

University of Mumbai



Bachelor of Engineering in

- Computer Science and Engineering (Data Science)
- Computer Science and Engineering (Artificial Intelligence and Machine Learning)
- Artificial Intelligence and Data Science
- Artificial Intelligence and Machine Learning
- Data Engineering

Fourth Year with Effect from AY 2023-24

(REV- 2019 'C' Scheme) from Academic Year 2019 – 20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

University of Mumbai



| Sr. No. | Heading | Particulars |
|---------|--------------------------------------|---|
| 1 | Title of the Course | Fourth Year Engineering |
| 2 | Eligibility for Admission | After Passing Second Year Engineering as per the Ordinance 0.6243 |
| 3 | Passing Marks | 40% |
| 4 | Ordinances / Regulations (if any) | Ordinance 0.6243 |
| 5 | No. of Years / Semesters | 8 semesters |
| 6 | Level | P.G. / U.G./Diploma / Certificate (Strike out which is not applicable) |
| 7 | Pattern | Yearly / Semester (Strike out which is not applicable) |
| 8 | Status | New/ Revised (Strike out which is not applicable) |
| 9 | To be implemented from Academic Year | With effect from Academic Year:2023-2024 |

Dr. S.K.Ukarande
Associate Dean
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Dr. Anuradha Muzumdar
Dean
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Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering) of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 13 weeks and remaining 2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2021-22. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2022-23, 2023-24, respectively.

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Incorporation and Implementation of Online Contents **from NPTEL/ Swayam Platform**

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of 'C' scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme 'A' and 'B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD's/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

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Preface by Board of Studies in Computer Engineering

Dear Students and Teachers, we, the members of Board of Studies Computer Engineering, are very happy to present Fourth Year Computer Engineering Specialization in Data Science, Data Engineering, Artificial Intelligence and Machine learning syllabus effective from the Academic Year 2021-22 (REV-2019'C' Scheme). We are sure you will find this syllabus interesting, challenging, fulfill certain needs and expectations.

Emerging Programs in the field of Computer Engineering is one of the most sought-after courses amongst engineering students. The syllabus needs revision in terms of preparing the student for the professional scenario relevant and suitable to cater the needs of industry in present day context. The syllabus focuses on providing a sound theoretical background as well as good practical exposure to students in the relevant areas. It is intended to provide a modern, industry-oriented education in Computer Engineering. It aims at producing trained professionals who can successfully acquaint with the demands of the industry worldwide. They obtain skills and experience in up-to-date the knowledge to analysis, design, implementation, validation, and documentation of computer software and systems.

The revised syllabus is finalized through a brain storming session attended by Heads of Departments or senior faculty from the Department of Computer Engineering of the affiliated Institutes of the Mumbai University. The syllabus falls in line with the objectives of affiliating University, AICTE, UGC, and various accreditation agencies by keeping an eye on the technological developments, innovations, and industry requirements.

The salient features of the revised syllabus are:

1. Reduction in credits to 170 is implemented to ensure that students have more time for extracurricular activities, innovations, and research.
2. The department Optional Courses will provide the relevant specialization within the branch to a student.
3. Introduction of Skill Based Lab and Mini Project to showcase their talent by doing innovative projects that strengthen their profile and increases the chance of employability.
4. Students are encouraged to take up part of course through MOOCs platform SWAYAM

We would like to place on record our gratefulness to the faculty, students, industry experts and stakeholders for having helped us in the formulation of this syllabus.

Board of Studies in Computer Engineering

| | |
|-----------------------|------------|
| Prof. Sunil Bhirud | : Chairman |
| Prof. SunitaPatil | : Member |
| Prof. Leena Ragha | : Member |
| Prof. Subhash Shinde | : Member |
| Prof .Meera Narvekar | : Member |
| Prof. Suprtim Biswas | : Member |
| Prof. Sudhir Sawarkar | : Member |
| Prof. Dayanand Ingle | : Member |
| Prof. Satish Ket | : Member |

Program Structure for Fourth Year CSE (AIML), CSE (DS) AI&DS, DE, AI&ML

UNIVERSITY OF MUMBAI (With Effect from 2023-2024)

Semester VIII

| Course Code | Course Name | Teaching Scheme (Contact Hours) | | | | Credits Assigned | | | |
|-------------|---|---------------------------------|--------|-----|-----------------|------------------------|-----------|--------------|-------|
| | | Theory | | | Pract. Tut. | Theory | Pract. | Total | |
| CSC801 | Advanced Artificial Intelligence | 3 | | | -- | 3 | -- | 3 | |
| CSDO 801X | Department Level Optional Course-5 | 3 | | | -- | 3 | -- | 3 | |
| CSDO 802X | Department Level OptionalCourse-6 | 3 | | | -- | 3 | -- | 3 | |
| ILO 801X | Institute Level OptionalCourse-2 | 3 | | | -- | 3 | -- | 3 | |
| CSL801 | Advanced Artificial Intelligence Lab | -- | | | 2 | -- | 1 | 1 | |
| CSDOL 801X | Department Level Optional Course-5 Lab | -- | | | 2 | -- | 1 | 1 | |
| CSDOL 802X | Department Level Optional Course-6 Lab | -- | | | 2 | -- | 1 | 1 | |
| CSP801 | Major Project-2 | -- | | | 12 [#] | -- | 6 | 6 | |
| Total | | 12 | | | 18 | 12 | 9 | 21 | |
| Course Code | Course Name | Examination Scheme | | | | | | | |
| | | Theory | | | | | Term Work | Pract & oral | Total |
| | | Internal Assessment | | | End Sem Exam | Exam Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| CSC801 | Advanced Artificial Intelligence | 20 | 20 | 20 | 80 | 3 | -- | -- | 100 |
| CSDO8 01X | Department Level Optional Course -5 | 20 | 20 | 20 | 80 | 3 | -- | -- | 100 |
| CSDO 802X | Department Level Optional Course -6 | 20 | 20 | 20 | 80 | 3 | -- | -- | 100 |
| ILO80X | Institute Level Optional Course-2 | 20 | 20 | 20 | 80 | 3 | -- | -- | 100 |
| CSL801 | Advanced Artificial Intelligence Lab | -- | -- | -- | -- | -- | 25 | 25 | 50 |
| CSDOL 801X | Department Level Optional Course -5 Lab | -- | -- | -- | -- | -- | 25 | 25 | 50 |
| CSDOL 802X | Department Level Optional Course -6 Lab | | | | | | 25 | 25 | 50 |
| CSP801 | Major Project 2 | -- | -- | -- | -- | -- | 100 | 50 | 150 |
| Total | | -- | -- | 80 | 320 | -- | 175 | 125 | 700 |

Major Project 1 and 2 :

- Students can form groups with minimum 2 (Two) and not more than 4 (Four)
- Faculty Load : In Semester VII – ½ hour per week per project group
In Semester VIII – 1 hour per week per project group

Program Structure for Fourth Year CSE (AIML), CSE (DS) AI&DS, DE, AI&ML**UNIVERSITY OF MUMBAI (With Effect from 2023-2024)****Department and Institute Optional Courses and Labs**

| Semester | Department/ Institute Optional Courses and Labs | Subject and Labs |
|-----------------|--|--|
| VIII | Department Optional Course -5 | CSDO8011: AI for financial & Banking application CSDO8012: Quantum Computing CSDO8013: Reinforcement Learning |
| | Department Optional Lab -5 | CSDOL8011: AI for financial & Banking application Lab CSDOL8012: Quantum Computing Lab CSDOL8013: Reinforcement Learning Lab |
| | Department Optional Course -6 | CSDO8021: Graph Data Science CSDO8022: Recommendation Systems CSDO8023: Social Media Analytic |
| | Department Optional Lab -6 | CSDOL8021: Graph Data Science Lab CSDOL8022: Recommendation Systems Lab CSDOL8023: Social Media Analytic Lab |
| | Institute level Optional Courses-II | ILO8021: Project Management ILO8022: Finance Management ILO8023: Entrepreneurship Development and Management ILO8024: Human Resource Management ILO8025: Professional Ethics and CSR ILO8026: Research Methodology ILO8027: IPR and Patenting ILO8028: Digital Business Management ILO8029: Environmental Management |

| Course Code | Course Title | Credit |
|-------------|----------------------------------|--------|
| CSC801 | Advanced Artificial Intelligence | 3 |

Prerequisite: Engineering Mathematics, Data Structures and Algorithm, Python Programming

Course Objectives:

| | |
|---|---|
| 1 | To relate with the basic concepts of Probabilistic Models. |
| 2 | To understand the scope of Generative Networks in the field of AI. |
| 3 | To recognize various components of Autoencoder Architecture and Training process. |
| 4 | To learn the fundamentals of Transfer Learning. |
| 5 | Provide students with a comprehensive understanding of ensemble methods and their applications. |
| 6 | To explore the nascent applications of AI |

Course Outcomes: After successful completion of the course student will be able to

| | |
|---|--|
| 1 | Acquire basic knowledge of Probabilistic Models. |
| 2 | Analyze the working and architecture for Generative Networks. |
| 3 | Interpret various components and various types of Autoencoders |
| 4 | Understand various aspects of Transfer Learning. |
| 5 | Apply ensemble learning techniques to real-world problems and demonstrate improved predictive performance. |
| 6 | Relate to the nascent technologies in the field of artificial intelligence. |

| Module | | Content | Hrs |
|--------|-----|--|-----|
| 1.0 | | Generative and Probabilistic Models | 08 |
| | 1.1 | Introduction: Overview of generative models and their importance in AI, Fundamentals of Probability theory and generative modeling, Introduction to GANs, VAEs and other generative models. Significance of generative models, Challenges with generative models. | |
| | 1.2 | Probabilistic Models: Gaussian Mixture Models (GMMs), Hidden Markov Models (HMMs), Bayesian Networks, Markov Random Field (MRFs), Probabilistic Graphical Model. | |
| 2.0 | | Generative Adversarial Network | 07 |
| | 2.1 | Basics of GAN : Generative Adversarial Networks (GANs) architecture, The discriminator model and generator model, Architecture and Training GANs, Vanilla GAN Architecture. GAN variants and improvements (DCGAN, WGAN, Conditional GAN, CycleGAN), Challenges- Training instability and model collapse, GAN applications in image synthesis and style transfer. | |
| 3.0 | | Variational Autoencoders | 07 |

