Ref.: CRCE / 2025 / 105   *Date* : March 26, 2025.

NOTE

<u>**Subject**</u> : **Implementation of Revised End Semester Examination (ESE) Pattern**

As per the resolution passed by the Second Academic Council Meeting held on 14th February, 2025, following rules will be applicable from **AY 2025-26** :

1. *"ESE will be of 90 Min durations with 30 marks question paper and question paper should be based on the remaining syllabus after MSE"*

2. *"It will not be compulsory to give both MSE and ESE examinations. However, to get higher than Pass 'P' grade it will be compulsory to give both the examinations. "*

Kindly take note of the above change which will be applicable from AY 2025-26. For any clarifications, please reach out to the Department Exam Coordinators of respective departments.

(DR. S.S. RATHOD)
PRINCIPAL

Society of St. Francis Xavier, Pilar's
Fr. Conceicao Rodrigues College of Engineering
Fr. Agnel Ashram, Bandstand, Bandra (W), Mumbai – 400 050
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CURRICULUM STRUCTURE
FINAL YEAR UG: B.E.
COMPUTER ENGINEERING
REVISION: FRCRCE-1-24

Effective from Academic Year 2024-25
Board of Studies Approval:08/03/2024
Academic Council Approval:16/03/2024

Dr. DEEPAK BHOIR
Dean Academics

Dr. Sujata P. Deshmukh
HOD (Computer)

DR. SURENDRA RATHOD
Principal

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Preamble:

Greetings and congratulations to all the education partners Fr Conceicao Rodrigues College of Engineering for getting autonomous status to the college from the year 2024-25. University Grant Commission vide letter No. F. 2-10/2023(AC-Policy) dated 23rd Nov 2023 conferred the autonomous status to Fr. Conceicao Rodrigues College of Engineering, Fr. Agnel Ashram, Bandstand, Bandra (West), Mumbai 400050 affiliated to University of Mumbai for a period of 10 years from the academic year 2024-2025 to 2033-2034 as per clause 7.5 of the UGC (Conferment of Autonomous Status Upon Colleges and Measures for Maintenance of Standards in Autonomous Colleges) Regulations,2023. We look towards autonomy as a great opportunity to design and implement curriculum sensitive to needs of Learner, Indian Society and Industries.

All India Council for Technical Education (AICTE) has made implementation of Internship policy mandatory for students. While applying for Extension of Approval (EoA) it is desired that institute has already implemented compulsory internship for all final year students.

The National Education Policy (NEP), 2020 suggests that students must actively engage with the practical side of their learning as part of a holistic education to further improve their employability. It states that students at all HEIs will be provided with opportunities for internships with local industry and businesses as well as research internships with faculty and researchers at their own or other HEIs/research institutions.

In line with the NEP and tracing the provisions of NcrF, Government of Maharashtra has subsequently released two Government Resolutions (GRs) (NEP GR dated – 1. 20 April 2023, and 2. 4 July 2023) to reinforce NEP implementation and credit revision across Maharashtra HEIs. These GRs lay out detailed guidelines for curriculum interventions.

Fr. CRCE has taken a strategic move as a response to the NEP's call for students to engage with practical learning through internships, a practice proven to enhance employability and refine skill sets for the final year students from academic year 2024-25.

Following two major changes applicable for Final Year Students of 2024-25 and 2025-26 batch:
1. Semester long internship option
2. Revised assessment in the form of ISE-1, MSE, ISE-2 and ESE to be taken by the college.

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I. Internship:
Following are the objectives of the Internships envisaged for the students:
- ✓ Exposing students to industrial environments that cannot be replicated in a classroom or lab.
- ✓ Providing opportunities to acquire and refine analytical and managerial skills crucial for a professional career.
- ✓ Offering hands-on experience in teamwork, thereby enhancing professional skills like communication, work ethics, conflict resolution, etc., with a lasting impact on lifelong learning and professional development.
- ✓ The general idea is to enable students to undertake immersive assignments within the organizations for a limited period.
- ✓ Establishing links between students and potential future job or research opportunities.

Methodology of Implementation of Internship Policy for Final Year Students of 2024-25:
A. Completion of Existing Credits:
1. Semester VIII will be conducted in Fast Track Mode during first week of July and winter vacation for completing Institute Level Elective common course to all the departments.
2. Each course will be conducted in a continuous training format for 10days (3hrs theory+2hours lab).
3. Honors course will be taken for two hours each day during Fast Track Mode.
4. Major project will be continued till the official semester end. Assessment of major project will be conducted in phase-wise manner. Students need to compulsorily present in person for each of the phases of assessment.
5. If required then provision for SWAYAM courses to be explored by departments
6. Assessments to be completed immediately after completion of all courses.
7. Release of Gazette and score cards will be only at the end of academic year

B. Internship Details:
1. Training and placement department shall contact companies and strive for providing Six months' internship to all the students. Preference should be given to Internship+PPO during regular placement cycle in SEM VII.
2. Internships should be an integral part of the academic curricula. But for 2024-25 and 2025-26 batch of Final Year students, credit framework is already given by University of Mumbai. For student of these batches internship is last moment value addition and therefor it will not be a part of credit framework. College is providing this as an additional experiential learning opportunity for the students by considering Market demand, Industry demand, Government Resolutions and Student desire.
3. Following are the types of internship opportunities that can be explored by students:
   a. Offered by Industry Govt./ NGO/MSME
   b. Research Institutes like BARC, TIFR, SAMEER and IITs
   c. At various Incubation Centres
   d. Internships offered through academic collaborations with Foreign Universities
   e. Internships offered by reputed colleges with whom MoUs are signed for the collaboration and credit exchange
   f. Or any other internship approved by HoI based on the merit of offer
4. All internships are subjected to approval of Head of the Institute. Students must take prior approval from college before starting internship

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5. Students opting for Entrepreneurship or Start-up are exempted from internship; however, they have to work in the pre-incubation centre of the college to work for their start-up initiative with demonstrable output.

6. Students who wish to work on academic / industry research project (Rather than other internships) assigned under a faculty of Fr CRCE is allowed to do so provided details of work to be done and outcomes are clearly stated and approved by the college authorities.

7. Students can proceed for Internships from 15th Jan.

8. On the request of student college will issue successful completion certificate after achieving predefined approved milestones of Internship/Entrepreneurship/Research Project etc.

Student Resources:

Government Internship Programs:
- ✓ AICTE Internship: https://internship.aicte-india.org/
- ✓ NITI Ayog Internship: https://www.niti.gov.in/internship
- ✓ TULP Internship Program: https://smartcities.gov.in/The_Urban_Learning_Internship_Program
- ✓ Digital India Internship: https://www.meity.gov.in/writereaddata/files/Digital%20Internship%20Scheme%202023%20%281%29.pdf
- ✓ Directorate General of Foreign Trade Internship program: https://www.dgft.gov.in/CP/?opt=intership-scheme
- ✓ National Commission for Scheduled Tribes Internship: https://ncst.nic.in/sites/default/files/2021/Internship/3677
- ✓ Corporate Affairs Ministry Internship program: https://www.mca.gov.in/bin/dms/getdocument?mds=aC%252B%252F82boz%252FD%252FdHcFkAAJ0A%253D%253D&type=open
- ✓ Finance Ministry Internship program: https://dpe.gov.in/schemes/scheme-internship
- ✓ Women and Child Development Ministry Internship program: https://wcd.nic.in/sites/default/files/Internship%20Guideline.._0.pdf
- ✓ Ministry of Culture Internship programs: https://nationalmuseumindia.gov.in/en/national-museum-internship-programme

Online Platforms for Internships:
- ✓ Internshala: https://internshala.com/
- ✓ LetsIntern: https://letsintern.in/
- ✓ Twenty19: http://twenty19.com.testednet.com/
- ✓ HelloIntern: https://hellointern.co/
- ✓ Freshersworld: https://www.freshersworld.com/
- ✓ Youth4work: https://www.youth4work.com/
- ✓ Freshersnow: https://www.freshersnow.com/internships-in-delhi/
- ✓ Zuno by Foundit: https://www.foundit.in/zuno/
- ✓ LinkedIn: https://www.linkedin.com/jobs/internshipjobs/?currentJobId=3647611763&originalSubdomain=in
- ✓ Well Found (earlier, AngelList Talent): https://wellfound.com/location/india
- ✓ Indeed: https://in.indeed.com/jobs?q=internships&l=&vjk=fd2d4f96a2564717
- ✓ Naukri.com: https://www.naukri.com/internship-jobs
- ✓ TimesJobs: https://www.timesjobs.com/jobs-by-roles/intern-jobs

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✓ NGO Box: https://ngobox.org/job_listing.php
✓ CSR Box: https://csrbox.org/

II. Honours and Minor Degree Eligibility Criteria for Students:

i. Following is the eligibility criteria for students opting the Honours/ Minor Degree program:
   a. Students with no backlog in semester I, II, and III
   b. The CGPI (based on semester I, II, and III) of the students must be 6.75 and above
   c. For direct second year (DSE) admitted students - No backlog in semester III and CGPI must be 6.75 and above
ii. Each eligible student can opt for maximum one Honour's or one Minor Programs at any time.
iii. However, it is optional for leaners to take Honours/Minor degree program.
iv. The Honours/ Minor degree program can be opted only during regular engineering studies
v. The student have to complete the Honours/ Minor degree program in stipulated four semesters only.

Note:
1. Courses offered during internship semester shall be in online mode
2. Technical support team for registration of Academic Bank of Credits (ABC), registration of elective/optional courses, registration of online courses, registration for degree options etc. under supervision of Dean Academics.

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SEMESTERWISE CURRICULUM STRUCTURE

FINAL YEAR Computer Engineering Program:

Semester VII										
Course Code	**Course Name**		**Contact Hours**	**Examination Marks (1 Credit=50 Marks)**					**Credits**	
				ISE1	MSE	ISE2	ESE	Total	Points	Total
CSC701	Machine Learning	TH	3	20	30	20	30	100	3	3
CSC702	Big Data Analysis	TH	3	20	30	20	30	100	3	3
CSDC701X	Department Level Optional Course-3	TH	3	20	30	20	30	100	3	3
CSDC702X	Department Level Optional Course-4	TH	3	20	30	20	30	100	3	3
ILO 701X	Institute Level Optional Course-1	TH	3	20	30	20	30	100	3	3
CSL 701	Machine Learning Lab	PR	2	25	--	25	-	50	1	1
CSL 702	Big Data Analytics Lab	PR	2	25	-	25	-	50	1	1
CSDL701X	Department Level Optional Course-3 Lab	PR	2	10	-	15	-	25	1	1
CSDL702X	Department Level Optional Course-4 Lab	PR	2	10	-	15	-	25	1	1
CSP701	Major Project 1	PR	6	25	-	25	25	75	3	3
		Total	**TH::PR 15:14=29**					725		22

Sem VIII										
Course Code	**Course Name**		**Contact Hours**	**Examination Marks (1 Credit=50 Marks)**					**Credits**	
				ISE1	MSE	ISE2	ESE	Total	Points	Total
CSC801	Distributed Computing	TH	3	20	30	20	30	100	3	3
CSDC 801X	Department Level Optional Course-5	TH	3	20	30	20	30	100	3	3
CSDC 802X	Department Level Optional Course-6	TH	3	20	30	20	30	100	3	3
ILO801X	Institute Level Optional Course-2	TH	3	20	30	20	30	100	3	3
CSL801	Distributed Computing Lab	PR	2	25		25		50	1	1
CSDL801X	Department Level Optional Course-5 Lab	PR	2	25		25		50	1	1
CSDL802X	Department Level Optional Course-6 Lab	PR	2	25		25		50	1	1
CSP801	Major Project 2	PR	12	50	-	50	50	150	6	6
		Total	**TH::PR 12:18=30**	-	-	-	-	700	-	21

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Semester	Department/Institute Optional Courses and Labs	Subject
VII	Department Optional Course-3	CSDC7011: Machine Vision CSDC7012: Quantum Computing CSDC7013: Natural Language Processing
	Department Optional Lab-3	CSDL7011: Machine Vision Lab CSDL7012: Quantum Computing Lab CSDL7013: Natural Language Processing Lab
	Department Optional Course-4	CSDC7021: Augmented and Virtual Reality CSDC7022: Block chain CSDC7023: Information Retrieval
	Department Optional Lab-4	CSDL7021: Augmented and Virtual Reality Lab CSDL7022: Block chain Lab CSDL7023: Information Retrieval Lab
	Institute level Optional Courses-I	ILO7011. Product Lifecycle Management ILO7012. Reliability Engineering ILO7013. Management Information System ILO7014. Design Experiments ILO7015. Operation Research ILO7016. Cyber Security Laws ILO7017. Disaster Management & Mitigation Measures ILO7018. Energy Audit and Management ILO7019. Development Engineering

Semester	Department/Institute Optional Courses and Labs	Subject
VIII	Department Optional Course-5	CSDC8011: Deep Learning CSDC8012: Digital Forensic CSDC8013: Applied Data Science
	Department Optional Lab-5	CSDL8011: Deep Learning Lab CSDL8012: Digital Forensic Lab CSDL8013: Applied Data Science Lab
	Department Optional Course-6	CSDC8021: Optimization in machine Learning CSDC8022: High Performance Computing CSDC8023: Social Media Analytics
	Department Optional Lab-6	CSDL8021: Optimization in machine Learning Lab CSDL8022: High Performance Computing Lab CSDL8023: Social Media Analytics 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 ILO7027. IPR and Patenting ILO7028. Digital Business Management ILO7029. Environment Management

