assigned
    - Task completed
    - Outcome / Learning's
3. Internship Completion Letter with proper hours & task completed.
4. Employer Feedback Form is prepared to assess based on the following:
    - Skills/ Knowledge
    - Self-Management
    - Dependability
    - Attitude
    - Relationships
5. Internship report:
    - Organization Overview
    - Description (Role, Activities, Technology Used, Live project link or screenshots)
    - SWOT Analysis
    - Introspection (knowledge acquired, Skills learned, challenging task performed)

- Employers Feedback.

6. Proper certification by the person, to whom the student was reporting, with Organization's seal should be attached as part of the documentation.

Note: - Students need to find Internships by themselves. It's their responsibility

**PASSING CRITERIA 40%:** - Students must acquire a minimum of 40% marks in each course individually (Theory, Practical, Project & Internship).