| | | |
|------------|---|-----------|
| | 3.1 Introduction: Basic components of Variational Autoencoders(VAEs), Architecture and training of VAEs the loss function, Latent space representation and inference, Applications of VAEs in image generation. | |
| | 3.2 Types of Autoencoders: Undercomplete autoencoders, Sparse autoencoders, Contractive autoencoders, Denoising autoencoders, Variational Autoencoders (for generative modelling) | |
| 4.0 | Transfer Learning | 05 |
| | 4.1 Introduction to transfer learning Basic terminologies, Pre-trained model and data sets, Feature extraction and fine tune transfer learning , Recent advancement in transfer learning : self-supervised learning and meta learning. | |
| 5.0 | Ensemble learning | 06 |
| | 5.1 Ensemble Classifiers: Introduction to Ensemble Methods. Bagging and random forests, Boosting algorithms : AdaBoost Stacking and blending models, Extreme Gradient Boosting (XGBoost): XGBoost Regression and classification. | |
| 6.0 | Nascent Technologies in AI | 06 |
| | 6.1 Convergence of AI with Augmented / Virtual reality techniques for product and process development Limitations of 2D Learning Environments, Evolution of virtual worlds and immersive technologies, Definition and concepts of Augmented Reality, Definition and concept of the Metaverse, Characteristics and components of the Metaverse, Challenges and opportunities in the Metaverse ecosystem, AI in the realm of emerging quantum computing paradigms | |

| Textbooks: | |
|-------------------|---|
| 1 | Foster, D., 2022. <i>Generative deep learning</i> . " O'Reilly Media, Inc." |
| 2 | Koller, D. and Friedman, N., 2009. <i>Probabilistic graphical models: principles and techniques</i> . MIT press |
| 3 | Goodfellow, I., 2016. Deep Learning-Ian Goodfellow, Yoshua Bengio, Aaron Courville- Google Books |
| 4 | Murphy, K.P., 2012. <i>Machine learning: a probabilistic perspective</i> . MIT press |
| 5 | Zhou, Z.H., 2012. <i>Ensemble methods: foundations and algorithms</i> . CRC press. |

| References: | |
|--------------------|--|
| 1 | Xiong, J., Hsiang, E.L., He, Z., Zhan, T. and Wu, S.T., 2021. Augmented reality and virtual reality displays: emerging technologies and future perspectives. <i>Light: Science & Applications</i> , 10(1), p.216. |
| 2 | Mystakidis, S., 2022. Metaverse. <i>Encyclopedia</i> , 2(1), pp.486-497 |
| 3 | Gill, S.S., Xu, M., Ottaviani, C., Patros, P., Bahsoon, R., Shaghaghi, A., Golec, M., Stankovski, V., Wu, H., Abraham, A. and Singh, M., 2022. AI for next generation computing: Emerging trends and future directions. <i>Internet of Things</i> , 19, p.100514 |

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|---|--|
| 4 | Mangini, S., Tacchino, F., Gerace, D., Bajoni, D. and Macchiavello, C., 2021. Quantum computing models for artificial neural networks. <i>Europhysics Letters</i> , 134(1), p.10002. |
| Digital References: | |
| https://nptel.ac.in/courses/106106201 | |
| https://onlinecourses.nptel.ac.in/noc20_cs62/preview | |
| https://machinelearningmastery.com/what-are-generative-adversarial-networks-gans/ | |

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| <u>Assessment:</u> | |
| Internal Assessment: | |
| Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour. | |
| End Semester Theory Examination: | |
| 1 | Question paper will comprise of total six questions. |
| 2 | All question carries equal marks |
| 3 | Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3) |
| 4 | Only Four question need to be solved. |
| 5 | In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus. |

| Course Code | Course Name | Total |
|-------------|--|-------|
| CSDO8011 | AI for financial & Banking application | 03 |

Course Objectives:

| Sr. No | Course Objectives |
|--------|---|
| 1 | To understand the impact of technology and digitization on financial and banking enterprises. |
| 2 | To explore blockchain technologies in the financial sector. |
| 3 | To examine digital money transfer mechanisms and GIFT cities. |
| 4 | To evaluate the benefits of digitization and cloud services in banking. |
| 5 | To analyze enterprise software solutions for financial operations. |
| 6 | To study the integration of AI in banking processes |

Course Outcomes:

| Sr. No | Course Outcomes |
|---|--|
| On successful completion, of course, learner/student will be able to: | |
| 1 | Gain knowledge of technology's influence on financial and banking enterprises. |
| 2 | Understand the applications of blockchain in the financial sector. |
| 3 | Recognize digital money transfer mechanisms and its role in digitization |
| 4 | Evaluate the advantages of digitization and cloud services in banking. |
| 5 | Analyze enterprise software solutions for financial operations. |
| 6 | Explore the integration of AI in banking processes. |

DETAILED SYLLABUS:

| Sr. No. | Module | Detailed Content | Hours |
|---------|--|---|-----------|
| 1 | Information Technology Infrastructure and Digitization of Financial Banking Enterprises | Digital Technology driven processes, BlockChain technologies for Financial – Banking sector, GIFT cities, Digital Money transfer Mechanisms. Digitization/ cloud services and solutions in banking and financial services Profiling enterprise software's in financial and banking enterprises. Building Efficiencies, productivity, and infallibility in financial & Banking operations. Detailed study of various processes which shall be transformed by AI integration in banking and financial services. | 04 |

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| | | Self-learning : Introduction to business efficiencies, industrial productivity and high degree reliability systems for competitive advantage and carbon neutral enterprises. | |
| 2 | Financial Statistics and The Sharpe Ratio | Probability, Combinatorics, Mathematical Expectation ,Sample Mean, Standard Deviation, and Variance ,Sample Skewness and Kurtosis ,Sample Covariance and Correlation ,Financial Returns ,Capital Asset Pricing Model ,Sharpe Ratio Formula, Time Periods and Annualizing, Ranking Investment Candidates, The Quantmod Package, Measuring Income Statement Growth, Sharpe Ratios for Income Statement Growth | 07 |
| 3 | Cluster Analysis | K-Means Clustering, Dissecting the K-Means Algorithm Sparsity and Connectedness of Undirected Graph Covariance and Precision Matrices, Visualizing Covariance, The Wishart distribution Glasso Penalization for Undirected Graphs, Running the Glasso Algorithm, Tracking a Value Stock through the Years Regression on Yearly Sparsity , Regression on Quarterly Sparsity , Regression on Monthly Sparsity | 07 |
| 4 | Gauging the Market Sentiment | Markov Regime Switching Model, Reading the Market Data, Bayesian Reasoning, The Beta Distribution , Prior and Posterior Distributions , Examining Log Returns for Correlation ,Momentum Graphs ,Simulating Trading Strategies , Foreign Exchange Markets , Chart Analytics Initialization and Finalization , Momentum Indicators , Bayesian Reasoning within Positions , Entries , Exits ,Profitability,, Short-Term Volatility, The State Machine | 07 |
| 5 | Trading algorithms | Vectorized Backtesting, Backtesting an SMA-Based Strategy, Backtesting a Daily DNN-Based Strategy Backtesting an Intraday DNN-Based Strategy , Risk Management : Trading Bot , Vectorized Backtesting Event-Based Backtesting ,Assessing Risk , Backtesting Risk Measures , Stop Loss , Trailing Stop Loss , Take Profit | 07 |
| 6 | Fraud Analytics | Introduction , The Analytical Fraud Model Life Cycle , Model Representation , Traffic Light Indicator Approach ,Decision Tables , Selecting the Sample to Investigate ,Fraud Alert and Case Management ,Visual Analytics ,Backtesting Analytical Fraud Models : Backtesting Data Stability ,Backtesting Model Stability ,Backtesting Model Calibration , Model Design and Documentation | 07 |

| Textbooks: | |
|-------------------|--|
| 1 | Financial Analytics with R Building a Laptop Laboratory for Data Science MARK J. BENNETT University of Chicago DIRK L. HUGEN University of Iowa |
| 2 | Artificial Intelligence in Finance A Python-Based Guide, Yves Hilpisch A |
| 3 | Fraud Analytics Using Descriptive, Predictive, and Social Network Techniques: A Guide to Data Science for Fraud Detection , Bart Baesens, Veronique Van Vlasselaer, Wouter Verbeke |

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|--|--|
| References: | |
| 1 | "Machine Learning for Asset Managers" by Marcos López de Prado |
| 2 | "Advances in Financial Machine Learning" by Marcos López de Prado. |
| Digital References: | |
| 1. https://www.eastnets.com/newsroom/digital-transformation-in-the-banking-and-financial-services-sector | |
| 2. https://www.techopedia.com/definition/34633/generative-ai | |

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| <u>Assessment:</u> | |
| Internal Assessment: | |
| Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour. | |
| End Semester Theory Examination: | |
| 1 | Question paper will comprise of total six questions. |
| 2 | All question carries equal marks |
| 3 | Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3) |
| 4 | Only Four question need to be solved. |
| 5 | In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus. |

| Course Code | Course Title | Credit |
|-------------|-------------------|--------|
| CSDO8012 | Quantum Computing | 3 |

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|---|--|---|------------|
| Prerequisite: Engineering Mathematics, Data Structures and Algorithm, Python Programming | | | |
| Course Objectives: | | | |
| 1 | To understand basics of quantum computing | | |
| 2 | To understand mathematics required for quantum computing | | |
| 3 | To understand building blocks of quantum computing and design algorithms | | |
| 4 | To understand quantum hardware principles and tools for quantum computing. | | |
| Course Outcomes: After successful completion of the course student will be able to | | | |
| 1 | Understand basic concepts of quantum computing | | |
| 2 | Illustrate building blocks of quantum computing through architecture and programming models. | | |
| 3 | Appraise various mathematical models required for quantum computing | | |
| 4 | Discuss various quantum hardware building principles. | | |
| 5 | Identify the various quantum algorithms | | |
| 6 | Describe usage of tools for quantum computing. | | |
| Module | | Content | Hrs |
| 1.0 | | Introduction to Quantum Computing | 7 |
| | 1.1 | Motivation for studying Quantum Computing Origin of Quantum Computing Quantum Computer vs. Classical Computer Introduction to Quantum mechanics Overview of major concepts in Quantum Computing | |
| | 1.2 | Qubits and multi-qubits states Bloch Sphere representation Quantum Superposition Quantum Entanglement Major players in the industry (IBM, Microsoft, Rigetti, D-Wave etc.) | |
| 2.0 | | Mathematical Foundations for Quantum Computing | 05 |
| | 2.1 | Matrix Algebra: basis vectors and orthogonality, inner product and Hilbert spaces, matrices and tensors, unitary operators and projectors, Dirac notation, Eigen values and Eigen vectors. | |
| 3.0 | | Building Blocks for Quantum Program | 08 |