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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	**T**	**P**		**L**	**T**	**P**	**Total**
CSC701	**Machine Learning**	**3**	**--**	**--**		**3**	**--**	**--**	**3**
		Examination Scheme							
		ISE1		MSE	ISE2	ESE			Total
		20		**30**	**20**	**100 (30% weightage)**			**100**

Pre-requisite		CSC 301, CSC 401, CSC 303, CSC 402
Course Outcomes	CO1	To acquire fundamental knowledge of developing machine learning models.
	CO2	To select, apply and evaluate an appropriate machine learning model for the given
	CO3	To demonstrate ensemble techniques to combine predictions from different models.
	CO4	To demonstrate the dimensionality reduction techniques.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction to Machine Learning**		04
	1.1	Machine Learning, Types of Machine Learning, Issues in Machine Learning, Application of Machine Learning, Steps in developing a Machine Learning Application.	[1],[2],[3],[4]	
	1.2	Training Error, Generalization error, Overfitting, Underfitting, Bias Variance trade-off.	[1],[2]	
2		**Learning with Regression and Trees**		09
	2.1	Learning with Regression: Linear Regression, Multivariate Linear Regression, Logistic Regression.	[1],2][6]	
	2.2	Learning with Trees: Decision Trees, Constructing Decision Tree using Gini Index (Regression), Classification and Regression Trees (CART)	[1],[2],[3],[7]	
	2.3	Performance Metrics: Confusion Matrix, [Kappa Statistics], Sensitivity, Specificity, Precision, Recall, F-measure, ROC curve	[4],[5]	
3		**Ensemble Learning**		06
	3.1	Understanding Ensembles, K-fold cross validation, Boosting, Stumping, XGBoost	[4]	

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	3.2	Bagging, Subagging, Random Forest, Comparison with Boosting, Different ways to combine classifiers	2],[4] [5]	
4		**Learning with Classification**		08
	4.1	Support Vector Machine Constrained Optimization, Optimal decision boundary, Margins and support vectors, SVM as constrained optimization problem, Quadratic Programming, SVM for linear and nonlinear classification, Basics of Kernel trick.	[1][2] [4]	
	4.2	Support Vector Regression, Multiclass Classification		
5		**Learning with Clustering**		07
	5.1	Introduction to clustering with overview of distance metrics and major clustering approaches.	[2]	
	5.2	Graph Based Clustering: Clustering with minimal spanning tree Modelbased Clustering: Expectation Maximization Algorithm, Density Based Clustering: DBSCAN	[2][5]	
6		**Dimensionality Reduction**		05
	6.1	Dimensionality Reduction Techniques, Principal Component Analysis, Linear Discriminant Analysis, Singular Valued Decomposition.	[1][5]	
			Total	**39**

Recommended Books:
1. Peter Harrington, "Machine Learning n Action", Dream Tech Press
2. Ethem Alpaydın, "Introduction to Machine Learning", MIT Press 3 Tom M. Mitchell, "Machine Learning" McGraw Hill
3. Stephen Marsland, "Machine Learning an Algorithmic Perspective", CRC Press
4. Han Kamber, "Data Mining Concepts and Techniques", Morgan Kaufmann Publishers
5. Margaret. H. Dunham, ―Data Mining Introductory and Advanced Topics, Pearson Education
6. Kevin P. Murphy, Machine Learning "A Probabilistic Perspective"
7. Samir Roy and Chakraborty, "Introduction to soft computing", Pearson Edition.
8. Richard Duda, Peter Hart, David G. Stork, "Pattern Classification", Second Edition, Wiley Publications

Course Assessment:
Theory:
> ISE-1:
> Two hours 20 Marks Activity: Quiz and assignments
> ISE-2:
> Two hours 20 Marks Activity: Quiz and assignments
> MSE:
> Two hours 30 Marks written examination based on 50% syllabus.
> ESE:
> Three hours 100 Marks (30% weightage) written examination based on entire syllabus

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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	**T**	**P**		**L**	**T**	**P**	**Total**
CSC702	**Big Data Analysis**	3	--	--		3	--	--	3
				Examination Scheme					
		ISE1	MSE	ISE2	ESE		Total		
		20	30	20	100 (30% weightage)		100		

Pre-requisite		CSC403, CSC504
Course Outcomes	CO1	Understand the building blocks of Big Data Analytics.
	CO2	Apply fundamental enabling techniques like Hadoop and MapReduce in solving real world problems.
	CO3	Understand different NoSQL systems and how it handles big data.
	CO4	Apply advanced techniques for emerging applications like stream analytics.
	CO5	Achieve adequate perspectives of big data analytics in various applications like recommender systems, social media applications, etc.
	CO6	Apply statistical computing techniques and graphics for analyzing big data.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction to Big Data and Hadoop**	[1][3]	02
	1.1	Introduction to Big Data - Big Data characteristics and Types of Big Data		
	1.2	Traditional vs. Big Data business approach		
	1.3	Case Study of Big Data Solutions		
	1.4	Concept of Hadoop, Core Hadoop Components; Hadoop Ecosystem		
2		**Hadoop HDFS and MapReduce**	[2]	08
	2.1	Distributed File Systems: Physical Organization of Compute Nodes, LargeScale File-System Organization		
	2.2	MapReduce: The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of MapReduce Execution, Coping With Node Failures.		

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	2.3	Algorithms Using MapReduce: Matrix-Vector Multiplication by MapReduce, Relational-Algebra Operations, Computing Selections byMapReduce, Computing Projections by MapReduce, Union ,Intersection, and Difference by MapReduce		
	2.4	Hadoop Limitations		
3		**NoSQL**	[2][3]	10
	3.1	Introduction to NoSQL, NoSQL Business Drivers		
	3.2	NoSQL Data Architecture Patterns: Key-value stores, Graph stores, Column family (Bigtable)stores, Document stores, Variations of NoSQL architectural patterns, NoSQL Case Study		
	3.3	NoSQL solution for big data, Understanding the types of big data problems; Analyzing big data with a shared-nothing architecture; Choosing distribution models: master-slave versus peer-to-peer; NoSQL systems to handle big data problems.		
4		**Mining Data Streams**	[1][3]	11
	4.1	The Stream Data Model: A Data-Stream-Management System, Examples of Stream Sources, Stream Queries, Issues in Stream Processing.		
	4.2	Sampling Data techniques in a Stream		
	4.3	Filtering Streams: Bloom Filter with Analysis.		
	4.4	Counting Distinct Elements in a Stream, Count Distinct Problem, Flajolet-Martin Algorithm, Combining Estimates, Space Requirements		
	4.5	Counting Ones in a Window: The Cost of Exact Counts,The Datar- Gionis-Indyk-Motwani Algorithm, Query Answering in the DGIM Algorithm, Decaying Windows.		
5		**Real-Time Big Data Models**	[1][3]	04
	5.1	A Model for Recommendation Systems, Content-Based Recommendations, Collaborative Filtering		
	5.2	Case Study: Product Recommendation		
	5.3	Social Networks as Graphs, Clustering of Social-Network Graphs, Direct Discovery of Communities in a social graph		
6		**Data Analytics with R**	[1][2][6]	04
	6.1	Exploring Basic features of R, Exploring RGUI, Exploring RStudio, Handling Basic Expressions in R, Variables in R, Working with Vectors, Storing and Calculating Values in R, Creating and using Objects, Interacting with users, Handling data in R workspace, Executing Scripts, Creating Plots, Accessing help and documentation in R		

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	6.2	Reading datasets and Exporting data from R, Manipulating and Processing Data in R, Using functions instead of script, built-in functions in R		
	6.3	Data Visualization: Types, Applications		
			Total	**39**

Recommended Books:
1. Cre Anand Rajaraman and Jeff Ullman ―Mining of Massive Datasets‖, Cambridge University Press
2. Alex Holmes ―Hadoop in Practice‖, Manning Press, Dreamtech Press.
3. Dan Mcary and Ann Kelly ―Making Sense of NoSQL‖ – A guide for managers and the rest of us, Manning Press.
4. DT Editorial Services, ―Big Data Black Book‖, Dreamtech Press
5. EMC Education Services, Data Science and Big Data Analytics, Wiley
6. Bill Franks , ―Taming The Big Data Tidal Wave: Finding Opportunities In HugeDataStreams with Advanced Analytics, Wiley
7. Chuck Lam, ―Hadoop in Action, Dreamtech Press
8. Jared Dean, ―Big Data, Data Mining, and Machine Learning: Value Creation for Business Leaders and Practitioners, Wiley India Private Limited, 2014.
9. Jiawei Han and Micheline Kamber, ―Data Mining: Concepts and Techniques‖, Morgan Kaufmann Publishers, 3rd ed, 2010.
10. Lior Rokach and Oded Maimon, ―Data Mining and Knowledge Discovery Handbook‖, Springer, 2nd edition,2010.
11. Ronen Feldman and James Sanger, ―The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data‖, Cambridge University Press, 2006.
12. Vojislav Kecman, ―Learning and Soft Computing‖, MIT Press, 2010.

Useful Links
1. https://nptel.ac.in/courses/106104189
2. https://www.coursera.org/specializations/big-data#courses
3. https://www.digimat.in/nptel/courses/video/106106169/L01.html
4. https://www.coursera.org/learn/nosql-databases#syllabus
5. https://www.coursera.org/learn/basic-recommender-systems#syllabus

Course Assessment:
Theory:
    ISE-1:
Two hours 20 Marks Activity:Quiz and assignments
    ISE-2:
Two hours 20 Marks Activity: Quiz and assignments
    MSE:
Two hours 30 Marks written examination based on 50% syllabus.
    ESE:
Three hours 100 Marks (30% weightage) written examination based on entire syllabus

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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P		L	T	P	Total
CSDC7011	Machine Vision	3	--	--		3	--	--	3
					Examination Scheme				
		ISE1	MSE	ISE2	ESE		Total		
		20	30	20	100 (30% weightage)		100		

Pre-requisite		CSC 305
Course Outcomes	CO1	Elaborate the components of Machine Vision Application
	CO2	Perform image ,video preprocessing operations
	CO3	Explain various transformations, interpolation.
	CO4	Elaborate motion tracking in video.
	CO5	Analyze and Implement appropriate filtering techniques for a given problem.
	CO6	Develop applications based on machine vision.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction to Machine Vision**		4
		Computer and Human Vision Systems., The Human Eye, Computer versus Human Vision Systems, Evolution of Computer Vision, Computer/Machine Vision and Image Processing, Applications of Computer Vision	[1][2] [3]	
2		**Digital Image Fundamentals**		8
		Digital Image, Monochrome and Color Images, Image Brightness and Contrast., 2D, 3D, and 4D Images, Digital Image Representation , Digital Image File Formats, Fundamental Image Operations, Points, Edges, and Vertices , Point Operations , Thresholding ,Brightness, Geometric Transformations , Spatial Transformation , Affine Transformation, Image Interpolation ,Nearest-Neighbor Interpolation ,Bilinear Interpolation , Bi-cubic Interpolation ,Fundamental Steps in Digital Image Processing.	[2][3] [4]	

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3		**Machine Vision and System Components**		8
		Machine Vision System, Machine Vision Camera: CCD and CMOS Image Sensors, TDI Sensor, Camera Type - Area Scan Cameras, Line Scan Cameras, Smart Cameras, Camera Lens Resolution, Contrast and Sharpness, Lenses and their parameters: Types of Lenses, Lens Mounts, Lens Selection Examples-Field of View Much larger than Camera sensor size or Smaller or close to Camera Sensor size, Machine Vision Lighting: Lighting: Light Sources in Machine Vision, Illumination Techniques- Backlighting, Front Lighting, Diffused Lighting, Oblique Lighting, Dark Field Lighting, Infrared and Ultraviolet Light, Filters, Machine Vision Software, Machine Vision Automation, Integration of Machine Vision Components.	[1][2] [3][6]	
4		**Digital Image Processing for Machine Vision Applications**		10
		Preprocessing., Image Filtering, Normalized Box Filter Gaussian Filter Bilateral Filter, Comparison of Filter Techniques, Sub sampling/Scaling Histogram, Image Segmentation, Threshold Based Segmentation Edge-Based Segmentation First-Order Derivative Edge Detection. Second-Order Derivative Operators, Comparison of Edge Detection Techniques, Region-Based Segmentation Region Growing Methods, Region Split and Merge Method, Morphological Image Processing: Dilation, Erosion, Opening, Closing, Hit-or-Miss transformation, Object Recognition. Template Matching. Blob Analysis	[2][3] [4][5] [6]	
5		**Motion Analysis**		4
		Differential motion Analysis, Optical Flow, Analysis based on correspondence of interest points, Detection of specific motion Patterns, Video Tracking	[2][3] [4][5]	
6		**Emerging Trends in Machine Vision**		5
	6.1	History of Industrial Revolution(s), Machine Vision and Industry 4.0, Emerging Vision Trends in Manufacturing, 3D Imaging, Emerging Vision Trends in Manufacturing,	[3][4] [5][6]	
	6.2	Applications in Machine/ Computer Vision: Face detection, face recognition, eigen faces, car on roads		
			Total	**39**

Recommended Books:

1. Sheila Anand and L.Priya , ―A Guide for Machine Vision in Quality Control‖, Taylor & Francis Inc, Imprint CRC Press Inc, Dec 2019
2. Rafael C. Gonzalez and Richard E. Woods, ―Digital Image Processing‖, Pearson
3. Carsten Stegar, Markus Ulrich, and Christian Wiedemann, ―Machine Vision Algorithms and Applications, Second completely Revised and Enlarged Edition

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4. Milan Sonka, Vaclav Hlavac, Roger Boyle, ―Image Processing Analysis and Machine Vision‖, Second Edition, Cengage Learning.
5. Chiranji Lal Chowdhary, Mamoun Alazab, Ankit Chaudhary, Saqib Hakak and Thippa Reddy Gadekallu ,‖Computer Vision and Recognition Systems Using Machine and Deep Learning Approaches,Fundamentals, technologies and applications‖ , IET COMPUTING SERIES 42
6. Joe Minichino Joseph Howse ,‖Learning OpenCV 3 Computer Vision with Python‖, Second Edition, Packt Publishing Ltd.
7. Alexander Hornberg,, ― Handbook of Machine and Computer Vision The Guide for Developers and Users,

Useful Links
1. https://nptel.ac.in/courses/108103174
2. https://www.coursera.org/learn/introduction-computer-vision-watson-opencv
3. https://www.udacity.com/course/introduction-to-computer-vision--ud810
4. https://onlinecourses.nptel.ac.in/noc21_ee23/preview

Course Assessment:
Theory:

> ISE-1:
> Two hours 20 Marks Activity: Quiz and assignments
> ISE-2:
> Two hours 20 Marks Activity: Quiz and assignments
> MSE:
> Two hours 30 Marks written examination based on 50% syllabus.
> ESE:
> Three hours 100 Marks (30% weightage) written examination based on entire syllabus

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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	**T**	**P**		**L**	**T**	**P**	**Total**
CSDC7012	**Quantum Computing**	3	--	--		3	--	--	3
					Examination Scheme				
		ISE1	MSE	ISE2	ESE			Total	
		20	30	20	100 (30% weightage)			100	

Pre-requisite	CSC 301, CSC 401, CSC 303, CSC 402, CSL 405

Course Outcomes	CO1	Understand basic concepts of quantum computing
	CO2	Illustrate building blocks of quantum computing through architecture and programming models
	CO3	Appraise various mathematical models required for quantum computing
	CO4	Discuss various quantum hardware building principles.
	CO5	Identify the various quantum algorithms
	CO6	Describe usage of tools for quantum computing.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction to Quantum Computing**		07
	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]	
	1.2	Qubits and multi-qubits states Bloch Sphere representation QuantumSuperposition Quantum Entanglement Major players in the industry (IBM, Microsoft, Rigetti, D-Wave etc.)		
2		**Mathematical Foundations for Quantum Computing**		05
	2.1	Matrix Algebra: basis vectors and orthogonality, inner product andHilbert spaces, matrices and tensors, unitary operators and projectors, Dirac notation, Eigen values and Eigen vectors.	[1][2] [3]	

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3		**Building Blocks for Quantum Program**		8
	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.	[2][3] [5]	
	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		**Quantum Algorithms and Error correction**		**06**
	4.1	Quantum Algorithms, Shor's Algorithm, Grover's Algorithm. Deutsch's Algorithm, Deutsch -Jozsa Algorithm	[1][2] [5]	
	4.2	Quantum error correction using repetition codes 3 qubit codes, Shor's 9 qubit error correction Code		
5		**Quantum Hardware**		**10**
	5.1	Ion Trap Qubits ,The DiVincenzo Criteria , Lagrangian and Hamiltonian Dynamics in a Nutshell: Dynamics of a Translating Rotor	[1][3] [5]	
	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 Sørenson 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		**OSS Toolkits for implementing Quantum program**		**03**
	6.1	IBM quantum experience Microsoft Q Rigetti PyQuil QPU/QVM)	[4][7] [8]	
			Total	**39**

Recommended Books:
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

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5. Bernard Zygelman, A First Introduction to Quantum Computing and Information,2018 2 Supriyo Bandopadhyay and Marc Cahy, ―Introduction to Spintronics‖, CRC Press, 20083 La Guardia, Giuliano Gladioli ―Quantum Error correction codes‖Springer,2021

6. Supriyo Bandopadhyay and Marc Cahy, ―Introduction to Spintronics‖, CRC Press, 2008

7. The Second Quantum Revolution: From Entanglement to Quantum Computing and Other Super-Technologies, Lars Jaeger

8. La Guardia, Giuliano Gladioli ―Quantum Error correction

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/

Course Assessment:
 Theory:
    ISE-1:
    Two hours 20 Marks Activity: Quiz and assignments
    ISE-2:
    Two hours 20 Marks Activity: Quiz and assignments
    MSE:
    Two hours 30 Marks written examination based on 50% syllabus.
    ESE:
    Three hours 100 Marks (30% weightage) written examination based on entire syllabus

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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P		L	T	P	Total
CSDC7013	**Natural Language Processing**	3	--	--		3	--	--	3
				Examination Scheme					
		ISE1	MSE	ISE2	ESE		Total		
		20	30	20	100 (30% weightage)		100		

Pre-requisite		CSC 501, CSC 601
	CO1	Describe the linguistic preliminaries necessary for various phases in NLP.
	CO2	Perform Word-Level and Syntax-Level analysis on a text.
Course Outcomes	CO3	Analyze the textual input at Semantic Level in NLP.
	CO4	Develop a basic understanding of Pragmatics in NLP
	CO5	Apply NLP techniques to design real-world NLP applications
	CO6	Describe the linguistic preliminaries necessary for various phases in NLP.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction to NLP**		03
	1.1	Origin & History of NLP; Language, Knowledge and Grammar inlanguage processing; Stages in NLP; Ambiguities and its types inEnglish and Indian Regional L languages; Challenges of NLP; Applications of NLP	[1][[3	
	1.2	**Self-Learning topics:** Variety types of tools for regional languages pre-processing and other functionalities	[1] [3]	

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2		**Word Level Analysis**		9
	2.1	Basic Terms: Tokenization, Stemming, Lemmatization; Survey of English Morphology, Inflectional Morphology, Derivational Morphology; Regular expression with types; Morphological Models: Dictionary lookup, finite state morphology; Morphological parsing with FST (Finite State Transducer);Lexicon free FST Porter Stemmer algorithm; Grams and its variation: Bigram, Trigram; Simple (Unsmoothed) N-grams; N-gram Sensitivity to the Training Corpus; Unknown Words: Open versus closed vocabulary tasks; Evaluating N-grams: Perplexity; Smoothing: Laplace Smoothing, Good-Turing Discounting;	[3] [4]	
	2.2	Self-Learning topics: Noisy channel models, various edit distance, Advance Issues in Language Modelling	[3] [4]	
3		**Syntax analysis**		10
	3.1	Part-Of-Speech tagging(POS); Tag set for English (Upenn Treebank); Difficulties /Challenges in POS tagging; Rule-based, Stochastic and Transformation-based tagging; Generative Model: Hidden Markov Model (HMM Viterbi) for POS tagging; Issues in HMM POS tagging; Discriminative Model: Maximum Entropy model, Conditional random Field (CRF);Parsers: Top down and Bottom up; Modelling constituency; Bottom Up Parser: CYK, PCFG (Probabilistic Context Free Grammar), Shift Reduce Parser; Top Down Parser: Early Parser, Predictive Parser	[3][4]	
	3.2	Self-Learning topics: Evaluating parsers, Parsers based language modelling, Regional languages POS tree banks	[3][4]	
4		**Semantic Analysis**		7
	4.1	Introduction, meaning representation; Lexical Semantics; Corpus study; Study of Various language dictionaries like WorldNet, Babel net; Relations among lexemes & their senses –Homonymy, Polysemy, Synonymy, Hyponymy; Semantic Ambiguity; Word Sense Disambiguation (WSD); Knowledge based approach (Lesk's Algorithm), Supervised (Naïve Bayes, Decision List),Introduction to Semi-supervised method (Yarowsky) Unsupervised (Hyperlex)	[2][3][4]	
	4.2	Self-Learning topics: Dictionaries for regional languages, Distributional Semantics, Topic Models	[2][3][4]	
5		**Pragmatic & Discourse Processing**		5
	5.1	Discourse: Reference Resolution, Reference Phenomena, Syntactic & Semantic constraint on coherence; Anaphora Resolution using Hobbs and Cantering Algorithm	[5] [6]	
	5.2	Self-Learning topics: Discourse segmentation, Conference resolution	[5] [6]	

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6		**Applications of NLP**		**5**
	6.1	Case studies on (preferable in regional language):Machine translation; Text Summarization; Sentiment analysis; Information retrieval; Question Answering system	1][[3]	
	6.2	Self-Learning topics: Applications based on Deep Neural Network with NLP such as LSTM network, Recurrent Neural network etc.	[1][3]	
			Total	**39**

Recommended Books:
1. Daniel Jurafsky, James H. and Martin, Speech and Language Processing, Second Edition, Prentice Hall,2008.
2. Christopher D. Manning and Hinrich Schutze, Foundations of Statistical Natural Language Processing, MITPress, 1999.
3. Siddiqui and Tiwary U.S., Natural Language Processing and Information Retrieval, Oxford UniversityPress, 2008.
4. Daniel M Bikel and Imed Zitouni ― Multilingual natural language processing applications: from theory to practice, IBM Press, 2013.
5. Alexander Clark, Chris Fox, Shalom Lappin ― The Handbook of Computational Linguistics and Natural Language Processing, John Wiley and Sons, 2012.
6. Nitin Indurkhya and Fred J. Damerau, ―Handbook of Natural Language Processing, Second Edition, Chapman and Hall/CRC Press, 2010.

Course Assessment:
Theory:
> **ISE-1:**
> Two hours 20 Marks Activity: Quiz and assignments
> **ISE-2:**
> Two hours 20 Marks Activity: Quiz and assignments/Seminar on research paper
> **MSE:**
> Two hours 30 Marks written examination based on 50% syllabus.
> **ESE:**
> Three hours 100 Marks (30% weightage) written examination based on entire syllabus

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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P		L	T	P	Total
CSDC7021	Augmented and Virtual Reality	3	--	--		3	--	--	3
					Examination Scheme				
		ISE1	MSE	ISE2	ESE		Total		
		20	30	20	100 (30% weightage)		100		

Pre-requisite		CSC 305
Course Outcomes	CO1	Describe how VR systems work and list the applications of VR
	CO2	Elaborate geometric presentation of the virtual world and its operations.
	CO3	Explain the concepts of motion and tracking in VR systems.
	CO4	Design and implementation of the hardware that enables VR systems to be built
	CO5	Describe how AR systems work and analyze the hardware requirement of AR
	CO6	Analyze and understand the working of various state of the art AR devices.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction to Virtual Reality**		5
		What is virtual reality? ,The beginnings of VR , VR paradigms, Collaboration, Virtual reality systems, Representation, User interaction	[1][5]	
2		**The Geometry of Virtual Worlds**		6
		Geometric Models, Changing Position and Orientation, Axis-Angle Representations of Rotation, Viewing Transformations, Chaining theTransformations	[1][2]	
3		**Motion in Real and Virtual Worlds**		6
		Velocities and Accelerations , The Vestibular System , Physics in the Virtual World , Mismatched Motion and Vection	[3][4][5]	

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4		**Applying Virtual Reality**		7
		Virtual reality: the medium, Form and genre, What makes an application a good candidate for VR, Promising application fields,Demonstrated benefits of virtual reality, More recent trends in virtual reality application development, A framework for VR application development	[3][4][5]	
5		**Augmented Reality**		8
		Terminology, Simple augmented reality, Augmented reality as an emerging technology, Augmented reality applications, Marker detection, Marker pose, Marker types and identification: Template markers, 2D bar-code markers, Imperceptible markers: Image markers, Infrared markers, Miniature markers, Discussion on marker use, General marker detection application	[1][6][7]	
6		**AR Development & Applications**		8
		User interfaces, Avoiding physical contacts, Practical experiences with head-mounted displays, Authoring and dynamic content ,AR applications and future visions, How to design an AR application, Technology adoption and acceptance , Where to use augmented reality	[3][4][6]	
			Total	**39**

Recommended Books:
1. Virtual Reality, Steven M. LaValle, Cambridge University Press, 2016
2. Understanding Virtual Reality: Interface, Application and Design, William R Sherman and Alan B Craig,(The Morgan Kaufmann Series in Computer Graphics)‖. Morgan Kaufmann Publishers, San Francisco, CA,2002
3. Developing Virtual Reality Applications: Foundations of Effective Design, Alan B Craig, William RSherman and Jeffrey D Will, Morgan Kaufmann, 2009.
4. Theory and applications of marker-based augmented reality Sanni Siltanen
5. AR Game Development‖, 1st Edition ,Allan Fowler, A press Publications, 2018, ISBN 978-14842361782
6. Augmented Reality: Principles & Practice by Schmalstieg / Hollerer, Pearson Education India; First edition (12 October 2016),ISBN-10: 9332578494
7. Learning Virtual Reality, Tony Parisi, O'Reilly Media, Inc., 2015, ISBN- 9781491922835

Digital Useful Links
1. https://freevideolectures.com/course/3693/virtual-reality
2. https://www.vrlabacademy.com/
3. https://arvr.google.com/ar/
4. https://konterball.com/

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<u>Course Assessment:</u>

Theory:

<u>ISE-1:</u>

Two hours 20 Marks Activity: Quiz and assignments

<u>ISE-2:</u>

Two hours 20 Marks Activity: Quiz and assignments

<u>MSE:</u>

Two hours 30 Marks written examination based on 50% syllabus.