| | | | |
|------------|-----|---|-----------|
| | 3.1 | Architecture of a Quantum Computing platform Details of q-bit system of information representation: Block Sphere Multi-qubits States Quantum superposition of qubits (valid and invalid superposition) Quantum Entanglement Useful states from quantum algorithmic perceptive e.g. Bell State Operation on qubits: Measuring and transforming using gates. Quantum Logic gates and Circuit No Cloning Theorem and Teleportation | |
| | 3.2 | Programming model for a Quantum Computing Program Steps performed on classical computer Steps performed on Quantum Computer Moving data between bits and qubits. | |
| 4.0 | | Quantum Algorithms and Error correction | 06 |
| | 4.1 | Quantum Algorithms, Shor's Algorithm, Grover's Algorithm. Deutsch's Algorithm, Deutsch-Jozsa Algorithm | |
| | 4.2 | Quantum error correction using repetition codes 3 qubit codes, Shor's 9 qubit error correction Code | |
| 5.0 | | Quantum Hardware | 10 |
| | 5.1 | Ion Trap Qubits ,The DiVincenzo Criteria , Lagrangian and Hamiltonian Dynamics in a Nutshell: Dynamics of a Translating Rotor | |
| | 5.2 | Quantum Mechanics of a Free Rotor: A Poor Person's Atomic Model: Rotor Dynamics and the Hadamard Gate, Two-Qubit Gates | |
| | 5.3 | The Cirac-Zoller Mechanism: Quantum Theory of Simple Harmonic Motion, A Phonon-Qubit Pair Hamiltonian, Light-Induced Rotor-Phonon Interactions, Trapped Ion Qubits, Mølmer-Sørensen Coupling .. | |
| | 5.4 | Cavity Quantum Electrodynamics (cQED): Eigenstates of the Jaynes-Cummings Hamiltonian Circuit QED (cirQED): Quantum LC Circuits, Artificial Atoms, Superconducting Qubits Quantum computing with spins: Quantum inverter realized with two exchange coupled spins in quantum dots, A 2-qubit spintronic universal quantum gate. | |
| 6.0 | | OSS Toolkits for implementing Quantum program | 03 |
| | 6.1 | IBM quantum experience Microsoft Q Rigetti PyQuil (QPU/QVM) | |

| Textbooks: | |
|-------------------|---|
| 1 | Michael A. Nielsen, —Quantum Computation and Quantum Information, Cambridge University Press. |
| 2 | David McMahon, —Quantum Computing Explained, Wiley ,2008 |
| 3 | Qiskit textbook https://qiskit.org/textbook-beta/ |
| 4 | Vladimir Silva, Practical Quantum Computing for Developers,2018 |

| | |
|---|---|
| References: | |
| 1 | Bernard Zygelman, A First Introduction to Quantum Computing and Information, 2018 |
| 2 | Supriyo Bandopadhyay and Marc Cahy, —Introduction to Spintronics, CRC Press, 2008 |
| 3 | The Second Quantum Revolution: From Entanglement to Quantum Computing and Other Super-Technologies, Lars Jaeger |
| 4 | La Guardia, Giuliano Gladioli —Quantum Error correction codes, Springer, 2021 |
| Digital References: | |
| https://onlinecourses.nptel.ac.in/noc21_cs103/preview | |
| https://www.coursera.org/courses?query=quantum%20computing | |
| https://www.cl.cam.ac.uk/teaching/1617/QuantComp/ | |

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|---|---|
| <u>Assessment:</u> | |
| Internal Assessment: | |
| Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour. | |
| End Semester Theory Examination: | |
| 1 | Question paper will comprise of total six questions. |
| 2 | All question carries equal marks |
| 3 | Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3) |
| 4 | Only Four question need to be solved. |
| 5 | In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus. |

| Course Code: | Course Title | Credit |
|--------------|------------------------|--------|
| CSDO8013 | Reinforcement Learning | 3 |

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|---|---|
| Prerequisite: Mathematical concepts of Geometry, Linear Algebra, Calculus, Basic Electronics | |
| Course Objectives: | |
| 1 | Learn about robots as an agent of automation and other Use cases |
| 2 | Design and Development of robots based on Direct and Inverse Kinematics |
| 3 | Learn the different types of Actuators, Sensors, and degree of freedom of Robots |
| 4 | Learn the concepts of Motions, Velocities and Dynamic/ force analysis of Robots |
| 5 | Learn algorithms governing Robot movements and Robot Programming |
| 6 | Learn about integration of electronics and communication devices for multimodal functions |
| 7 | Learn about integration of AI in robotics and self-configuring Robots |
| Course Outcomes: | |
| 1 | Understand different types of robots, specifications of Robots its characteristics and applications. |
| 2 | Understanding Direct – Inverse kinematics of robotic manipulator. |
| 3 | Identify actuators, sensors, and control of a robot for different applications |
| 4 | Developing the differential relationships of motion, velocities and dynamic analysis of force |
| 5 | Developing perspectives on AI and Robotics |
| 6 | Developing footprints of algorithms, programming associated with Robots and conceptualizing self-configuring Robots and use of Robots in different applications |

| Module | | Content | Hrs |
|--------|-----|--|-----|
| 1 | | Introduction and Fundamentals of Robotics and Automation | 4 |
| | 1.1 | Automation and its types, definition of Robotics and a Robot, History of Robotics, Advantages and Disadvantages of Robot, Robotic Manipulators, Robot Motions, Robot Anatomy, Links and Joints, Classification of Robots, Specification of Robot, Applications of Robots | |
| 2 | | Direct and Inverse Kinematics | 7 |

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|----------|-----|--|----------|
| | 2.1 | Direct (Forward) Kinematics: Homogeneous coordinates, Link coordinates, Coordinate frame, coordinate transform, Arm equations, An example – Four Axis SCARA. | |
| | 2.2 | Inverse Kinematics: Inverse kinematics problem, Tool Configuration, An example – Four Axis SCARA. | |
| 3 | | Actuators and Sensors | 7 |
| | 3.1 | Characteristics of Actuating Systems, Comparison of Actuating Systems, Hydraulic Devices, Pneumatic Devices, Electric Motors, Magneto strictive Actuators | |
| | 3.2 | Sensor Characteristics, Position Sensors, Velocity Sensors, Acceleration Sensors, Force and Pressure Sensors, Torque Sensors, Light and Infrared Sensors, Touch and Tactile Sensors, Proximity Sensors, Sniff Sensors, Vision Systems, Voice Synthesizer | |
| 4 | | Motions, velocities and dynamic analysis of force | 7 |
| | 4.1 | Differential relationship, Jacobian, Differential motions of a frame and robot, Inverse Jacobian, Lagrangian mechanics, Moments of Inertia, Dynamic equations of robots, Transformation of forces and moment between coordinate frames | |
| 5 | | Self-configuring Robots and AI integration | 8 |
| | 5.1 | Historical perspective of AI in Robotics, Uncertainty in Robotics Reinforcement Learning: Basic overview, examples, elements, Tabular Solution Methods - Multiarmed bandits, Finite Markov decision process, Dynamic programming (Policy Evaluation, Policy Iteration, Value Iteration), Monte Carlo Methods. | |
| 6 | | Applications of Robotics for Automation | 6 |
| | 6.1 | Robot Application in Manufacturing: Material Transfer - Material handling, loading and unloading Processing - spot and continuous arc welding & spray painting – Assembly Inspection, Selected Embedded System based Applications: Database Applications (smart cards), Process-Control (Fuzzy logic), Robot application in Medical, Industrial Automation, Security | |

| Textbooks: | |
|--------------------|---|
| 1 | Robert Shilling, “Fundamentals of Robotics-Analysis and control”, PHI, 2003. |
| 2 | Saeed B. Niku, “Introduction to Robotics Analysis, Systems, Applications”, 3rd Edition, Wiley, 2019. |
| 3 | Saha, S.K., “Introduction to Robotics”, 2nd Edition, McGraw-Hill Higher Education, New Delhi, 2014. |
| 4 | Staughard, Robotics and AI, Prentice Hall of India |
| 5 | Ashitava Ghoshal, “Robotics-Fundamental Concepts and Analysis”, Oxford University Press, Sixth impression, 2010 |
| 6 | Mukherjee S., “Robotics Process Automation”, 1st Edition, Khanna Publishing House, New Delhi, 2020. |
| References: | |
| 1 | John J. Craig, “Introduction to Robotics – Mechanics & Control”, 3rd Edition, Pearson Education, India, 2009 |
| 2 | Mark W. Spong & M. Vidyasagar, “Robot Dynamics & Control”, 2nd Wiley India Pvt. Ltd., 2004 |
| 3 | Principles of Robot Motion – Theory, Algorithms and Implementation by Howie Choset, Lynch, PHI. |

| <u>Assessment:</u> | |
|---|---|
| Internal Assessment: | |
| Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour. | |
| End Semester Theory Examination: | |
| 1 | Question paper will comprise of total six questions. |
| 2 | All question carries equal marks |
| 3 | Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3) |
| 4 | Only Four question need to be solved |
| 5 | In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus |

| Useful Links | |
|--------------|---|
| 1 | https://swayam.gov.in/nc_details/NPTEL |
| 2 | https://www.udemy.com/course/robotics-course/ |
| 3 | https://www.coursera.org/courses?query=robotics |

| Course Code | Course Name | Credit |
|-------------|--------------------|--------|
| CSDO8021 | Graph Data Science | 03 |

Course Objectives:

| Sr. No | Course Objectives |
|--------|---|
| 1 | To Understand the basics of graphs, including definitions, connectivity, and properties. |
| 2 | To Explore the use of graphs in solving puzzles and optimization problems. |
| 3 | To Learn about the advantages of graph databases over relational and NoSQL databases. |
| 4 | To Gain knowledge of data modeling with graphs, including the labeled property graph model. |
| 5 | To Develop skills in building graph database applications, including data modeling and testing. |
| 6 | To Explore real-world use cases and understand non-functional characteristics of graph databases. |

Course Outcomes:

| Sr. No | Course Outcomes |
|---|---|
| On successful completion, of course, learner/student will be able to: | |
| 1 | Demonstrate a solid understanding of graph concepts and properties. |
| 2 | Apply graph algorithms to solve puzzles and optimization problems. |
| 3 | Compare graph databases with relational and NoSQL databases. |
| 4 | Model data using the labeled property graph model and avoid common pitfalls. |
| 5 | Build graph database applications with proper data modeling and testing. |
| 6 | Analyze and implement graph database solutions for real-world use cases, considering non-functional characteristics |

DETAILED SYLLABUS:

| Sr. No. | Module | Detailed Content | Hours |
|---------|--|--|-----------|
| 1 | Introduction to Graph | Definitions and examples, Three puzzles, Paths and cycles, Connectivity, Eulerian graphs, Hamiltonian graphs, shortest path, Chinese postman problem, traveling salesman problem, trees, properties of trees | 04 |
| 2 | Introduction to Graph databases | A High-Level View of the Graph Space, Graph Databases, Graph Compute Engines, The Power of Graph Databases, Performance, Flexibility, Agility, Options for Storing Connected Data, Relational Databases Lack Relationships, NOSQL Databases Also Lack Relationships, Graph databases embraces relationship | 07 |
| 3 | Data Modelling with Graphs | Models and Goals, The Labelled Property Graph Model, Querying Graphs, A Comparison of Relational and Graph Modelling, Cross-Domain Models, Common Modelling Pitfalls, Identifying Nodes and Relationships, Avoiding Anti-Patterns | 07 |

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|---|--|---|-----------|
| 4 | Building a Graph Database Application | Data Modelling , Application Architecture ,Testing ,Capacity Planning ,Importing and Bulk Loading Data , | 07 |
| 5 | Graphs in the Real World | Organizations Choose Graph Databases, Common Use Cases, Real-World Examples, Authorization and Access Control, Geospatial and Logistics, Graph Database Internals, Native Graph Processing, Native Graph Storage, Programmatic APIs, Kernel API, Core API, Traversal Framework, Non-functional Characteristics | 07 |
| 6 | Case Study | Neo4j – About, Neo4j – Installation, Neo4j – Browser, Neo4j - Query Language (Cypher), Neo4j - Create a Node, Neo4j - Create a Relationship, Neo4j - Create an Index, Neo4j - Create a Constraint, Neo4j - Select Data with MATCH, Neo4j - Import Data from CSV, Neo4j - Drop an Index, Neo4j - Drop a Constraint, Neo4j - Delete a Node, Neo4j - Delete a Relationship | 07 |

Textbooks:

| | |
|---|---|
| 1 | Introduction to Graph Theory Fourth edition, Robin J. Wilson |
| 2 | Daphne Koller and Nir Friedman, "Probabilistic Graphical Models: Principles and Techniques", Cambridge, MA: The MIT Press, 2009 (ISBN 978-0-262-0139- 2). |
| 3 | Graph databases, Ian Robinson, Jim Webber & Emil Eifrem |

References:

| | |
|---|---|
| 1 | "Graph Databases: New Opportunities for Connected Data" by Ian Robinson, Jim Webber, and Emil Eifrem. |
| 2 | "Neo4j in Action" by Aleksa Vukotic, Nicki Watt, and Tareq Abedrabbo. |
| 3 | "Graph Databases for Beginners" by Mark Needham and Amy E. Hodler. |
| 4 | "Practical Neo4j" by Gregory Jordan. |
| 5 | "Learning Neo4j" by Rik Van Bruggen. |
| 6 | "Graph Database Applications and Concepts with Neo4j" by Dionysios Synodinos. |

Digital References:

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|----|---|
| 1. | https://web4.ensiie.fr/~stefania.dumbrava/OREilly_Graph_Databases.pdf |
| 2. | https://www.quackit.com/neo4j/tutorial/ |

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|---|---|
| <u>Assessment:</u> | |
| Internal Assessment: | |
| Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour. | |
| End Semester Theory Examination: | |
| 1 | Question paper will comprise of total six questions. |
| 2 | All question carries equal marks |
| 3 | Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3) |
| 4 | Only Four question need to be solved. |
| 5 | In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus. |

| Course Code: | Course Title | Credit |
|--------------|------------------------|--------|
| CSDO8022 | Recommendation Systems | 3 |

| | |
|--|---|
| Prerequisite: Artificial Intelligence and Machine Learning, Basic knowledge of Python | |
| Course Objectives: | |
| 1 | To introduce Recommendation systems and it's basic concepts. |
| 2 | To understand design and working of Collaborative Filtering based recommendation. |
| 3 | To analyze design and working of Content-based recommendation. |
| 4 | To understand design and working of Knowledge based recommendation. |
| 5 | To understand design and working of Ensembled- Based and Hybrid Recommendation Systems. |
| 6 | To identify the methods for evaluation of recommendation systems. |
| Course Outcomes: After successful completion of the course student will be able to | |
| 1 | To have a broad understanding of the field of Recommendation Systems. |
| 2 | In-depth Knowledge of the architecture and models for Collaborative Filtering. |
| 3 | Understanding the architecture and working of Content based recommendation systems. |
| 4 | Understanding the architecture and basics of Knowledge based recommendation systems. |
| 5 | Analyzing hybrid and ensembles recommendation systems. |
| 6 | Evaluation of recommendation systems by selecting right evaluation parameter. |

| Module | | Content | Hrs |
|--------|-----|--|-----------|
| 1.0 | | Introduction to Recommendation System | 06 |
| | 1.1 | History of recommendation system, Eliciting Ratings and other Feedback Contributions, Implicit and Implicit Ratings, Recommender system functions. | |
| | 1.2 | Linear Algebra notation: Matrix addition, Multiplication, transposition, and inverses; covariance matrices, Understanding ratings, Applications of recommendation systems, Issues with recommender system. | |
| 2.0 | | Collaborative Filtering | 06 |
| | 2.1 | Architecture of Collaborative Filtering, User-based nearest neighbour recommendation, Item-based nearest neighbour recommendation, Model based and pre-processing based approaches, Clustering for recommendation system, Attacks on collaborative recommender systems, Advantages and drawbacks of Collaborative Filtering. | |

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|------------|------------|--|-----------|
| 3.0 | | Content-based recommendation | 07 |
| | 3.1 | Architecture of content-based systems, Content representation and content similarity, Item profiles, Discovering features of documents, Obtaining item features from tags, Representing item profiles, Methods for learning user profiles, Similarity based retrieval, The Role of User Generated Content in the Recommendation Process. | |
| | 3.2 | Bayes classifier for recommendation, Regression based recommendation system. Advantages and drawbacks of content-based filtering | |
| 4.0 | | Knowledge based recommendation | 06 |
| | 4.1 | Knowledge representation and reasoning, Constraint based recommenders, Case based recommenders, Persistent Personalization in Knowledge-Based Systems, Conversational Recommendation. Search based recommendation, Navigation-based recommendation. | |
| 5.0 | | Ensembled- Based and Hybrid Recommendation System | 06 |
| | 5.1 | Opportunities for hybridization, Monolithic hybridization design: Feature combination, Feature augmentation, Parallelized hybridization design: Weighted, Switching, Mixed, Pipelined hybridization design: Cascade Meta-level, Limitations of hybridization strategies. | |
| 6.0 | | Evaluating Recommendation System | 08 |
| | 6.1 | Characteristics and properties of evaluation research, Evaluation design goals- Accuracy, Coverage, Confidence and Trust, Novelty, Serendipity, Diversity, Robustness, Stability and Scalability. | |
| | 6.2 | Comparison between evaluation design of classification model and recommendation system, Error metrics, Decision-Support metrics, User-Centred metrics. Comparative analysis between different types of recommendation systems. | |

| | |
|---------------------------|---|
| Textbooks: | |
| 1 | Jannach, D., Zanker, M., Felfernig, A., & Friedrich, G. (2010). <i>Recommender systems: an introduction</i> . Cambridge University Press. |
| 2 | Ricci, F., Rokach, L., & Shapira, B. (2011). <i>Introduction to Recommender Systems Handbook</i> . Springer, Boston, MA. |
| References: | |
| 1 | Aggarwal, C. C. (2016). <i>Recommender systems</i> (Vol. 1). Cham: Springer International Publishing. |
| Online References: | |

| | |
|---|---|
| 1 | http://www.iem.iitkgp.ac.in/eco/Recommender_Systems/ |
| 2 | https://www.coursera.org/specializations/recommender-systems |
| 3 | https://www.udemy.com/course/recommender-systems/ |
| 4 | https://www.analyticsvidhya.com/blog/2021/08/developing-a-course-recommender-system-using-python/ |

| | |
|---|---|
| <u>Assessment:</u> | |
| Internal Assessment: | |
| Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour. | |
| End Semester Theory Examination: | |
| 1 | Question paper will comprise of total six questions. |
| 2 | All question carries equal marks |
| 3 | Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3) |
| 4 | Only Four questions need to be solved. |
| 5 | In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus |

| Course Code | Course Name | Credit |
|-------------|------------------------|--------|
| CSDO8023 | Social Media Analytics | 03 |

Prerequisite: Graph Theory, Data Mining, Python/R programming

Course Objectives: The course aims:

| | |
|---|--|
| 1 | Familiarize the learners with the concept of social media. |
| 2 | Familiarize the learners with the concept of social media analytics and understand its significance. |
| 3 | Enable the learners to develop skills required for analyzing the effectiveness of social media. |
| 4 | Familiarize the learners with different tools of social media analytics. |
| 5 | Familiarize the learner with different visualization techniques for Social media analytics. |
| 6 | Examine the ethical and legal implications of leveraging social media data. |

Course Outcomes:

| | |
|---|--|
| 1 | Understand the concept of Social media |
| 2 | Understand the concept of social media Analytics and its significance. |
| 3 | Learners will be able to analyze the effectiveness of social media |
| 4 | Learners will be able to use different Social media analytics tools effectively and efficiently. |
| 5 | Learners will be able to use different effective Visualization techniques to represent social media analytics. |
| 6 | Acquire the fundamental perspectives and hands-on skills needed to work with social media data. |

| Module | Detailed Content | Hours |
|-----------|---|-------|
| 1. | Social Media Analytics: An Overview | |
| | Core Characteristics of Social Media, Types of Social Media, Social media landscape, Need for Social Media Analytics (SMA), SMA in small & large organizations. Purpose of Social Media Analytics, Social Media vs. Traditional Business Analytics, Seven Layers of Social Media Analytics, Types of Social Media Analytics, Social Media Analytics Cycle, Challenges to Social Media Analytics, Social Media Analytics Tools | 6 |
| 2. | Social Network Structure, Measures & Visualization | |
| | Basics of Social Network Structure - Nodes, Edges & Tie Describing the Networks Measures - Degree Distribution, Density, Connectivity, Centralization, Tie Strength & Trust Network Visualization - Graph Layout, Visualizing Network features, Scale Issues. Social Media Network Analytics - Common Network Terms, Common Social Media Network Types, Types of Networks, Common Network Terminologies, Network Analytics Tools. | 6 |
| 3. | Social Media Text, Action & Hyperlink Analytics | |
| | Social Media Text Analytics - Types of Social Media Text, Purpose of Text Analytics, Steps in Text Analytics, Social Media Text | 8 |

| | | |
|-----------|--|---|
| | Analysis Tools Social Media Action Analytics - What Is Actions Analytics? Common Social Media Actions, Actions Analytics Tools Social Media Hyperlink Analytics - Types of Hyperlinks, Types of Hyperlink Analytics, Hyperlink Analytics Tools | |
| 4. | Social Media Location & Search Engine Analytics | |
| | Location Analytics - Sources of Location Data, Categories of Location Analytics, Location Analytics and Privacy Concerns, Location Analytics Tools Search Engine Analytics - Types of Search Engines, Search Engine Analytics, Search Engine Analytics Tools | 6 |
| 5. | Social Information Filtering | |
| | Social Information Filtering - Social Sharing and filtering , Automated Recommendation systems, Traditional Vs social Recommendation Systems Understanding Social Media and Business Alignment, Social Media KPI, Formulating a Social Media Strategy, Managing Social Media Risks | 6 |
| 6. | Social Media Analytics Applications and Privacy | |
| | Social media in public sector - Analyzing public sector social media, analyzing individual users, case study. Business use of Social Media - Measuring success, Interaction and monitoring, case study. Privacy - Privacy policies, data ownership and maintaining privacy online. | 7 |