<u>ESE:</u>

Three hours 100 Marks (30% weightage) written examination based on entire syllabus

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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	**T**	**P**		**L**	**T**	**P**	**Total**
CSDC7022	**Blockchain**	3	--	--		3	--	--	3
		Examination Scheme							
		ISE1	MSE	ISE2	ESE		Total		
		20	30	20	100 (30% weightage)		100		

Pre-requisite		CSC 602	
Course Outcomes	CO1	Explain Blockchain concepts in the context of distributed ledger.	
	CO2	Associate concepts of cryptocurrencies, consensus algorithms and mining with security of blockchain.	
	CO3	Apply the concepts of smart contact using Solidity programming for a given application.	
	CO4	Explore Hyperledger Fabric and its working as a private blockchain.	
	CO5	Explain basic working principles of Ethereum.	
	CO6	Compare various tools of BCT using case studies.	

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction to Blockchain**		**6**
	1.1	What is a blockchain, Origin of blockchain (cryptographically securehash functions), Foundation of blockchain: Merkle trees	[1], [4]	
	1.2	Components of blockchain, Block in blockchain, Types: Public, Private, and Consortium, Consensus Protocol, Limitations and Challenges of blockchain	[2], [4]	
2		**Cryptocurrency**		**6**
	2.1	Cryptocurrency: Bitcoin, Altcoin, and Tokens (Utility and Security), Cryptocurrency wallets: Hot and cold wallets, Cryptocurrency usage,Transactions in Blockchain, UTXO and double spending problem	[1], [4]	
	2.2	Bitcoin blockchain: Consensus in Bitcoin, Proof-of-Work (PoW), Proof-of-Burn (PoB), Proof-of-Stake (PoS), and Proof-of-Elapsed Time (PoET), Life of a miner, Mining difficulty, Mining pool and its methods	[1], [4]	
3		**Programming for Blockchain**		**8**
	3.1	Introduction to Smart Contracts, Types of Smart Contracts, Structure of a Smart Contract, Smart Contract Approaches, Limitations of Smart Contracts	[2]	

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	3.2	Introduction to Programming: Solidity Programming – Basics, functions, Visibility and Activity Qualifiers, Address and Address Payable, Bytes and Enums, Arrays-Fixed and Dynamic Arrays, Special Arrays-Bytes and strings, Struct, Mapping, Inheritance, Error handling	[2]	
	3.3	Case Study – Voting Contract App, Preparing for smart contract Development	[2]	
4		**Public Blockchain**		8
	4.1	Introduction to Public Blockchain, Ethereum and its Components, Mining in Ethereum, Ethereum Virtual Machine (EVM), Transaction, Accounts, Architecture and Workflow, Comparison between Bitcoin and Ethereum	[3]	
	4.2	Types of test-networks used in Ethereum, Transferring Ethers usingMetamask, Mist Wallet, Ethereum frameworks, Case study of Ganache for Ethereum blockchain. Exploring etherscan.io and ether block structure	[3]	
5		**Private Blockchain**		8
	5.1	Introduction, Key characteristics, Need of Private Blockchain, Smart Contract in a Private Environment, State Machine Replication, Consensus Algorithms for Private Blockchain - PAXOS and RAFT, Byzantine Faults: Byzantine Fault Tolerant (BFT) and Practical BFT	[3]	
	5.2	Introduction to Hyperledger, Tools and Frameworks, HyperledgerFabric, Comparison between Hyperledger Fabric & Other Technologies	[3] [6]	
	5.3	Hyperledger Fabric Architecture, Components of Hyperledger Fabric: MSP, Chain Codes, Transaction Flow, Working of Hyperledger Fabric,Creating Hyperledger Network, Case Study of Supply Chain Management using Hyperledger		
6		**Tools and Applications of Blockchain**		**3**
	6.1	Corda, Ripple, Quorum and other Emerging Blockchain Platforms, Blockchain in DeFi: Case Study on any of the Blockchain Platforms.	[3]	
			Total	**39**

Recommended Books:

1. Blockchain Technology, Chandramouli Subramanian, Asha A. George, Abhillash K. A and Meena Karthikeyen, Universities Press.
2. Mastering Ethereum, Building Smart Contract and Dapps, Andreas M. Antonopoulos Dr. Gavin Wood, O'reilly.
3. Imran Bashir, Mastering Blockchain: A deep dive into distributed ledgers, consensus protocols, smartcontracts, DApps, cryptocurrencies, Ethereum, and more, 3rd Edition, Packt Publishing
4. Blockchain for Beginners, Yathish R and Tejaswini N, SPD
5. Blockchain Basics, A non Technical Introduction in 25 Steps, Daniel Drescher, Apress.

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6. Blockchain with Hyperledger Fabric, Luc Desrosiers, Nitin Gaur, Salman A. Baset, VenkatramanRamakrishna, Packt Publishing

Digital Useful Links
1. Blockchain By Example, Bellaj Badr, Richard Horrocks, Xun (Brian) Wu, November 2018, Implement decentralized blockchain applications to build scalable Dapps.
2. Blockchain for Business, https://www.ibm.com/downloads/cas/3EGWKGX7.
3. https://www.hyperledger.org/use/fabric
4. NPTEL: https://onlinecourses.nptel.ac.in/noc19_cs63/preview

Course Assessment:

Theory:

ISE-1:
Two hours 20 Marks Activity: Quiz and assignments
ISE-2:
Two hours 20 Marks Activity: Quiz and assignments/Seminar on research paper
MSE:
Two hours 30 Marks written examination based on 50% syllabus.
ESE:
Three hours 100 Marks (30% weightage) written examination based on entire syllabus

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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	**T**	**P**		**L**	**T**	**P**	**Total**
CSDC7023	**Information Retrieval**	**3**	**--**	**--**		**3**	**--**	**--**	**3**
				Examination Scheme					
		ISE1		MSE	ISE2		ESE		Total
		20		**30**	**20**		**100 (30% weightage)**		**100**

Pre-requisite		CSC 303, CSC 402
Course Outcomes	CO1	Define and describe the basic concepts of the Information retrieval system.
	CO2	Design the various modeling techniques for information retrieval systems.
	CO3	Understand the query structure and various query operations
	CO4	Analyzing the indexing and scoring operation in information retrieval systems
	CO5	Perform the evaluation of information retrieval systems
	CO6	Analyze various information retrieval for real world application

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction to Information Retrieval**		**4**
	1.1	Introduction to Information Retrieval, Basic Concepts, Information Versus Data, Trends and research issues in information retrieval.	[1][2]	
	1.2	The retrieval process, Information retrieval in the library, web and digital libraries.		
2		**Modeling in Information Retrieval**		**8**
	2.1	Taxonomy of Information Retrieval models, Classic Information Retrieval, Alternate set: Theoretical model, Alternative Algebraic models, Alternative Probabilistic models	[2][3][4]	
	2.2	Structured text Retrieval models, Models for browsing		
3		**Query and Operations in Information Retrieval**		8
	3.1	Query structures, Keyboard based querying, Pattern matching, Structured queries	[2][3][4]	

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	3.2	User relevance feedback, Automatic local analysis, Automatic global analysis		
4		**Indexing and Scoring in Information Systems**		8
	4.1	Introduction, Inverted Files, Other Indices for Text, Boolean queries and Introduction to Sequential searching	[1][2][3]	
	4.2	Scoring, term weighting and the vector space model, Parametric and zone indexes, Weighted zone scoring, Learning weights, The optimal weight, Term frequency and weighting, Inverse document frequency,Tf-idf weighting. The vector space model for scoring, Queries as vectors, Computing vector scores, Efficient scoring and ranking, Inexact top K document retrieval		
5		**Evaluation of Information Retrieval Systems**		6
	5.1	Information retrieval system evaluation, Standard test collections, Evaluation of unranked retrieval sets, Evaluation of ranked retrieval results, Assessing and justifying the concept of relevance	[2][3][4]	
	5.2	System quality and user utility, System issues, Refining a deployed system		
6		**Applications of Information Retrieval Systems**	[5][6]	5
	6.1	Introduction to Multimedia Information Retrieval		
	6.2	Introduction to Distributed Information Retrieval		
			Total	**39**

Recommended Books:
1. Modern information retrieval, Baeza-Yates, R. and Ribeiro-Neto, B., 1999. ACM press.
2. Introduction to Information Retrieval By Christopher D. Manning and Prabhakar Raghavan, CambridgeUniversity Press
3. Information Storage & Retrieval By Robert Korfhage – John Wiley & Sons
4. Storage Network Management and Retrieval, Vaishali Khairnar
5. Introduction to Modern Information Retrieval. G.G. Chowdhury. Neal Schuman
6. Natural Language Processing and Information Retrieval by Tanveer Siddiqui, U.S Tiwarey

Useful Digital Links
1. https://web.stanford.edu/class/cs276/
2. https://www.coursera.org/learn/text-retrieval
Course Assessment:
 Theory:
ISE-1:
Two hours 20 Marks Activity: Quiz and assignments
ISE-2:
Two hours 20 Marks Activity: Quiz and assignments
MSE:
Two hours 30 Marks written examination based on 50% syllabus.
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P		L	T	P	Total
ILO 7011	Product Life Cycle Management	3	--	--		3	--	--	3
					Examination Scheme				
		ISE1	MSE	ISE2	ESE		Total		
		20	30	20	100 (30% weightage)		100		

Pre-requisite		------		
Course Outcomes	CO1	Gain knowledge about phases of PLM, PLM strategies andmethodology for PLM feasibility study and PDM implementation.		
	CO2	Illustrate various approaches and techniques for designing and developing products.		
	CO3	Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.		
	CO4	Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant		

Module No.	Unit No.	Topics	Ref.	Hrs.
1	1.1	**Introduction to Product Lifecycle Management (PLM)**	[1][2]	10
		Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications PLM Strategies: Industrial strategies, Strategy elements, its identification, selectionand implementation, Developing PLM Vision and PLM Strategy, Change management for PLM			
2	2.1	**Product Design**	[2][3]	9

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		Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process		
3	3.1	**Product Data Management (PDM)**	[2][3]	5
		Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation		
4	4.1	**Virtual Product Development Tools**	[2][3]	5
		For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies		
5	5.1	**Integration of Environmental Aspects in Product Design**	[3] [4]	5
		Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End- of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design		
6	6.1	**Life Cycle Assessment and Life Cycle Cost Analysis**	[3][4]	5
		Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis		
			Total	**39**

Recommended Books:
1. John Stark, ―Product Lifecycle Management: Paradigm for 21st Century Product Realisation‖, Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, Antonino Risitano, ―Product Design for the environment A life cycle approach‖, Taylor & Francis 2006, ISBN: 0849327229
3. Saaksvuori Antti, Immonen Anselmie, ―Product Life Cycle Management‖, Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, ―Product Lifecycle Management: Driving the next generation of lean

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thinking‖, Tata McGraw Hill, 2006, ISBN: 0070636395

Course Assessment:

Theory:

ISE-1:

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MSE:

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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	**T**	**P**		**L**	**T**	**P**	**Total**
ILO 7012	**Reliability Engineering**	3	--	--		3	--	--	3
				Examination Scheme					
		ISE1	MSE	ISE2	ESE		Total		
		20	30	20	100 (30% weightage)		100		

Pre-requisite		------	
Course Outcomes	CO1	Understand and apply the concept of Probability to engineering problems	
	CO2	Apply various reliability concepts to calculate different reliability parameters	
	CO3	Estimate the system reliability of simple and complex systems	
	CO4	Carry out a Failure Mode Effect and Criticality Analysis	

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Probability theory: Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. Probability Distributions: Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. Measures of Dispersion: Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	[1][2]	8
2		Reliability Concepts: Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. Failure Data Analysis: Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. Reliability Hazard Models: Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	[1][2]	8
3		System Reliability: System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	[2][3]	5
4		Reliability Improvement: Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	[2][3]	8

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5		Maintainability and Availability: System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	[2][3] [5]	5
6		Failure Mode, Effects and Criticality Analysis: Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	[2][3] [6]	5
			Total	**39**

Recommended Books:
1. L.S. Srinath, ―Reliability Engineering‖, Affiliated East-Wast Press (P) Ltd., 1985.
2. Charles E. Ebeling, ―Reliability and Maintainability Engineering‖, Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, ―Engineering Reliability‖, John Wiley & Sons, 1980.
4. P.D.T. Conor, ―Practical Reliability Engg.‖, John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, ―Reliability in Engineering Design‖, John Wiley & Sons.
6. Murray R. Spiegel, ―Probability and Statistics‖, Tata McGraw-Hill Publishing Co. Ltd.