| Textbooks: | |
|--------------------|--|
| 1. | Seven Layers of Social Media Analytics_ Mining Business Insights from Social Media Text, Actions, Networks, Hyperlinks, Apps, Search Engine, and Location Data, Gohar F. Khan,(ISBN-10: 1507823207). |
| 2. | Analyzing the Social Web 1st Edition by Jennifer Golbeck |
| 3. | Mining the Social Web_ Analyzing Data from Facebook, Twitter, LinkedIn, and Other Social Media Sites, Matthew A Russell, O'Reilly |
| 4 | Charu Aggarwal (ed.), Social Network Data Analytics, Springer, 2011 |
| References: | |
| 1. | Social Media Analytics [2015], Techniques and Insights for Extracting Business Value Out of Social Media, Matthew Ganis, AvinashKohirkar, IBM Press |
| 2. | Social Media Analytics Strategy_ Using Data to Optimize Business Performance, Alex Gonçalves, APress Business Team |
| 3. | Social Media Data Mining and Analytics, Szabo, G., G. Polatkan, O. Boykin & A. Chalkiopoulos (2019), Wiley, ISBN 978-1-118-82485-6 |

| Useful Links | |
|---------------------|---|
| 1 | https://cse.iitkgp.ac.in/~pawang/courses/SC16.html |
| 2 | https://onlinecourses.nptel.ac.in/noc20_cs78/preview |
| 3 | https://nptel.ac.in/courses/106106146 |
| 4 | https://7layersanalytics.com/ |

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|---|--|
| Assessment: | |
| Internal Assessment: | |
| Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour. | |
| End Semester Theory Examination: | |
| 1 | Question paper will consist of 6 questions, each carrying 20 marks. |
| 2 | The students need to solve a total of 4 questions. |
| 3 | Question No.1 will be compulsory and based on the entire syllabus. |
| 4 | Remaining question (Q.2 to Q.6) will be selected from all the modules. |

| Course Code | Course Name | Credits |
|-------------|--------------------|---------|
| ILO8021 | Project Management | 03 |

Objectives:

1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Outcomes: Learner will be able to...

1. Apply selection criteria and select an appropriate project from different options.
2. Write work break down structure for a project and develop a schedule based on it.
3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.
4. Use Earned value technique and determine & predict status of the project.
5. Capture lessons learned during project phases and document them for future reference

| Module | Detailed Contents | Hrs |
|--------|---|-----|
| 01 | Project Management Foundation: Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI). | 5 |
| 02 | Initiating Projects: How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics. | 6 |
| 03 | Project Planning and Scheduling: Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS). | 8 |
| 04 | Planning Projects: Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan. Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks | 6 |
| 05 | 5.1 Executing Projects: Planning monitoring and controlling cycle. Information needs and reporting, | 8 |

| | | |
|----|---|---|
| | <p>engaging with all stakeholders of the projects.</p> <p>Team management, communication and project meetings.</p> <p>Monitoring and Controlling Projects:</p> <p>Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit.</p> <p>Project Contracting</p> <p>Project procurement management, contracting and outsourcing,</p> | |
| 06 | <p>Project Leadership and Ethics:</p> <p>Introduction to project leadership, ethics in projects.</p> <p>Multicultural and virtual projects.</p> <p>Closing the Project:</p> <p>Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.</p> | 6 |

REFERENCES:

1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7thEd.
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Gido Clements, Project Management, Cengage Learning.
4. Gopalan, Project Management, , Wiley India
5. Dennis Lock, Project Management, Gower Publishing England, 9th Ed.

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

| Course Code | Course Name | Credits |
|-------------|--------------------|---------|
| ILO8022 | Finance Management | 03 |

Objectives:

1. Overview of Indian financial system, instruments and market
2. Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
3. Knowledge about sources of finance, capital structure, dividend policy

Outcomes: Learner will be able to...

1. Understand Indian finance system and corporate finance
2. Take investment, finance as well as dividend decisions

| Module | Detailed Contents | Hrs |
|--------|---|-----|
| 01 | <p>Overview of Indian Financial System: Characteristics, Components and Functions of Financial System.</p> <p>Financial Instruments: Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills.</p> <p>Financial Markets: Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market</p> <p>Financial Institutions: Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges</p> | 06 |
| 02 | <p>Concepts of Returns and Risks: Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio.</p> <p>Time Value of Money: Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.</p> | 06 |
| 03 | <p>Overview of Corporate Finance: Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision.</p> <p>Financial Ratio Analysis: Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.</p> | 09 |
| 04 | <p>Capital Budgeting: Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR)</p> | 10 |

| | | |
|-----------|---|----|
| | Working Capital Management: Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities. | |
| 05 | Sources of Finance: Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. Capital Structure: Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure | 05 |
| 06 | Dividend Policy: Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches— Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach | 03 |

REFERENCES:

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

| Course Code | Course Name | Credits |
|-------------|---|---------|
| ILO8023 | Entrepreneurship Development and Management | 03 |

Objectives:

1. To acquaint with entrepreneurship and management of business
2. Understand Indian environment for entrepreneurship
3. Idea of EDP, MSME

Outcomes: Learner will be able to...

1. Understand the concept of business plan and ownerships
2. Interpret key regulations and legal aspects of entrepreneurship in India
3. Understand government policies for entrepreneurs

| Module | Detailed Contents | Hrs |
|--------|---|-----|
| 01 | Overview Of Entrepreneurship: Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship | 04 |
| 02 | Business Plans And Importance Of Capital To Entrepreneurship: Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur Entrepreneurship And Business Development: Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations | 09 |
| 03 | Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises | 05 |
| 04 | Indian Environment for Entrepreneurship: key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organizations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc | 08 |
| 05 | Effective Management of Business: Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing | 08 |
| 06 | Achieving Success In The Small Business: Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business | 05 |

REFERENCES:

1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
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Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

| Course Code | Course Name | Credits |
|-------------|---------------------------|---------|
| ILO8024 | Human Resource Management | 03 |

Objectives:

1. To introduce the students with basic concepts, techniques and practices of the human resource management.
2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations.
3. To familiarize the students about the latest developments, trends & different aspects of HRM.
4. To acquaint the student with the importance of inter-personal & inter-group behavioral skills in an organizational setting required for future stable engineers, leaders and managers.

Outcomes: Learner will be able to...

1. Understand the concepts, aspects, techniques and practices of the human resource management.
2. Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
3. Gain knowledge about the latest developments and trends in HRM.
4. Apply the knowledge of behavioral skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

| Module | Detailed Contents | Hrs |
|--------|---|-----|
| 01 | <p>Introduction to HR</p> <ul style="list-style-type: none"> • Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions. • Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues. | 5 |
| 02 | <p>Organizational Behavior (OB)</p> <ul style="list-style-type: none"> • Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues • Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness • Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behavior. • Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor); • Group Behavior and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. • Case study | 7 |
| 03 | <p>Organizational Structure & Design</p> <ul style="list-style-type: none"> • Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and | 6 |

| | | |
|----|---|----|
| | <p>stress.</p> <ul style="list-style-type: none"> • Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. • Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies. | |
| 04 | <p>Human resource Planning</p> <ul style="list-style-type: none"> • Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale. • Performance Appraisal Systems: Traditional & modern methods, Performance Counseling, Career Planning. • Training & Development: Identification of Training Needs, Training Methods | 5 |
| 05 | <p>Emerging Trends in HR</p> <ul style="list-style-type: none"> • Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment • Cross Cultural Leadership and Decision Making: Cross Cultural Communication and diversity at work, Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation. | 6 |
| 06 | <p>HR & MIS Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries)</p> <p>Strategic HRM Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals</p> <p>Labor Laws & Industrial Relations Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act</p> | 10 |

REFERENCES:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15th edition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

| Course Code | Course Name | Credits |
|-------------|---|---------|
| ILO8025 | Professional Ethics and Corporate Social Responsibility (CSR) | 03 |

Objectives:

1. To understand professional ethics in business
2. To recognized corporate social responsibility

Outcomes: Learner will be able to...

1. Understand rights and duties of business
2. Distinguish different aspects of corporate social responsibility
3. Demonstrate professional ethics
4. Understand legal aspects of corporate social responsibility

| Module | Detailed Contents | Hrs |
|--------|---|-----|
| 01 | Professional Ethics and Business: The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business | 04 |
| 02 | Professional Ethics in the Marketplace: Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy Professional Ethics and the Environment: Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources | 08 |
| 03 | Professional Ethics of Consumer Protection: Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy Professional Ethics of Job Discrimination: Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs. | 06 |
| 04 | Introduction to Corporate Social Responsibility: Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India | 05 |
| 05 | Corporate Social Responsibility: Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India | 08 |
| 06 | Corporate Social Responsibility in Globalizing India: Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013. | 08 |

REFERENCES:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. [Corporate Social Responsibility in India \(2015\) by Bidyut Chakrabarty, Routledge, New Delhi.](#)

Assessment:

Internal:

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End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

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4. Only Four question need to be solved.

| Course Code | Course Name | Credits |
|-------------|----------------------|---------|
| ILO8026 | Research Methodology | 03 |

Objectives:

1. To understand Research and Research Process
2. To acquaint students with identifying problems for research and develop research strategies
3. To familiarize students with the techniques of data collection, analysis of data and interpretation

Outcomes: Learner will be able to...

1. Prepare a preliminary research design for projects in their subject matter areas
2. Accurately collect, analyze and report data
3. Present complex data or situations clearly
4. Review and analyze research findings

| Module | Detailed Contents | Hrs |
|--------|--|-----|
| 01 | <p>Introduction and Basic Research Concepts</p> <p>Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology</p> <p>Need of Research in Business and Social Sciences</p> <p>Objectives of Research</p> <p>Issues and Problems in Research</p> <p>Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical</p> | 09 |
| 02 | <p>Types of Research</p> <p>Basic Research</p> <p>Applied Research</p> <p>Descriptive Research</p> <p>Analytical Research</p> <p>Empirical Research</p> <p>2.6 Qualitative and Quantitative Approaches</p> | 07 |
| 03 | <p>Research Design and Sample Design</p> <p>Research Design – Meaning, Types and Significance</p> <p>Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors</p> | 07 |
| 04 | <p>Research Methodology</p> <p>4.1 Meaning of Research Methodology</p> <p>4.2. Stages in Scientific Research Process:</p> <p>a. Identification and Selection of Research Problem</p> <p>b. Formulation of Research Problem</p> <p>c. Review of Literature</p> <p>d. Formulation of Hypothesis</p> <p>e. Formulation of research Design</p> <p>f. Sample Design</p> <p>g. Data Collection</p> <p>h. Data Analysis</p> <p>i. Hypothesis testing and Interpretation of Data</p> | 08 |

| | | |
|-----------|---|-----------|
| | j. Preparation of Research Report | |
| 05 | Formulating Research Problem 5.1 Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis | 04 |
| 06 | Outcome of Research Preparation of the report on conclusion reached Validity Testing & Ethical Issues Suggestions and Recommendation | 04 |

REFERENCES:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R., 1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nded), Singapore, Pearson Education

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or at least 6 assignment on complete syllabus or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
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3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

| Course Code | Course Name | Credits |
|-------------|-------------------|---------|
| ILO8027 | IPR and Patenting | 03 |

Objectives:

1. To understand intellectual property rights protection system
2. To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
3. To get acquaintance with Patent search and patent filing procedure and applications

Outcomes: Learner will be able to...

1. understand Intellectual Property assets
2. assist individuals and organizations in capacity building
3. work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

| Module | Detailed Contents | Hr |
|--------|--|----|
| 01 | Introduction to Intellectual Property Rights (IPR): Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. Importance of IPR in Modern Global Economic Environment: Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development | 05 |
| 02 | Enforcement of Intellectual Property Rights: Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement Indian Scenario of IPR: Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc. | 07 |
| 03 | Emerging Issues in IPR: Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc. | 05 |
| 04 | Basics of Patents: Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent | 07 |
| 05 | Patent Rules: Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.) | 08 |
| 06 | Procedure for Filing a Patent (National and International): Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication etc, Time frame and cost, Patent Licensing, Patent Infringement | 07 |

REFERENCE BOOKS:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi, IPR: Drafting, Interpretation of Patent Specifications and Claims, New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers, IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

Assessment:

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End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

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4. Only Four question need to be solved.

| Course Code | Course Name | Credits |
|----------------|------------------------------------|-----------|
| ILO8028 | Digital Business Management | 03 |

Objectives:

1. To familiarize with digital business concept
2. To acquaint with E-commerce
3. To give insights into E-business and its strategies

Outcomes: The learner will be able to

1. Identify drivers of digital business
2. Illustrate various approaches and techniques for E-business and management
3. Prepare E-business plan

| Module | Detailed content | Hours |
|--------|---|-------|
| 1 | <p>Introduction to Digital Business-</p> <p>Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts</p> <p>Difference between physical economy and digital economy,</p> <p>Drivers of digital business- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services)</p> <p>Opportunities and Challenges in Digital Business,</p> | 09 |
| 2 | <p>Overview of E-Commerce</p> <p>E-Commerce- Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement</p> <p>B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals</p> <p>Other E-C models and applications, innovative EC System-From E- government and learning to C2C, mobile commerce and pervasive computing</p> <p>EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e- commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC</p> | 06 |

| | | |
|---|--|----|
| 3 | Digital Business Support services: ERP as e –business backbone, knowledge Tope Apps, Information and referral system Application Development: Building Digital business Applications and Infrastructure | 06 |
| 4 | Managing E-Business- Managing Knowledge, Management skills for e-business, Managing Risks in e –business Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications | 06 |
| 5 | E-Business Strategy- E-business Strategic formulation- Analysis of Company’s Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation) | 04 |
| 6 | Materializing e-business: From Idea to Realization- Business plan preparation Case Studies and presentations | 08 |

References:

1. A textbook on E-commerce, Er Arunrajan Mishra, Dr W K Sarwade, Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, Vinocenzo Morabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective -DOI:[10.1787/9789264221796-en](https://doi.org/10.1787/9789264221796-en) OECD Publishing

Assessment:

Internal:

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End Semester Theory Examination:

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4. Only Four question need to be solved.

| Course Code | Course Name | Credits |
|-------------|--------------------------|---------|
| ILO8029 | Environmental Management | 03 |

Objectives:

1. Understand and identify environmental issues relevant to India and global concerns
2. Learn concepts of ecology
3. Familiarise environment related legislations

Outcomes: Learner will be able to...

1. Understand the concept of environmental management
2. Understand ecosystem and interdependence, food chain etc.
3. Understand and interpret environment related legislations

| Module | Detailed Contents | Hrs |
|--------|--|-----|
| 01 | Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities. Environmental issues relevant to India, Sustainable Development, The Energy scenario. | 10 |
| 02 | Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc. | 06 |
| 03 | Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc. | 05 |
| 04 | Scope of Environment Management, Role & functions of Government as a planning and regulating agency. Environment Quality Management and Corporate Environmental Responsibility | 10 |
| 05 | Total Quality Environmental Management, ISO-14000, EMS certification. | 05 |
| 06 | General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc. | 03 |

REFERENCES:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management, **T V Ramachandra and Vijay Kulkarni, TERI Press**
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Macmillan India, 2000

6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
7. Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

Assessment:

Internal:

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End Semester Theory Examination:

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 4. Only Four question need to be solved.
-

| Course Code: | Course Title | Credit |
|--------------|-----------------|--------|
| CSL801 | Advanced AI Lab | 01 |

| | |
|---|---|
| Prerequisite: C/C++/Java/MATLAB | |
| Lab Objectives: | |
| 1 | Articulate basic knowledge of fuzzy set theory through programing. |
| 2 | To design Associative Memory Networks. |
| 3 | To apply Unsupervised learning towards Networks design. |
| 4 | To demonstrate Special networks and its applications in soft computing. |
| 5 | To implement Hybrid computing systems. |
| Lab Outcomes: At the end of the course, the students will be able to | |
| 1 | Implement Fuzzy operations and functions towards Fuzzy-rule creations. |
| 2 | Build and training Associative Memory Network. |
| 3 | Build Unsupervised learning based networks . |
| 4 | Design and implement architecture of Special Networks |
| 5 | Implement Neuro-Fuzzy hybrid computing applications. |

| Suggested Experiments: | |
|-------------------------------|---|
| Sr. No. | Name of the Experiment |
| 1 | Design and implement a Hidden Markov Models for outcome prediction. |
| 2 | Design and implement a Bayesian Network for outcome prediction. |
| 3 | Design and implement a Gaussian Mixture Models for outcome prediction. |
| 4 | Build and Train a Generative Multi-Layer Network Model using appropriate dataset. |
| 5 | Build and Train a Deep Convolution Generative Multi-Layer (DCGAN) Network Model for an image based dataset. |
| 6 | Develop a Conditional GAN (CGAN) Network to direct the image generation process of the generator model. |
| 7 | Train a variational autoencoder using Tensorflow on Fashion MNIST |

| | |
|----|--|
| 8 | Explore the working of any pre-trained model towards outcome generation. |
| 9 | Implement and analyze the working of Local Interpretable Model-agnostic Explanations(LIME) supervised model. |
| 10 | Case-study on the emerging technologies in AI like Metaverse, Augmented reality etc. |
| 11 | Mini Project Report: For any one chosen real world application as per the syllabus of CSC801 : Advanced AI. |
| 12 | Implementation and Presentation of Mini Project |

| Useful Links | |
|--------------|---|
| 1 | https://nptel.ac.in/courses/106106224 |
| 2 | https://www.tensorflow.org/tutorials/generative/cvae |
| 3 | https://www.analyticsvidhya.com/blog/2022/07/everything-you-need-to-know-about-lime/ |
| 4 | https://onlinecourses.nptel.ac.in/noc20_cs62/preview |
| 5 | https://machinelearningmastery.com/what-are-generative-adversarial-networks-gans/ |

| Term Work: | |
|-------------------------|---|
| 1 | Term work should consist of any 06 experiments, 1 case study, Mini Project. |
| 2 | Journal must include at least 2 assignments based on Theory and Practical's. |
| 3 | The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. |
| 4 | Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks) |
| Practical and Oral exam | |
| | Oral examination on the entire syllabus of CSC801 and CSL801 |

| Lab Code | Lab Name | Credit |
|-----------|--|--------|
| CSDOL8011 | AI for financial & Banking application Lab | 1 |

Prerequisite: Python Programming, Deep Learning, Machine Learning.

Lab Objectives: Students will try

| | |
|---|--|
| 1 | To implement digital money transfer systems in the banking sector. |
| 2 | To calculate risk-adjusted performance measures for investment portfolios. |
| 3 | To apply cluster analysis to identify patterns in financial data. |
| 4 | To analyze market sentiment using the Markov regime switching model. |
| 5 | To design and backtest trading algorithms for financial markets |
| 6 | To detect and prevent fraudulent activities using fraud analytics techniques |

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

| | |
|---|--|
| 1 | Proficiency in implementing secure and efficient digital money transfer systems. |
| 2 | Ability to assess investment performance using risk-adjusted measures. |
| 3 | Competence in identifying meaningful patterns and segments in financial data. |
| 4 | Understanding of market sentiment and its impact on trading decisions. |
| 5 | Practical skills in developing and evaluating trading algorithms. |
| 6 | Knowledge of fraud detection methods for financial systems. |

Suggested List of Experiments

| | |
|-----|--|
| 1. | Setting up a Digital Money Transfer System |
| 2. | Calculating Sharpe Ratios for Investment Portfolios |
| 3. | Cluster Analysis of Financial Data for Market Segmentation |
| 4. | Analyzing Market Sentiment using the Markov Regime Switching Model |
| 5. | Developing and Backtesting a Simple Trading Algorithm |
| 6. | Implementing Advanced Risk Management Techniques in Trading Algorithms |
| 7. | Fraud Detection using Machine Learning Algorithms |
| 8. | Visualizing Fraud Patterns and Analytics |
| 9. | Designing and Backtesting Complex Trading Strategies |
| 10. | Evaluating and Enhancing the Performance of Trading Algorithms |
| 11. | Applying Machine Learning for Predictive Fraud Analytics |

| Textbooks: | |
|-------------------|--|
| 1 | Financial Analytics with R Building a Laptop Laboratory for Data Science MARK J. BENNETT University of Chicago DIRK L. HUGEN University of Iowa |
| 2 | Artificial Intelligence in Finance A Python-Based Guide, Yves Hilpisch A |
| 3 | Fraud Analytics Using Descriptive, Predictive, and Social Network Techniques: A Guide to Data Science for Fraud Detection , Bart Baesens, Veronique Van Vlasselaer, Wouter Verbeke |

| References: | |
|--|--|
| 1 | " Machine Learning for Asset Managers" by Marcos López de Prado |
| 2 | "Advances in Financial Machine Learning" by Marcos López de Prado. |
| Digital References: | |
| 1. https://www.eastnets.com/newsroom/digital-transformation-in-the-banking-and-financial-services-sector | |
| 2. https://www.techopedia.com/definition/34633/generative-ai | |

| Term Work: | |
|--------------------------------|--|
| 1 | Term work should consist of 10 experiments and 2 assignments. |
| 2 | The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. |
| 3 | The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Total 25 Marks (Experiments and Project: 15-marks, Attendance(Theory & Practical): 05-marks, Assignment: 05-marks) |
| Practical and Oral exam | |
| | Oral examination on the entire syllabus of CSDO8011 & CSDOL8011 |

| Lab Code | Lab Name | Credit |
|-----------|-----------------------|--------|
| CSDOL8012 | Quantum Computing Lab | 1 |

Prerequisite: Python Programming Language.