Course Assessment:
 Theory:
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P		L	T	P	Total
ILO 7013	Management Information System	3	--	--		3	--	--	3
					Examination Scheme				
		ISE1		MSE	ISE2	ESE		Total	
		20		30	20	100 (30% weightage)		100	

Pre-requisite		------	
Course Outcomes		CO1	Explain how information systems Transform Business
		CO2	Identify the impact information systems have on an organization
		CO3	Describe IT infrastructure and its components and its current trends
		CO4	Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS	[1],[2]	4
2		Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	[1]	7
3		Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	[1],[3]	7
4		Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	[1]	7
5		Computer Networks Wired and Wireless technology, Pervasive computing, Cloud computing model	[1], [3]	6
6		Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models	[1],[3]	8
			Total	39

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Recommended Books:
1. Kelly Rainer, Brad Prince, Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed.,Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008.

Course Assessment:

Theory:

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> **ISE-2:**
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P		L	T	P	Total
		3	--	--		3	--	--	3
ILO 7014	**Design of Experiments**				Examination Scheme				
		ISE1	MSE		ISE2	ESE		Total	
		20	30		20	100 (30% weightage)		100	

Pre-requisite		------	
Course Outcomes		CO1	Plan data collection, to turn data into information and to make decisions that lead to appropriate action
		CO2	Apply the methods taught to real life situations
		CO3	Plan, analyze, and interpret the results of experiments

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction**	[1][2]	6
	1.1	Strategy of Experimentation		
	1.2	Typical Applications of Experimental Design		
	1.3	Guidelines for Designing Experiments		
	1.4	Response Surface Methodology		
2		**Fitting Regression Models**	[1][2][3]	8
	2.1	Linear Regression Models		
	2.2	Estimation of the Parameters in Linear Regression Models		
	2.3	Hypothesis Testing in Multiple Regression		
	2.4	Confidence Intervals in Multiple Regression		
	2.5	Prediction of new response observation		
	2.6	Regression model diagnostics		
	2.7	Testing for lack of fit		
3		**Two-Level Factorial Designs**	[2][3][4]	7
	3.1	The 22 Design		
	3.2	The 23 Design		
	3.3	The General2k Design		
	3.4	A Single Replicate of the 2k Design		
	3.5	The Addition of Center Points to the 2k Design		
	3.6	Blocking in the 2k Factorial Design		
	3.7	Split-Plot Designs		
4		**Two-Level Fractional Factorial Designs**	[2][3][4]	7
	4.1	The One-Half Fraction of the 2k Design		
	4.2	The One-Quarter Fraction of the 2k Design		
	4.3	The General 2k-p Fractional Factorial Design		
	4.4	Resolution III Designs		
	4.5	Resolution IV and V Designs		
	4.6	Fractional Factorial Split-Plot Designs		

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5		**Response Surface Methods and Designs**	[2]	7
	5.1	Introduction to Response Surface Methodology	[3][4]	
	5.2	The Method of Steepest Ascent		
	5.3	Analysis of a Second-Order Response Surface		
	5.4	Experimental Designs for Fitting Response Surfaces		
6		**Taguchi Approach**		4
	6.1	Crossed Array Designs and Signal-to-Noise Ratios	[3][4]	
	6.2	Analysis Methods	[5]	
	6.3	Robust design examples		
			Total	**39**

Recommended Books:
1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3 rd edition, John Wiley &Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation andDiscovery, 2nd Ed. Wiley
4. W J Dimond, Practical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T. Voss

Course Assessment:
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  ISE-2:
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P		L	T	P	Total
ILO 7015	Operations Research	3	--	--		3	--	--	3
					Examination Scheme				
		ISE1		MSE	ISE2	ESE		Total	
		20		30	20	100 (30% weightage)		100	

Pre-requisite		------
Course Outcomes	CO1	Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
	CO2	Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
	CO3	Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
	CO4	Understand the applications of integer programming and a queuing model and compute important performance measures

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction to Operations Research**	[1][2]	14
		Introduction, Structure of the Mathematical Model, Limitations of Operations Research
Linear Programming: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method,
Duality, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis
Transportation Problem: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method.
Assignment Problem: Introduction, Mathematical Formulation		

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		of theProblem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem **Integer Programming Problem:** Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.		
2		**Queuing models**	[1][2][3]	5
		queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population		
3		**Simulation**	[2][3][4]	5
		Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages 05 of Simulation, Limitations of Simulation		
4		**Dynamic programming**	[2][3][4]	5
		Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems		
5		**Game Theory**	[3][4][5]	5
		Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games		
6		**Inventory Models**	[3][4][5]	5
		Classical EOQ Models, EOQ Model with Price Breaks, EOQ withShortage, Probabilistic EOQ Model,		
			Total	**39**

Recommended Books:
1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willeyand Sons, 2nd Edition, 2009
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons

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Course Assessment:

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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	**T**	**P**		**L**	**T**	**P**	**Total**
ILO 7016	**Cyber Security and Laws**	3	--	--		3	--	--	3
		Examination Scheme							
		ISE1	MSE	ISE2	ESE		Total		
		20	30	20	100 (30% weightage)		100		

Pre-requisite		------
Course Outcomes	CO1	Understand the concept of cybercrime and its effect on outside world
	CO2	Interpret and apply IT law in various legal issues
	CO3	Distinguish different aspects of cyber law
	CO4	Apply Information Security Standards compliance during software design and development

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction to Cybercrime**	[1],[3]	4
		Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes		
2		**Cyber offenses & Cybercrime**	[1],[2]	9
		How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures inMobile Computing Era, Laptops		

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3		**Tools and Methods Used in Cyberline**	[1],[2],[4]	6
		Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)		
4		**The Concept of Cyberspace**		8
		E-Commerce, The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law,Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	[1],[3]	
5		**Indian IT Act.**	[3],[8]	6
		Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments		
6		**Information Security Standard compliances**		6
		SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	[6],[9]	
			Total	**39**

Recommended Books:
1. Nina Godbole, Sunit Belapure, Cyber Security, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, Information Systems Security, Wiley India, New Delhi
6. Kennetch J. Knapp, Cyber Security &Global Information Assurance Information Science Publishing.
7. William Stallings, Cryptography and Network Security, Pearson Publication
8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
9. Website for more information , A Compliance Primer for IT professional : https://www.sans.org/reading-room/whitepapers/compliance/compliance-primerprofessionals-33538

Course Assessment:

Theory:

ISE-1:

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ISE-2:

Two hours 20 Marks Activity: Quiz and assignments

MSE:

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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P		L	T	P	Total
ILO 7017	Disaster Management and Mitigation Measures	3	--	--		3	--	--	3
		Examination Scheme							
		ISE1		MSE	ISE2	ESE		Total	
		20		30	20	100 (30% weightage)		100	

Pre-requisite		------	
Course Outcomes	CO1	Get to know natural as well as manmade disaster and their extent and possible effects on the economy	
	CO2	Plan of national importance structures based upon the previous history.	
	CO3	Get acquainted with government policies, acts and various organizational structure associated with an emergency	
	CO4	Get to know the simple do's and don'ts in such extreme events and act accordingly.	

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction**	[1][2]	3
	1.1	Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change		
2		**Natural Disaster and Manmade disasters**	[1][2][3]	9
	2.1	Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion		
	2.2	Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.		

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3		**Disaster Management, Policy and Administration**	[1][2] [3][4]	6
	3.1	Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management		
	3.2	Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.		
4		**Institutional Framework for Disaster Management in India:**	[1][2] [3][4]	6
	4.1	Importance of public awareness, Preparation and execution of emergency management program. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations.		
	4.2	Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.		
5		**Financing Relief Measures:**	[1][2] [3][4]	9
	5.1	Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams		
	5.2	International relief aid agencies and their role in extreme events.		
6		**Preventive and Mitigation Measures:**		6
	6.1	Pre-disaster, during disaster and post-disaster measures in some events in general	[3][4] [5]	
	6.2	Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication		
	6.3	Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans.		
	6.4	Do's and don'ts in case of disasters and effective implementation of relief aids.		
			Total	**39**

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Recommended Books:

1. Disaster Management' by Harsh K. Gupta, Universities Press Publications.
2. Disaster Management: An Appraisal of Institutional Mechanisms in India' by O. S. Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elsevier Publications.
4. Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. Disaster management & rehabilitation' by Rajdeep Dasgupta, Mittal Publications, New Delhi.

(Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

Course Assessment:
 Theory:
        ISE-1:
        Two hours 20 Marks Activity: Quiz and assignments
        ISE-2:
        Two hours 20 Marks Activity: Quiz and assignments
        MSE:
        Two hours 30 Marks written examination based on 50% syllabus.
        ESE:
        Three hours 100 Marks (30% weightage) written examination based on entire syllabus

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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P		L	T	P	Total
ILO 7018	**Energy Audit and Management**	3	--	--		3	--	--	3
					Examination Scheme				
		ISE1	MSE	ISE2	ESE		Total		
		20	30	20	100 (30% weightage)		100		

Pre-requisite		------	
Course Outcomes		CO1	To identify and describe present state of energy security and its importance
		CO2	To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
		CO3	To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
		CO4	To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Energy Scenario:**	[1][2]	4
		Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act2001 and its Features. Basics of Energy and its various forms, Material and Energy balance		
2		**Energy Audit Principles:**	[1][2][3]	8
		Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)		

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3		**Energy Management and Energy Conservation in Electrical System:**	[1][2][3]	10
		Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.		
4		**Energy Management and Energy Conservation in Thermal Systems:**	[4][5][6]	10
		Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, 10 use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.		
5		**Energy Performance Assessment:**		4
		On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis		
6		**Energy conservation in Buildings:**	[4][5][6]	3
		Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources		
			Total	**39**

Recommended Books:
1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute(TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

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Course Assessment:

Theory:

ISE-1:

Two hours 20 Marks Activity: Quiz and assignments

ISE-2:

Two hours 20 Marks Activity: Quiz and assignments

MSE:

Two hours 30 Marks written examination based on 50% syllabus.

ESE:

Three hours 100 Marks (30% weightage) written examination based on entire syllabus

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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P		L	T	P	Total
ILO 7019	Development Engineering	3	--	--		3	--	--	3
					Examination Scheme				
		ISE1	MSE	ISE2	ESE		Total		
		20	30	20	100 (30% weightage)		100		

Pre-requisite		------
Course Outcomes	CO1	Apply knowledge for Rural Development.
	CO2	Apply knowledge for Management Issues.
	CO3	Apply knowledge for Initiatives and Strategies.
	CO4	Develop acumen for higher education and research.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Introduction to Rural Development Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services.	[1][2]	4
2		Post-Independence rural Development Balwant Rai Mehta Committee - three tier system of rural local Government; Need and scope for people's participation and Panchayati Raj; Ashok Mehta Committee - linkage between Panchayati Raj, participation and rural development	[1][2] [3]	8
3		Rural Development Initiatives in Five Year Plans Five Year Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring organizations and agencies; Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub-plan for the weaker section; Micro-eco zones; Data base for local planning; Need for decentralized planning; Sustainable rural development.	[2][3] [4]	10

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4		Post 73rd Amendment Scenario 73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including 04 social mobilization; Information Technology and rural planning; Need for further amendments.	[1][2][5][6][7]	10
5		Values and Science and Technology Material development and its values; the challenge of science and technology; Values in planning profession, research and education. Types of Values Psychological values — integrated personality; mental health; Societal values — the modern search for a good society; justice, democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; human values as freedom, creativity, love and wisdom		4
6		Ethics Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	[2][3][9][10]	3
			Total	**39**

Recommended Books:
1. ITPI, Village Planning and Rural Development, ITPI, New Delhi
2. Thooyavan, K.R. Human Settlements: A 2005 MA Publication, Chennai
3. GoI, Constitution (73rd GoI, New Delhi Amendment) Act, GoI, New Delhi
4. Planning Commission, Five Year Plans, Planning Commission
5. Planning Commission, Manual of Integrated District Planning, 2006, Planning Commission New Delhi
6. Planning Guide to Beginners
7. Weaver, R.C., The Urban Complex, Doubleday.
8. Farmer, W.P. et al, Ethics in Planning, American Planning Association, Washington.
9. How, E., Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp. 123-150.
10. Watson, V. , Conflicting Rationalities: -- Implications for Planning Theory and Ethics, Planning Theory and Practice, Vol. 4, No.4, pp.395 – 407

Course Assessment:

Theory:
ISE-1:
Two hours 20 Marks Activity: Quiz and assignments
ISE-2:
Two hours 20 Marks Activity: Quiz and assignments
MSE:
Two hours 30 Marks written examination based on 50% syllabus.
ESE:Three hours 100 Marks (30% weightage) written examination based on entire syllabus

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
CSL70011	**Machine Learning Lab**	--	--	2	--	--	1	1
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	--	--	--	--	--	
		Lab	25	--	25	--	50	

Pre-requisite Course Codes		CSC 303, CSC 402	
Course Outcomes		CO1	To implement an appropriate machine learning model for the given application.
		CO2	To implement ensemble techniques to combine predictions from different models.
		CO3	To implement the dimensionality reduction techniques

Sr. No.	Topics
1	To implement Linear Regression
2	To implement Logistic Regression.
3	To implement Ensemble learning (bagging/boosting)
4	To implement multivariate Linear Regression.
5	To implement SVM
6	To implement PCA/SVD/LDA
7	To implement Graph Based Clustering
8	To implement DB Scan
9	To implement CART
10	To implement LDA

Course Assessment:

Lab:

ISE:

1. **ISE-1**

    Quizzes/Assignments/Paper Presentation/Article Discussion/Quizzes/Assignments based on 50% experiments

2. **ISE-2**

    Quizzes/Assignments/Paper Presentation/Article Discussion/Quizzes/Assignments based on 50% experiments

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
CSL7012	**Big Data Analytics Lab**	**Examination Scheme**						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	--	--	--	--	--	
		Lab	25	--	25	--	50	

Pre-requisite Course Codes	FEL 204	
Course Outcomes	CO1	To interpret business models and scientific computing paradigms, and apply software tools for big data analytics.
	CO2	To implement algorithms that uses Map Reduce to apply on structured and unstructured data
	CO3	To perform hands-on NoSQL databases such as Cassandra, Hadoop HBase, MongoDB, etc.
	CO4	To implement various data streams algorithms.
	CO5	To develop and analyze the social network graphs with data visualization techniques.