Lab Objectives:

| | |
|---|--|
| 1 | To implement fundamental quantum computing concepts |
| 2 | To learn quantum computation and quantum information |
| 3 | To understand quantum entanglement, quantum algorithms |
| 4 | To understand quantum information theory and channels |

Lab Outcomes: Students will be able to

| | |
|---|---|
| 1 | Implement basic quantum computing logic by building dice and random numbers using open source simulation tools. |
| 2 | Understand quantum logic gates using open source simulation tools. |
| 3 | Implement quantum circuits using open source simulation tools. |
| 4 | Implement quantum algorithms using open source simulation tools. |

Suggested Experiments: Students are required to complete at least 10 experiments. Faculty may develop their own set of experiments for students. List below is only suggestive.

| Sr. No. | Name of the Experiment |
|---------|--|
| 1 | Building Quantum dice |
| 2 | Building Quantum Random No. Generation |
| 3 | Composing simple quantum circuits with q-gates and measuring the output into classical bits. |
| 4 | Implementation of Shor's Algorithms |
| 5 | Implementation of Grover's Algorithm |
| 6 | Implementation of Deutsch's Algorithm |
| 7 | Implementation of Deutsch-Jozsa's Algorithm |
| 8 | Quantum Circuits |
| 9 | Qubit Gates |
| 10 | Bell Circuit & GHZ Circuit |
| 11 | Accuracy of Quantum Phase Estimation |
| 12 | Mini Project such as implementing an API for efficient search using Grover's Algorithms or Integer factorization using Shor's Algorithm. |

Useful Links:

| | |
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| 1 | IBM Experience: https://quantum-computing.ibm.com/ |
| 2 | Microsoft Quantum Development Kit https://azure.microsoft.com/en-us/resources/development-kit/quantum-computing/#overview |
| 3 | Forest SDK PyQuil: https://pyquil-docs.rigetti.com/en/stable/ |
| 4 | Google Quantum CIRQ https://quantumai.google/cirq |
| 5 | Qiskit Labs IBM https://learn.qiskit.org/course/ch-labs/lab-1-quantum-circuits |

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| Term Work: | |
| 1 | Term work should consist of 10 experiments. |
| 2 | Journal must include at least 2 assignments. |
| 3 | The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work. |
| 4 | Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks) |
| Oral & Practical exam: | |
| Oral examination based on the entire syllabus of CSDO8012 and CSDOL8012 | |

| Course Code: | Course Title | Credit |
|--------------|----------------------------|--------|
| CSDOL8013 | Reinforcement Learning Lab | 1 |

| | |
|---|---|
| Prerequisite: Python Programming, Deep Learning, Machine Learning. | |
| Lab Objectives: Students will try | |
| 1 | Introduce the fundamentals of reinforcement learning and problem formulation using MDPs and Bandit problems |
| 2 | Explore different exploration strategies and their impact on online learning scenarios. |
| 3 | Understand dynamic programming algorithms for solving Markov Decision Processes. |
| 4 | Apply dynamic programming techniques to solve small-scale MDP problems |
| 5 | Implement and compare Monte Carlo methods and Temporal-Difference learning algorithms. |
| 6 | Explore real-world applications of reinforcement learning in domains such as autonomous driving or robotics |
| Lab Outcomes: At the end of the course, the students will be able to | |
| 1 | Gain a solid understanding of reinforcement learning concepts and problem formulation. |
| 2 | Evaluate and compare exploration strategies in online learning scenarios. |
| 3 | Solve Markov Decision Processes using dynamic programming algorithms |
| 4 | Apply dynamic programming techniques to solve small-scale MDP problems. |
| 5 | Implement and analyze Monte Carlo methods and Temporal-Difference learning algorithms |
| 6 | Explore practical applications of reinforcement learning in real-world domains. |

| Suggested List of Experiments | |
|-------------------------------|---|
| 1. | Implementing a simple grid-world environment and training an agent using basic Q-learning |
| 2. | Implementing a multi-armed bandit problem and comparing different exploration strategies like epsilon-greedy and UCB. |
| 3, | Implementing a basic grid-world environment as an MDP and applying policy iteration and value iteration algorithms to find optimal policies. |
| 4. | Applying dynamic programming algorithms, such as policy evaluation and policy improvement, to solve a small-scale MDP problem. |
| 5. | Implementing Monte Carlo control and Temporal Difference (TD) learning algorithms to train an agent in a grid-world environment. |
| 6. | Exploration vs. Exploitation Trade-off: Experimenting with different exploration strategies and analyzing their impact on the learning performance of an agent in a bandit problem. |
| 7. | Function Approximation in Reinforcement Learning: Using function approximation |

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| | techniques, such as linear regression or neural networks, to approximate value functions in reinforcement learning problems. |
| 8. | Deep Reinforcement Learning: Implementing a deep Q-network (DQN) to train an agent to play a popular Atari game, such as Pong or Space Invaders. |
| 9. | Transfer Learning and Multi-Task Reinforcement Learning: Investigating transfer learning in reinforcement learning by training an agent in one environment and transferring its knowledge to a different but related environment |
| 10. | Policy Gradient Methods: Implementing policy gradient methods, such as REINFORCE or Proximal Policy Optimization (PPO), to train an agent in a continuous control environment. |
| *11. | Applications and Case Studies: Applying reinforcement learning techniques to solve a real-world problem, such as training a self-driving car to navigate a simulated road environment. |

Text Books:

1. Reinforcement Learning: An Introduction, by Richard S. Sutton and Andrew G. Barto
2. Alessandro Palmas, Dr. Alexandra Galina Petre, Emanuele Ghelfi, The Reinforcement Learning Workshop: Learn how to Apply Cutting-edge Reinforcement Learning Algorithms to a Wide Range of Control Problems, 2020 Packt publishing.
3. Phil Winder, Reinforcement Learning Industrial Applications with Intelligent Agents, O'Reilly
4. Dr Engr S M Farrukh Akhtar, Practical Reinforcement Learning, Packt Publishing, 2017.

References Books:

1. Maxim Lapan, Deep Reinforcement Learning Hands-On: Apply modern RL methods, with deep Q-networks, value iteration, policy gradients, TRPO, AlphaGo Zero.
2. Csaba Szepesvári, Algorithms for Reinforcement Learning, Morgan & Claypool Publishers
3. Alberto Leon-Garcia, Probability, Statistics and Random Processes for Electrical Engineering, Third Edition, Pearson Education, Inc.

Useful Links

1. [Machine Learning and Friends at Carnegie Mellon University](#)
2. [Reinforcement Learning: A Survey](#)
3. [Bibliography on Reinforcement Learning](#)
4. [David J. Finton's Reinforcement Learning Page](#)

| Term Work: | |
|------------|--|
| 1 | Term work should consist of any 8 experiments, 1 case study and 2 assignments. |
| 2 | The final certification and acceptance of term work ensures satisfactory performance o |

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| | laboratory work and minimum passing marks in term work. |
| 3 | The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Total 25 Marks (Experiments and Project: 15-marks, Attendance(Theory & Practical): 05-marks, Assignment: 05-marks) |
| Oral exam | |
| | Oral Examination based on the entire syllabus of CSDO8011 and CSL8011 |

| Lab Code | Lab Name | Credit |
|-----------|---------------------------|--------|
| CSDOL8021 | Graph Data Science Lab | 1 |

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|---|---|
| Lab Objectives: Students will try | |
| 1 | To understand graph database fundamentals and their advantages. |
| 2 | To design and implement effective data models using the labeled property graph model. |
| 3 | To develop proficiency in querying and analyzing graph data using Cypher. |
| 4 | To gain knowledge of graph database administration tasks and data management. |
| 5 | To apply graph database techniques to real-world use cases. |
| 6 | To develop practical skills in graph database application development. |
| Lab Outcomes: At the end of the course, the students will be able to | |
| 1 | Comprehensive understanding of graph databases and their benefits. |
| 2 | Proficiency in creating data models for representing complex relationships. |
| 3 | Ability to write efficient queries and analyze graph data effectively. |
| 4 | Competence in administering and managing graph databases. |
| 5 | Application of graph database techniques to solve real-world problems. |
| 6 | Understand developing graph database applications. |

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| Prerequisite: Python Programming, Deep Learning, Machine Learning. |
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| Suggested List of Experiments | |
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| 1. | Graph Database Fundamentals: <ul style="list-style-type: none"> Install and set up a graph database system (e.g., Neo4j) on a local machine. Familiarize yourself with the graph database environment, including the query language (Cypher) and browser interface. |

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| 2. | <p>Data Modeling with Graphs:</p> <ul style="list-style-type: none"> ◦ Design a data model using the labeled property graph model for a specific domain (e.g., social network, e-commerce). ◦ Implement the data model in the graph database and populate it with sample data. |
| 3. | <p>Basic Graph Queries:</p> <ul style="list-style-type: none"> ◦ Perform basic graph queries using Cypher to retrieve nodes, relationships, and their properties. ◦ Explore different query patterns, such as finding paths, filtering nodes, and ordering results. |
| 4. | <p>Advanced Graph Queries:</p> <ul style="list-style-type: none"> ◦ Extend your query knowledge by performing more complex graph queries, including subgraph matching, aggregation, and conditional filtering. ◦ Optimize query performance by understanding and utilizing indexes. |
| 5. | <p>Graph Database Administration:</p> <ul style="list-style-type: none"> ◦ Learn and practice essential administrative tasks, such as managing users, roles, and access control. ◦ Perform backup and restore operations to ensure data integrity. |
| 6. | <p>Importing and Exporting Data:</p> <ul style="list-style-type: none"> ◦ Import data from external sources (e.g., CSV files) into the graph database. ◦ Export graph data to different formats for analysis or sharing. |
| 7. | <p>Graph Algorithms and Analytics:</p> <ul style="list-style-type: none"> ◦ Explore the built-in graph algorithms provided by the graph database system (e.g., centrality, community detection). ◦ Apply graph algorithms to analyze and extract insights from your graph data. |
| 8. | <p>Graph Visualization and Exploration:</p> <ul style="list-style-type: none"> ◦ Utilize visualization tools and libraries to visualize your graph data. ◦ Explore and navigate the graph visually to gain a better understanding of its structure and relationships. |
| 9. | <p>Performance Optimization:</p> <ul style="list-style-type: none"> ◦ Identify and address performance bottlenecks in your graph database application. ◦ Optimize queries, indexes, and data modeling to improve overall system |