Sr. No.	Topics
	(Select a case study and perform the experiments 1 to 8.). **Star (*) marked experiments are compulsory**.
1*	Hadoop HDFS Practical: - HDFS Basics, Hadoop Ecosystem Tools Overview. - Installing Hadoop. - Copying File to Hadoop. - Copy from Hadoop File system and deleting file. - Moving and displaying files in HDFS. - Programming exercises on Hadoop
2	Use of Sqoop tool to transfer data between Hadoop and relational database servers. - Sqoop - Installation. - To execute basic commands of Hadoop eco system component Sqoop
3*	To install and configure MongoDB/ Cassandra/ HBase/ Hyper table to execute NoSQL commands

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4	Experiment on Hadoop Map-Reduce: • Write a program to implement a word count program usingMapReduce.
5	Experiment on Hadoop Map-Reduce: -Implementing simple algorithms in Map-Reduce: Matrix multiplication, Aggregates, Joins, Sorting, Searching, etc
6	Create HIVE Database and Descriptive analytics-basic statistics.
7*	Data Stream Algorithms (any one): • Implementing DGIM algorithm using any Programming Language • Implement Bloom Filter using any programming language • Implement Flajolet Martin algorithm using any programming language
8	Social Network Analysis using R (for example: Community Detection Algorithm)
9	Data Visualization using Hive/PIG/R/Tableau/.
10	Exploratory Data Analysis using Spark/ Pyspark.
11	Mini Project: One real life large data application to be implemented (Use standard Datasets available on the web). • Streaming data analysis – use flume for data capture, HIVE/PYS park for analysis of twitter data, chat data, weblog analysis etc. • Recommendation System (for example: Health Care System, Stock Market Prediction, Movie Recommendation, etc.) Spatio Temporal Data Analytics

Course Assessment:
Lab:
ISE:

1. **ISE-1**
    Quizzes/Assignments/Paper Presentation/Article Discussion/Quizzes/Assignments based on 50% experiments.
2. **ISE-2**
    Quizzes/Assignments/Paper Presentation/Article Discussion/Quizzes/Assignments based on 50% experiments.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
CSDL7011	**Machine Vision Lab**	--	--	2	--	--	1	1
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	--	--	--	--	--	
		Lab	10	--	15	--	25	

Pre-requisite CourseCodes		CSC 305, CSDLO6012, CSL 405
Course Outcomes	CO1	Students will be able to read image and video file, perform. different processing
	CO2	Students will be able to do edge detection, depth estimation
	CO3	Students will be able to choose appropriate algo for segmentation
	CO4	Students will be able to implement object detection technique

Sr. No.	Topics
1	**Handling Files, Cameras, and GUIs** Basic I/O scripts ,Reading/writing an image file ,Converting betweenan image and raw bytes ,Accessing image data with numpy array ,Reading/writing a video file ,Capturing camera frames, Displaying images in a window, Displaying camera frames in a window
2	**Processing Images** with OpenCV 3 Converting between different color spaces, The Fourier Transform, High pass filter, Low pass filter,
3	**Edge detection** with Canny, Contour detection, Contours – boundingbox, minimum area rectangle, and minimum enclosing circle, Contours – convex contours and the Douglas-Peucker algorithm
4	**Depth Estimation** Capturing frames from a depth camera Creating a mask from a disparity map Masking a copy operation Depth estimation with a normal camera
5	**Object segmentation** using the Watershed and Grab Cut algorithms Example of foreground detection with Grab Cut Image segmentation with the Watershed algorithm
6	**Detecting and Recognizing faces** Conceptualizing Haar cascades Getting Haar cascade data Using OpenCV to perform face detection Performing face detection on a still image

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7	**Performing face detection on video** Performing face recognition Generating the data for face recognition Recognizing faces Preparing the training data Loading the data and recognizing faces Performing an Eigenfaces recognition
8	**Retrieving Images and Searching** Using Image Descriptors, Feature detection algorithms, Defining features etecting features – corners Feature extraction and description using DoG and SIFT Anatomy of a keypoint
9	**Detecting and Recognizing Objects** Object detection and recognition techniques HOG descriptors. The scale issue The location issue Non-maximum (or on-maxima) suppressionSupport vector machines People detection
10	**Creating and training an object detector** Bag-of-words BOW in computer vision Detecting cars in a scene

Reference &Useful Links:

1. Learning OpenCV 3 Computer Vision with Python Second Edition, by Joe Minichino Joseph Howse Published by Packt Publishing Ltd.
2. http://iitk.ac.in/ee/computer-vision-lab
3. https://nptel.ac.in/courses/108103174
4. https://docs.opencv.org/3.4/d9/df8/tutorial_root.html

Course Assessment:
Lab:
ISE:
1. **ISE-1**
   Quizzes/Assignments/Paper Presentation/Article Discussion/Quizzes/Assignments based on 50% experiments.
2. **ISE-2**
   Quizzes/Assignments/Paper Presentation/Article Discussion/Quizzes/Assignments based on 50% experiments.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
CSDL7012	**Quantum Computing Lab**	**Examination Scheme**						
			ISE1	**MSE**	**ISE2**	**ESE**	**Total**	
		Theory	--	--	--	--	--	
		Lab	10	--	15	--	25	

Pre-requisite CourseCodes		CSL 405	
Course Outcomes	CO1	Implement basic quantum computing logic by building dice and random numbers using open source simulation tools.	
	CO2	Understand quantum logic gates using open source simulation tools.	
	CO3	Implement quantum circuits using open source simulation tools	
	CO4	implement quantum algorithms using open source simulation tools.	

Sr. No.	Topics
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.

Course Assessment:

Lab:

ISE:

1. **ISE-1**

    Quizzes/Assignments/Paper Presentation/Article Discussion/Quizzes/Assignments based on 50% experiments

2. **ISE-2**

    Quizzes/Assignments/Paper Presentation/Article Discussion/Quizzes/Assignments based on 50% experiments

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
CSDL7013	**Natural Language processing Lab**	--	--	2	--	--	1	1
		Examination Scheme						
			ISE1	**MSE**	**ISE2**	**ESE**	**Total**	
		Theory	--	--	--	--	--	
		Lab	10	--	15	--	25	

Pre-requisite Course Codes		CSL 304/ CSL 405
Course Outcomes	CO1	Apply various text processing techniques.
	CO2	Design language model for word level analysis.
	CO3	Model linguistic phenomena with formal grammar.
	CO4	Design, implement and analyze NLP algorithms.
	CO5	To apply NLP techniques to design real world NLP applications such as machine translation, sentiment analysis, text summarization, information extraction, Question Answering system etc
	CO6	Implement proper experimental methodology for training and evaluating empirical NLP systems

Sr. No.	Topics
	(Select a case study and perform the experiments 1 to 8.).
1	Study various applications of NLP and Formulate the Problem Statement for Mini Project based on chosen real world NLP applications: [Machine Translation, Text Categorization, Text summarization, chat Bot, Plagarism, Spelling & Grammar checkers, Sentiment / opinion analysis, Question answering, Personal Assistant, Tutoring Systems, etc.]
2	Apply various text preprocessing techniques for any given text : Tokenization and Filtration & Script Validation.
3	Apply various other text preprocessing techniques for any given text : Stop Word Removal, Lemmatization / Stemming.
4	Perform morphological analysis and word generation for any given text.
5	Implement N-Gram model for the given text input.
6	Study the different POS taggers and Perform POS tagging on the given text.
7	Perform Chunking for the given text input
8	Implement Named Entity Recognizer for the given text input
9	Implement Text Similarity Recognizer for the chosen text documents.
10	Exploratory data analysis of a given text (Word Cloud)
11	Mini Project Report: For any one chosen real world NLP application.
12	Implementation and Presentation of Mini Project
13	Implementation and Presentation of Mini Project

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Course Assessment:

Lab:
ISE:

1. **ISE-1**
   Quizzes/Assignments/Paper Presentation/Article Discussion/Quizzes/Assignments based on 50% experiments.
2. **ISE-2**
   Quizzes/Assignments/Paper Presentation/Article Discussion/Quizzes/Assignments based on 50% experiments.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
	Augmented and Virtual Reality Lab	L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
CSDL7021		**Examination Scheme**						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	--	--	--	--	--	
		Lab	10	--	15	--	25	

Pre-requisite Course Codes		CSC 305, CSDLO6012, CSL 405	
Course Outcomes		CO1	Setup VR development environment
		CO2	Use HTC Vive/ Google Cardboard/ Google Daydream and Samsung gear VR.
		CO3	Develop VR scene and place object
		CO4	Work with Augmented Faces features

Sr. No.	Topics
1	Installation of Unity and Visual Studio, setting up Unity for VR development, understanding documentation of the same.
2	Demonstration of the working of HTC Vive, Google Cardboard, Google Daydream and Samsung gear VR.
3	Develop a scene in Unity that includes: i. a cube, plane and sphere, apply transformations on the 3 game objects. ii. add a video and audio source
4	Develop a scene in Unity that includes a cube, plane and sphere. Create a new material and texture separately for three Game objects.Change the colour, material and texture of each Game object separately in the scene. Write a C# program in visual studio to change the colour and material/texture of the game objects dynamically on button click
5	Develop a scene in Unity that includes a sphere and plane . Apply Rigid body component, material and Box collider to the game Objects. Write a C# program to grab and throw the sphere using vr controller.
6	Develop a simple UI(User interface) menu with images, canvas, sprites and button. Write a C# program to interact with UI menuthrough VR trigger button such that on each successful trigger interaction display a score on scene.
7	Place a three-dimensional ARCore pawn on detected AR plane surfaces
8	Using the Augmented Faces feature in your own apps.

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Course Assessment:
Lab:
ISE:

1. **ISE-1**

   Quizzes/Assignments/Paper Presentation/Article Discussion/Quizzes/Assignments based on 50% experiments.

2. **ISE-2**

   Quizzes/Assignments/Paper Presentation/Article Discussion/Quizzes/Assignments based on 50% experiments.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
CSDL7022	**Blockchain Lab**	**Examination Scheme**						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	--	--	--	--	--	
		Lab	10	--	15	--	25	

Pre-requisite Course Codes		CSC 602
Course Outcomes	CSDL7022.1	Create cryptographic hash using Merkle tree.
	CSDL7022.2	Design smart contract using solidity for a given application.
	CSDL7022.3	Implement Ethereum blockchain using any of the Ethereum platforms.
	CSDL7022.4	Explore Hyperledger Fabric and its working.
	CSDL7022.5	Demonstrate the concepts of blockchain in real world applications.

Sr. No.	Topics
1	Cryptography in Blockchain, Merkle root tree hash
2	Creating Smart Contract using Solidity and Remix IDE.
3	Creating Transactions using Solidity and Remix IDE
4	Embedding wallet and transaction using Solidity
5	Blockchain platform Ethereum using Geth.
6	Blockchain platform Ganache.
7	Case Study on Hyperledger
8	Case Study on Other Blockchain platforms.
9	Creating a blockchain Application

Course Assessment:

Lab:

ISE:

1. **ISE-1**

   Quizzes/Assignments/Paper Presentation/Article Discussion/Quizzes/Assignments based on 50% experiments.

2. **ISE-2**

   Quizzes/Assignments/Paper Presentation/Article Discussion/Quizzes/Assignments based on 50% experiments.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
CSDL7023	**Information Retrieval Lab**	**Examination Scheme**						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	--	--	--	--	--	
		Lab	10	--	15	--	25	

Pre-requisite Course Codes		CSL 304, CSL 405	
Course Outcomes		CO1	To frame queries for information retrieval
		CO2	To implement modeling techniques
		CO3	To perform query expansion techniques
		CO4	To demonstrate evaluation techniques for IR

Sr. No.	Topics
	Suggested Experiments: Students are required to perform any **5 experiments** from the suggested list along with **a case study** (* indicates compulsory experiment)
1	To understand the query structure and execute various structured queries
2	To implement any IR modeling technique
3	To implement Pattern matching method used for IR
4	To execute query expansion technique (Local/Global)
5	To design inverted indices for any information retrieval model
6	To implement tf-id weighting
7	To evaluate the system/application under study
8*	To understand the Case Study and generate a report for the same

Course Assessment:

Lab:
ISE:

1. **ISE-1**
   Quizzes/Assignments/Paper Presentation/Article Discussion/Quizzes/Assignments based on 50% experiments
2. **ISE-2**
   Quizzes/Assignments/Paper Presentation/Article Discussion/Quizzes/Assignments based on 50% experiments

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
		--	--	6	--	--	3	3
CSP701	**Major Project 1**	Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	--	--	--	--	--	
		Lab	25	--	25	25	75	

Pre-requisite Course Codes		
Course Outcomes	1	To develop the understanding of the problem domain through extensive review of literature.
	2	To Identify and analyze the problem in detail to define its scope with problem specific data.
	3	To know various techniques to be implemented for the selected problem and related technical skills through feasibility analysis
	4	To design solutions for real-time problems that will positively impact society and environment
	5	To develop clarity of presentation based on communication, teamwork and leadership skills
	6	To inculcate professional and ethical behavior.

Guidelines:
  1. Project Topic Selection and Allocation:
- Project topic selection Process to be defined and followed:
    o Project orientation can be given at the end of sixth semester.
    o Students should be informed about the domain and domain experts whose guidance can be taken before selecting projects.
    o Student's should be recommended to refer papers from reputed conferences/ journals like IEEE, Elsevier, ACM etc. which are not more than 3 years old for review of literature.
    o Students can certainly take ideas from anywhere, but be sure that they should evolve them in the unique way to suit their project requirements. Students can be informed to refer DigitalIndia portal, SIH portal or any other hackathon portal for problem selection.
- Topics can be finalized with respect to following criterion:
    o **Topic Selection**: The topics selected should be novel in nature (Product based, Application based or Research based) or should work towards removing the lacuna in currently existing systems.
    o **Technology Used:** Use of latest technology or modern tools can be encouraged**.**
    o Students should not repeat work done previously (work donein the last three years).
    o Project work must be carried out by the group of at least 2

students and maximum 4.

- o The project work can be undertaken in a research institute or organization/Industry/any business establishment. (out-house projects)
- o The project proposal presentations can be scheduled according to the domains and should be judged by faculty who are expert in the domain.
- o Head of department and senior staff along with project coordinators will take decision regarding final selection of projects.
- o Guide allocation should be done and students have to submit weekly progress report to the internal guide.
- o 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.
- o In case of industry/ out-house projects, visit by internal guide will be preferred and external members can be called during the presentation at various levels

2. Project Report Format:

At the end of semester, each group needs to prepare a project report as perthe guidelines issued by the University of Mumbai.

A project report should preferably contain at least following details:
- o Abstract
- o Introduction
- o Literature Survey/ Existing system
- o Limitation Existing system or research gap
- o Problem Statement and Objective
- o Proposed System
  - o Analysis/Framework/ Algorithm
  - o Design details
  - o Methodology (your approach to solve the problem) Proposed System
- o Experimental Set up
  - o Details of Database or details about input to systems or selected data
  - o Performance Evaluation Parameters (for Validation)
  - o Software and Hardware Set up

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- o Implementation Plan for Next Semester
  - o Timeline Chart for Term1 and Term-II (Project Managementtools can be used.)
  - o References

Desirable

Students can be asked to undergo some Certification course (for thetechnical skill set that will be useful and applicable for projects.)

3. In Semester Evaluation:

Distribution of marks for term work shall be done based on following:
- o Weekly Log Report
- o Project Work Contribution
- o Project Report (Spiral Bound) (both side print)
- o Term End Presentation (Internal)

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

4. End Sem Evaluation:

Oral and Practical examination (Final Project Evaluation) of Project 1 should be conducted by Internal examiners approved byUniversity of Mumbai at the end of the semester.

Suggested quality evaluation parameters are as follows:

- o Quality of problem selected
- o Clarity of problem definition and feasibility of problem solution
- o Relevance to the specialization / industrial trends
- o Originality
- o Clarity of objective and scope
- o Quality of analysis and design
- o Quality of written and oral presentation
- o Individual as well as team work

Course Assessment:

1. ISE-1
   midterm presentation will be carried out and evaluation is based on rubrics decided by the department.
2. ISE-2
   midterm presentation will be carried out and evaluation is based on rubrics decided by the department.
3. ESE   -
   Oral examination will be carried out at the end of the semester by the panel of the department.

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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	**T**	**P**		**L**	**T**	**P**	**Total**
		3	**--**	**--**		**3**	**--**	**--**	**3**
CSC801	**Distributed Computing**				**Examination Scheme**				
		ISE1		**MSE**	**ISE2**	**ESE**		**Total**	
		20		**30**	**20**	**100 (30% weightage)**		**100**	

Pre-requisite	CSC 503, CSC 404	
Course Outcomes	CO1	Demonstrate the knowledge of basic elements and concepts related to distributed system technologies.
	CO2	Illustrate the middleware technologies that support distributed applications such as RPC, RMI and Object-based middleware.
	CO3	Analyze the various techniques used for clock synchronization, mutual exclusion and deadlock.
	CO4	Demonstrate the concepts of Resource and Process management.
	CO5	Demonstrate the concepts of Consistency, Replication Management and fault Tolerance.
	CO6	Apply the knowledge of Distributed File systems in building large-scale distributed applications.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction to Distributed Systems**		4
	1.1	Characterization of Distributed Systems: Issues, Goals, Types of distributed systems, Grid and Cluster computing Models, Hardware and Software Concepts:NOS, DOS.	[1][4]	
	1.2	Middleware: Models of middleware, Services offered by middleware.	[1][4]	
2		**Communication**		4
	2.1	Interposes communication (IPC): Remote Procedure Call (RPC), Remote Method Invocation (RMI).	[1][4]	
	2.2	Message-Oriented Communication, Stream Oriented Communication, Group Communication.	[1][4]	
3		**Synchronization**		10
	3.1	Clock Synchronization: Physical clock, Logical Clocks, Election Algorithms	[1][2]	

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Course Assessment:

Theory:

ISE-1:

Two hours 20 Marks Activity: Quiz and assignments

ISE-2:

Two hours 20 Marks Activity: Quiz and assignments

MSE:

Two hours 30 Marks written examination based on 50% syllabus.

ESE:

Three hours 100 Marks (30% weightage) written examination based on entire syllabus

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	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P		L	T	P	Total
CSDC8011	Deep Learning	3	--	--		3	--	--	3
		Examination Scheme							
		ISE1	MSE		ISE2	ESE		Total	
		20	30		20	100 (30% weightage)		100	

Pre-requisite	FEC 101, FEC 202, CSC 401, CSC 701

Course Outcomes	CO1	Gain basic knowledge of Neural Networks.
	CO2	Acquire in depth understanding of training Deep Neural Networks.
	CO3	Design appropriate DNN model for supervised, unsupervised and sequence learning applications.
	CO4	Gain familiarity with recent trends and applications of Deep Learning.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Fundamentals of Neural Network**	[1][2]	04
	1.1	Biological neuron, Mc-Culloch Pitts Neuron, Perceptron, Perceptron Learning, Delta learning, Multilayer Perceptron: Linearly separable, linearly non-separable classes		
	1.2	Deep Networks: Fundamentals, Brief History, Three Classes of Deep Learning Basic Terminologies of Deep Learning		
2		**Training, Optimization and Regularization of Deep Neural Network**	[1][2][3]	10
	2.1	Training Feedforward DNN Multi Layered Feed Forward Neural Network, Learning Factors, Activation functions: Tanh, Logistic, Linear, Softmax, ReLU, Leaky Re LU, Loss functions: Squared Error loss, Cross Entropy, Choosing output function and loss function		

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	2.2	Optimization Learning with backpropagation, Learning Parameters:Gradient Descent (GD), Stochastic and Mini Batch GD, Momentum Based GD, Nesterov Accelerated GD, Ada Grad, Adam, RMS Prop		
	2.3	Regularization Overview of Overfitting, Types of biases, Bias Variance Tradeoff Regularization Methods: L1, L2 regularization, Parameter sharing, Dropout, Weight Decay, Batch normalization, Early stopping, Data Augmentation, Adding noise to input and output		
		Autoencoders: Unsupervised Learning	[1][2] [3]	06
	3.1	Introduction, Linear Autoencoder, Undercomplete Autoencoder, Overcomplete Autoencoders, Regularization in Autoencoders		
	3.2	Denoising Autoencoders, Sparse Autoencoders, Contractive Autoencoders		
	3.3	Application of Autoencoders: Image Compression		
4		**Convolutional Neural Networks (CNN): Supervised Learning**	[2][3] [4][6] [7]	07
	4.1	Convolution operation, Padding, Stride, Relation between input, output and filter size, CNN architecture: Convolution layer, Pooling Layer, Weight Sharing in CNN, Fully Connected NN vs CNN, Variants of basic Convolution function		
	4.2	Modern Deep Learning Architectures: LeNET: Architecture, AlexNET: Architecture		
5		**Recurrent Neural Networks (RNN)**	[3][4]	08
	5.1	Sequence Learning Problem, Unfolding Computational graphs, Recurrent Neural Network, Bidirectional RNN, Backpropagation Through Time (BTT), Vanishing and Exploding Gradients, Truncated BTT		
	5.2	Long Short Term Memory: Selective Read, Selective write, Selective Forget, Gated Recurrent Unit		
6		Recent Trends and Applications	[2][3] [4]	04
	6.1	Generative Adversarial Network (GAN): Architecture		
	6.2	Applications: Image Generation, DeepFake		
			Total	**39**

Recommended Books:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville. ―Deep Learning‖, MIT Press Ltd, 2016
2. Li Deng and Dong Yu, ―Deep Learning Methods and Applications‖, Publishers Inc.
3. Satish Kumar "Neural Networks A Classroom Approach" Tata McGraw-Hill.
4. JM Zurada ―Introduction to Artificial Neural Systems‖, Jaico Publishing House 5 M. J. Kochenderfer, Tim A. Wheeler. ―Algorithms for Optimization‖, MIt Press
5. Buduma, N. and Locascio, N., ―Fundamentals of deep learning: Designing next-generation machineintelligence algorithms" 2017. O'Reilly Media, Inc.".

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6. François Chollet. ―Deep learning with Python ―(Vol. 361). 2018 New York: Manning.3 Douwe Osinga. ―Deep Learning Cookbook‖, O'REILLY, SPD Publishers, Delhi.
7. Simon Haykin, Neural Network- A Comprehensive Foundation- Prentice Hall International, Inc5 S.N. Sivanandam and S.N. Deepa, Principles of soft computing-Wiley India

Useful Links
1. https://nptel.ac. https://deeplearning.cs.cmu.edu/S21/index.html
2. http://www.cse.iitm.ac.in/~miteshk/CS6910.html
3. https://nptel.ac.in/courses/106/106/106106184
4. https://www.deeplearningbook.org/

Course Assessment:
 Theory:
ISE-1:
Two hours 20 Marks Activity: Quiz and assignments
ISE-2:
Two hours 20 Marks Activity: Quiz and assignments
MSE:
Two hours 30 Marks written examination based on 50% syllabus.
ESE:
Three hours 100 Marks (30% weightage) written examination based on entire syllabus

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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P		L	T	P	Total
CSDC8012	Digital Forensics	3	--	--		3	--	--	3
		Examination Scheme							
		ISE1	MSE	ISE2	ESE		Total		
		20	30	20	100 (30% weightage		100		

Pre-requisite		CSC 503, CSC 602
Course Outcomes	CO1	Discuss the phases of Digital Forensics and methodology to handle the computer security incident.
	CO2	Describe the process of collection, analysis and recovery of the digital evidence
	CO3	Explore various tools to analyze malwares and acquired images of RAM/hard drive
	CO4	Acquire adequate perspectives of digital forensic investigation in mobile devices

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction to Digital Forensics**	[1][2]	10
	1.1	Digital Forensics Definition, Digital Forensics Goals, Digital Forensics Categories - Computer Forensics, Mobile Forensics, Network Forensics, Database Forensics		
	1.2	Introduction to Incident - Computer Security Incident, Goals of Incident Response, CSIRT, Incident Response Methodology, Phase after detection of an incident		
2		**Digital Evidence, Forensics Duplication and Digital Evidence Acquisition**	[1][2]	06
	2.1	Digital evidence, Types of Digital Evidence, Challenges in acquiring Digital evidence, Admissibility of evidence, Challenges in evidence handling, Chain of Custody		

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	2.2	Digital Forensics Examination Process - Seizure, Acquisition, Analysis, Reporting. Necessity of forensic duplication, Forensic image formats, Forensic duplication techniques,		
	2.3	Acquiring Digital Evidence - Forensic Image File Format, Acquiring Volatile Memory (Live Acquisition), Acquiring Nonvolatile Memory(Static Acquisition), Hard Drive Imaging Risks and Challenges, Network Acquisition		
3		**Forensics Investigation**		07
	3.1	Analyzing Hard Drive Forensic Images, Analyzing RAM Forensic Image, Investigating Routers	[1][2]	
	3.2	Malware Analysis - Malware, Viruses, Worms, Essential skills and tools for Malware Analysis, List of Malware Analysis Tools and Techniques		
4		**Windows and Unix Forensics Investigation**		08
	4.1	Investigating Windows Systems - File Recovery, Windows Recycle Bin Forensics, Data Carving, Windows Registry Analysis, USB Device Forensics, File Format Identification, Windows Features Forensics Analysis, Windows 10 Forensics, Cortana Forensics	[1][2][3]	
	4.2	Investigating Unix Systems - Reviewing Pertinent Logs, Performing Keyword Searches, Reviewing Relevant Files, Identifying Unauthorized User Accounts or Groups, Identifying Rogue Processes, Checking for Unauthorized Access Points, Analyzing Trust Relationships		
5		**Mobile Forensics**		**08**
	5.1	Android Forensics, Mobile Device Forensic Investigation – Storage location, Acquisition methods, Data Analysis	[1][2][3]	
	5.2	GPS forensics - GPS Evidentiary data, GPS Exchange Format (GPX),GPX Files, Extraction of Waypoints and TrackPoints, Display the Tracks on a Map.		
	5.3	SIM Cards Forensics - The Subscriber Identification Module (SIM), SIM Architecture, Security, Evidence Extraction.		
6		**Browser, Email Forensic & Forensic Investigation Reporting**		**04**
	6.1	Web Browser Forensics, Google chrome, Other web browser investigation Email forensics - Sender Policy Framework (SPF),Domain Key Identified Mail (DKIM), Domain based Message Authentication Reporting and Confirmation (DMARC)	[1][2][3]	
	6.2	Investigative Report Template, Layout of an Investigative Report, Guidelines for Writing a Report		
			Total	**39**