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| | performance. |
| 10. | Scaling and Replication: <ul style="list-style-type: none"> ◦ Learn techniques for scaling and replicating a graph database to handle larger datasets and higher workloads. ◦ Implement and test replication strategies to ensure data availability and fault tolerance. |
| *11. | Real-World Use Cases: <ul style="list-style-type: none"> ◦ Choose a specific real-world use case (e.g., recommendation systems, fraud detection) and apply graph database techniques to solve the problem. ◦ Design and implement a graph database application that addresses the unique requirements of the chosen use case. |

| Textbooks: | |
|------------|---|
| 1 | Introduction to Graph Theory Fourth edition, Robin J. Wilson |
| 2 | Daphne Koller and Nir Friedman, "Probabilistic Graphical Models: Principles and Techniques", Cambridge, MA: The MIT Press, 2009 (ISBN 978-0-262-0139- 2). |
| 3 | Graph databases, Ian Robinson, Jim Webber & Emil Eifrem |

| References: | |
|---------------------|---|
| 1 | "Graph Databases: New Opportunities for Connected Data" by Ian Robinson, Jim Webber, and Emil Eifrem. |
| 2 | "Neo4j in Action" by Aleksa Vukotic, Nicki Watt, and Tareq Abedrabbo. |
| 3 | "Graph Databases for Beginners" by Mark Needham and Amy E. Hodler. |
| 4 | "Practical Neo4j" by Gregory Jordan. |
| 5 | "Learning Neo4j" by Rik Van Bruggen. |
| 6 | "Graph Database Applications and Concepts with Neo4j" by Dionysios Synodinos. |
| Digital References: | |

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| 1. https://web4.ensiie.fr/~stefania.dumbrava/OREilly_Graph_Databases.pdf |
| 2. https://www.quackit.com/neo4j/tutorial/ |

| Term Work: | |
|-------------------|--|
| 1 | Term work should consist of any 8 experiments , 1 case study and 2 assignments. |
| 2 | The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. |
| 3 | The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Total 25 Marks (Experiments and Project: 15-marks, Attendance(Theory & Practical): 05-marks, Assignment: 05-marks) |
| Oral exam | |
| | Oral examination on the entire syllabus of CSDO8021 and CSDOL8021 |

| Course Code: | Course Title | Credit |
|--------------|----------------------------|--------|
| CSDOL8022 | Recommendation Systems Lab | 1 |

Prerequisite: Java/Python

Lab Objectives:

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|---|---|
| 1 | To understand the key concepts of Recommendation systems. |
| 2 | Design and implement cluster-based approaches for recommendation systems. |
| 3 | Design, implement and analyze classification algorithms for recommendation systems. |
| 4 | To understand various Recommendation system Algorithms. |
| 5 | To understand data processing for Recommendation system Algorithms |

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

- | | |
|---|---|
| 1 | Understand mathematics and representation of data for recommendation systems. |
| 2 | Design, implement and analyze Collaborative filtering based for recommendation systems. |
| 3 | Design, implement and analyze Content-based recommendation systems. |
| 4 | Design, implement and analyze Knowledge-based recommendation systems. |
| 5 | Understanding feature engineering and pre-processing for recommendation systems. |
| 6 | To solve real world problems using recommendation systems. |

Suggested Experiments:

| Sr. No. | Name of the Experiment |
|---------|---|
| 1 | Implementation of Matrix operations and data representation towards understanding mathematics for recommendation system |
| 2 | Experiment on the role of clustering methods with respect to recommendation systems |
| 3 | Feature engineering and pre-processing of data for recommendation systems. |
| 4 | Implementation of Bayes classifier for recommendation. |
| 5 | Implement User-based Nearest neighbor recommendation. |
| 6 | Implement Item-based Nearest neighbor recommendation |
| 7 | Implement Content-based recommendation system. |
| 8 | Implement Knowledge-based recommendation system. |

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| 9 | Implementation of a recommendation system using Hybrid approach. |
| 10 | Implementation of a recommendation system using Ensembled approach. |
| 11 | Implementation of a Regression based recommendation system. |
| 12 | Analyze results on the basis of different evaluation parameters and graphical representations for recommendation systems. |
| 13 | Mini Project Report: For any one chosen real world Recommendation systems application. |
| 14 | Implementation and Presentation of Mini Project |

Useful Links

| | |
|---|---|
| 1 | https://towardsdatascience.com/recommendation-systems-explained-a42fc60591ed |
| 2 | https://www.coursera.org/specializations/recommender-systems |

Term Work:

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|---|---|
| 1 | Term work should consist of any 08 experiments and mini project |
| 2 | Journal must include at least 2 assignments based on Theory and Practical's |
| 3 | The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. |
| 4 | Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks) |

Oral exam:

| | |
|--|---|
| | Oral examination based on the entire syllabus of CSDO8022 and CSL8022 |
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| Lab Code | Lab Name | Credit |
|-----------|----------------------------|--------|
| CSDOL8023 | Social Media Analytics Lab | 1 |

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|---|---|
| Prerequisite: Types of Graphs, Data Mining, Data Analytics | |
| Lab Objectives: | |
| 1 | To understand the fundamental concepts of social media networks. |
| 2 | To learn various social media analytics tools and evaluation matrices. |
| 3 | To collect and store social media data. |
| 4 | To analyze and visualize social media data |
| 5 | To design and develop social media analytics models. |
| 6 | To design and build a social media analytics application. |
| Lab Outcomes: The students will be able to | |
| 1 | Understand characteristics and types of social media networks. |
| 2 | Use social media analytics tools for business |
| 3 | Collect, monitor , store and track social media data |
| 4 | Analyze and visualize social media data from multiple platforms |
| 5 | Design and develop content and structure based social media analytics models. |
| 6. | Design and implement social media analytics applications for business. |

| Suggested Experiments: | |
|-------------------------------|--|
| | |
| Sr. No. | Name of the Experiment |
| 1 | Study various - i) Social Media platforms (Facebook, twitter, YouTubeetc) ii) Social Media analytics tools (Facebook insights, google analytics net lyticetc) iii) Social Media Analytics techniques and engagement metrics (page level, post level, member level) iv) Applications of Social media analytics for business. e.g. Google Analytics https://marketingplatform.google.com/about/analytics/ https://netlytic.org/ |
| 2 | Data Collection-Select the social media platforms of your choice (Twitter, Facebook, LinkedIn, YouTube, Web blogs etc) ,connect to and capture social media data for business (scraping, crawling, parsing). |

| | |
|----|---|
| 3 | Data Cleaning and Storage- Preprocess, filter and store social media data for business (Using Python, MongoDB, R, etc). |
| 4 | Exploratory Data Analysis and visualization of Social Media Data for business. |
| 5 | Develop Content (text, emoticons, image, audio, video) based social media analytics model for business. (e.g. Content Based Analysis :Topic , Issue ,Trend, sentiment/opinion analysis, audio, video, image analytics) |
| 6 | Develop Structure based social media analytics model for any business. (e.g. Structure Based Models -community detection, influence analysis) |
| 7 | Develop a dashboard and reporting tool based on real time social media data. |
| 8 | Design the creative content for promotion of your business on social media |
| | |
| | platform. |
| 9 | Analyze competitor activities using social media data. |
| 10 | Develop social media text analytics models for improving existing product/ service by analyzing customer's reviews/comments. |

Reference Books:

| | |
|---|---|
| 1 | Python Social Media Analytics: Analyze and visualize data from Twitter, YouTube, GitHub, and more Kindle Edition by Siddhartha Chatterjee , Michal Krystyanczuk |
| 2 | Learning Social Media Analytics with R, by Raghav Bali, Dipanjan Sarkar, Tushar Sharma. |
| 3 | Jennifer Golbeck, Analyzing the social web, Morgan Kaufmann, 2013 |
| 4 | Matthew A. Russell. Mining the Social Web: Data Mining Facebook, Twitter, LinkedIn, Google+, Github, and More, 2nd Edition, O'Reilly Media, 2013 |
| 5 | Charu Aggarwal (ed.), Social Network Data Analytics, Springer, 2011 |

Term Work:

| | |
|---|---|
| 1 | Term work should consist of 10 experiments. |
| 2 | Journal must include at least 2 assignments. |
| 3 | The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. |
| 4 | Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks) |

Practical and Oral Exam

Oral examination based on the entire syllabus of **CSDC8023** and **CSDL80223**

| Course Code: | Course Title | Credit |
|--------------|-----------------|--------|
| CSP801 | Major Project 2 | 6 |

| Course Objectives: | |
|--------------------|---|
| 1 | To acquaint with the process of identifying the needs and converting it into the problem. |
| 2 | To familiarize the process of solving the problem in a group. |
| 3 | To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems. |
| 4 | To inculcate the process of self-learning and research. |
| Course Outcomes: | |
| 1 | Identify problems based on societal /research needs. |
| 2 | Apply Knowledge and skill to solve societal problems in a group |
| 3 | Draw the proper inferences from available results through theoretical/ experimental/simulations |
| 4 | Analyse the impact of solutions in societal and environmental context for sustainable development. |
| 5 | Demonstrate capabilities of self-learning in a group, which leads to lifelong learning. |
| 6 | Demonstrate project management principles during project work. |

Guidelines:

1. Internal guide has to keep track of the progress of the project and also has to maintain attendance report. This progress report can be used for awarding term work marks.

2. Project Report Format:

At the end of semester, each group needs to prepare a project report as per the guidelines issued by the University of Mumbai. Report should be submitted in hardcopy. Also, each group should submit softcopy of the report along with project documentation, implementation code, required utilities, software and user Manuals.

A project report should preferably contain at least following details:

- Abstract
- Introduction
- Literature Survey/ Existing system
- Limitation Existing system or research gap
- Problem Statement and Objective
- Proposed System
 - Analysis/Framework/ Algorithm
 - Design details
 - Methodology (your approach to solve the problem) Proposed System
- Experimental Set up

- Details of Database or details about input to systems or selected data
- Performance Evaluation Parameters (for Validation)
- Software and Hardware Setup
- Results and Discussion
- Conclusion and Future Work
- References
- Appendix – List of Publications or certificates

Desirable:

Students should be encouraged -

- to participate in various project competition.
- to write minimum one technical paper & publish in good journal.
- to participate in national / international conference.

3. Term Work:

Distribution of marks for term work shall be done based on following:

- a. Weekly Log Report
- b. Completeness of the project and Project Work Contribution
- c. Project Report (Black Book) (both side print)
- d. Term End Presentation (Internal)

The final certification and acceptance of TW ensures the satisfactory performance on the above aspects.

4. Oral & Practical:

Oral & Practical examination (Final Project Evaluation) of Project 2 should be conducted by Internal and External examiners approved by University of Mumbai at the end of the semester.

Suggested quality evaluation parameters are as following:

- a. Relevance to the specialization / industrial trends
- b. Modern tools used
- c. Innovation
- d. Quality of work and completeness of the project
- e. Validation of results
- f. Impact and business value
- g. Quality of written and oral presentation
- h. Individual as well as teamwork