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Recommended Books:
1. Kevin Mandia, Chris Prosise, ―Incident Response and computer forensics‖, Tata McGraw-Hill, 2006
2. Digital Forensics Basics A Practical Guide Using Windows OS — Nihad A. Hassan, A Press Publication,2019
3. Xiaodong Lin, ―Introductory Computer Forensics: A Hands-on Practical Approach‖, Springer Nature,2018

Suggested MOOC Course Links
1. Course on ―Ethical Hacking‖
   https://nptel.ac.in/courses/106/105/106105217/
2. Course on ―Digital Forensics
   https://onlinecourses.swayam2.ac.in/cec20_lb06/preview
3. Course on Cyber Incident Response
   https://www.coursera.org/learn/incident-response
4. Course on ―Penetration Testing, Incident Responses and Forensics‖
   https://www.coursera.org/learn/ibm-penetration-testing-incident-response-forensics

Course Assessment:
 Theory:
   ISE-1:
   Two hours 20 Marks Activity: Quiz and assignments
   ISE-2:
   Two hours 20 Marks Activity: Quiz and assignments
   MSE:
   Two hours 30 Marks written examination based on 50% syllabus.
   ESE:
   Three hours 100 Marks (30% weightage) written examination based on entire syllabus

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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	**T**	**P**		**L**	**T**	**P**	**Total**
CSDC8013	**Applied Data Science**	3	--	--		3	--	--	3
		Examination Scheme							
		ISE1	**MSE**		**ISE2**	**ESE**		**Total**	
		20	30		20	100 (30% weightage		100	

Pre-requisite		CSC 701, CSC 303, CSC 402
Course Outcomes	CO1	To gain fundamental knowledge of the data science process.
	CO2	To apply data exploration and visualization techniques.
	CO3	To apply anomaly detection techniques.
	CO4	To apply anomaly detection techniques.
	CO5	Apply different methodologies and evaluation strategies.
	CO6	Apply different methodologies and evaluation strategies.

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction Data Science**	General Topic All Books	2
	1.1	Introduction to Data Science, Data Science Process	General Topic All Books	
	1.2	Motivation to use Data Science Techniques: Volume, Dimensions and Complexity, Data Science Tasks and Examples	General Topic All Books	
	1.3	Overview of Data Preparation, Modeling, Difference between Data science and data analytics	[1]	
2		**Data Exploration**		8
	2.1	Types of data, Properties of data **Descriptive Statistics:** Univariate Exploration: Measure of Central Tendency, Measure of Spread, Symmetry, Skewness: Karl Pearson Coefficient of skewness, Bowley's Coefficient, Kurtosis Multivariate Exploration: Central Data Point, Correlation, Different forms of correlation, Karl Pearson Correlation Coefficient forbivariate distribution	[2],[4] [8]	

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	2.2	**Inferential Statistics:**	[2],[4] [7]	
		Overview of Various forms of distributions: Normal, Poisson, Test Hypothesis, Central limit theorem, Confidence Interval, Z- test, t-test,Type-I, Type-II Errors, ANOVA		
3		**Methodology and Data Visualization**		6
	3.1	**Methodology:** Overview of model building, Cross Validation, K-fold cross validation, leave-1 out, Bootstrapping	[1],[2]	
	3.2	**Data Visualization** Univariate Visualization: Histogram, Quartile, Distribution Chart Multivariate Visualization: Scatter Plot, Scatter Matrix, Bubble chart, Density Chart Roadmap for Data Exploration	[1],[2]	
	3.3	**Self-Learning Topics:** Visualizing high dimensional data: Parallel chart, Deviation chart, Andrews Curves.	[1],[2]	
4		**Anomaly Detection**		6
	4.1	Outliers, Causes of Outliers, Anomaly detection techniques, Outlier Detection using Statistics	[1]	
	4.2	Outlier Detection using Distance based method, Outlier detection using density-based methods, SMOTE	[1]	
5		**Time Series Forecasting**		4
	5.1	Taxonomy of Time Series Forecasting methods, Time Series Decomposition	[1]	
	5.2	Smoothening Methods: Average method, Moving Average smoothing, Time series analysis using linear regression, ARIMA Model, Performance Evaluation: Mean Absolute Error, Root Mean Square Error, Mean Absolute Percentage Error, Mean Absolute Scaled Error	[1]	
	5.3	Predictive Modeling: House price prediction, FraudDetection Clustering: Customer Segmentation Time series forecasting: Weather Forecasting Recommendation engines: Product recommendation	[1]	
6	6.1	**Applications of Data Science**	[1]	4
		Predictive Modeling: House price prediction, FraudDetection Clustering: Customer Segmentation Time series forecasting: Weather Forecasting Recommendation engines: Product recommendation		
				39

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Recommended Books:

1. Vijay Kotu, Bala Deshpande. ―Data Science Concepts and Practice‖, Elsevier, M.K. Publishers.
2. Steven Skiena, ―Data Science Design Manual‖, Springer International Publishing AG
3. Samir Madhavan. ―Mastering Python for Data Science‖, PACKT Publishing
4. Dr. P. N. Arora, Sumeet Arora, S. Arora, Ameet Arora, ―Comprehensive Statistical Methods‖, S.Chand Publications, New Delhi.
5. Jake VanderPlas. ‒Python Data Science Handbook‖, O'reilly Publications.
6. Francesco Ricci, LiorRokach, BrachaShapira, Paul B. Kantor, ‒Recommender Systems Handbook‖, Springer.
7. S.C. Gupta, V. K. Kapoor ‒Fundamentals of Mathematical Statistics‖, S. Chand and Sons, New Delhi.
8. B. L. Agrawal. ‒Basic Statistics‖, New Age Publications, Delhi.

Useful Links

1. https://onlinecourses.nptel.ac.in/noc22_cs32/preview
2. https://onlinecourses.nptel.ac.in/noc21_cs69/preview

Course Assessment:

Theory:

ISE-1:
Two hours 20 Marks Activity: Quiz and assignments
ISE-2:
Two hours 20 Marks Activity: Quiz and assignments
MSE:
Two hours 30 Marks written examination based on 50% syllabus.
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Three hours 100 Marks (30% weightage) written examination based on entire syllabus

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Course Name		Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P		L	T	P	Total
CSDC8021	Optimization in Machine Learning	3	--	--		3	--	--	3
		Examination Scheme							
		ISE1	MSE		ISE2	ESE		Total	
		20	30		20	100 (30% weightage)		100	

Pre-requisite		CSC 301CSC 401, CSC 303. CSC	
Course Outcomes	CO1	Understand foundational optimization ideas including gradient descent, stochasticgradient methods	
	CO2	Apply convex optimization algorithm	
	CO3	Analyze and demonstrate severalpopulation methods in Evolutionary Computation	
	CO4	Apply advanced evolutionary algorithms such as particle swarm andant colony optimization	

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction and Background to Optimization Theory**	[1][2]	4
	1.1	Basic Ingredients of Optimization Problems, Optimization Problem Classifications, Optima Types, Optimization Method Classes, Overview of Unconstrained and Constrained Optimization, Basics of convex optimization		
2		**Derivative based Optimization**	[1][2]	10
	2.1	The Basics of Optimization (univariate, bivariate and multivariate optimization), Convex Objective Functions		
	2.2	First-Order optimization Methods : Gradient Descent, Conjugate Gradient, Momentum, Nesterov Momentum,		
	2.3	Second order optimization: Newton method		
3		**Stochastic Methods**	[1][2]	6
	3.1	Noisy Descent, Mesh Adaptive Direct Search, Cross-Entropy Method, Natural Evolution Strategies, Covariance Matrix Adaptation		

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4		**Convex Optimization**		6
	4.1	Optimization problems, Convex optimization, Linear optimization problems, Quadratic optimization problems, Geometric programming, Overview of Generalized inequality constraints and Vector optimization		
5		**Evolutionary Methods**	[1][2] [3]	8
	5.1	Introduction to Evolutionary Computation: Generic Evolutionary Algorithm, Representation: The Chromosome, Initial Population, Fitness Function, Selection: Selective Pressure, Random Selection, Proportional Selection, Tournament Selection, Rank-Based Selection, Elitism and Evolutionary Computation versus Classical Optimization, Stopping conditions		
	5.2	Canonical Genetic Algorithm, Binary Representations of Crossover and Mutation: Binary Representations, Control Parameters		
6		**Advance Evolutionary Methods**	[1][2] [3]	5
	6.1	Basic Particle Swarm Optimization, Global Best PSO, Local Best PSO, g-best versus l-best PSO, Velocity Components, Geometric Illustration, Algorithm Aspects, Social Network Structures		
	6.2	Ant Colony Optimization Meta-Heuristic, Foraging Behavior of Ants, Stigmergy and Artificial Pheromone,Simple Ant Colony Optimization, Ant System, Ant Colony System		
Total				**39**

Recommended Books:
1. Suvrit Sra, Sebastian Nowozin, Stephen J. Wright, Optimization for Machine Learning, The MIT Press
2. Xin-She Yang Middlesex ,Optimization techniques and applications with examples, Wiley
3. A.E. Eiben, J. E. Smith, Introduction to Evolutionary Computing, Springer

Useful Links
1. Convex optimization (NPTEL)
2. Constrained and Unconstrained optimization (NPTEL)
3. Machine-learning-model-performance (Coursera)
4. Deep-neural-network optimization (Coursera)

Course Assessment:

Theory:

ISE-1:

Two hours 20 Marks Activity: Quiz and assignments

ISE-2:

Two hours 20 Marks Activity: Quiz and assignments

MSE:

Two hours 30 Marks written examination based on 50% syllabus.

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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	**T**	**P**		**L**	**T**	**P**	**Total**
CSDC8022	**High Performance Computing**	**3**	**--**	**--**		**3**	**--**	**--**	**3**
					Examination Scheme				
		ISE1	MSE	ISE2	ESE		Total		
		20	**30**	**20**	**100 (30% weightage**		**100**		

Pre-requisite	CSC 304, CSC 404, CSL 605	
Course Outcomes	CO1	Understand parallel and pipeline processing approaches
	CO2	Design a parallel algorithm to solve computational problems and identify issues in parallel programming.
	CO3	Analyze the performance of parallel computingsystems for clusters in terms of execution time, total parallel overhead, speedup.
	CO4	Develop efficient and high-performance parallel algorithms using OpenMP and message passing paradigm
	CO5	Develop high-performance parallel programming using OpenCL and CUDA framework
	CO6	Perform the range of activities associated with High Performance Computing in Cloud Computing

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction to Parallel Computing**		5
	1.1	Parallelism (What, Why, Applications), Levels ofparallelism (instruction, transaction , task, thread, memory, function)	[1][2]	

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	1.2	**Classification Models:** Architectural Schemes (Flynn's, Shore's, Feng's,handler's)	[1][2]	
	1.3	**Memory Access:** Distributed Memory, Shared Memory, Hybrid Distributed shared memory)		
	1.4	**Parallel Architecture:** Pipeline Architecture: Arithmetic pipelines, Floating point, Array Processor		
2		**Parallel Programming Platform and Algorithm Design**		11
	2.1	**Parallel Programming Platform:** Physical Organization of Parallel Platforms, Communication Costs in Parallel Machines	[1][2][3]	
	2.2	**Algorithm Design:** Preliminaries, Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing, Methods for Containing Interaction Overheads, Parallel Algorithm Models.		
3		**Performance Measures**		3
	3.1	**Performance Measures:** Speedup, execution time, efficiency, cost, scalability, Effect of granularity on performance, Scalability of Parallel Systems, Amdahl_s Law, Gustavson_s Law, Performance Bottlenecks, The Karp Flatt Metric.	[1][2][3]	
4		**HPC Programming: OpenMP and MPI**		08
	4.1	Introduction: Threads, Share memory Architecture, Multi-core processors and Hyper threading, Fork and join model.	[2][3][4]	
	4.2	OpenMP directives: #pragma omp parallel, Hello worldwith openMP, #pragma omp for, #pragma omp for schedule. Serial vs Parallel PI program.		
	4.3	Synchronisation: Introduction, Private vs Shared variables. and Synchronous		
	4.4	Introduction: Processes, Multiprocessor programming model, Distributed system programming model, Inter- process communication using message passing: Asynchronous and Synchronous		
	4.5	MPI Programming: Hello world problem, mpi_ initMPI_ send MPI_ Recv, Synchronisation: MPI_ Barrier		
	4.6	Hybrid (MPI + OpenMP) programming, Hardware requirement, Threads inside Processes, Hybrid Matrix multiplication		

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	4.7	Message passing vs Share memory communication: Advantages and disadvantage		
5		**Parallel programming using accelerators**		04
	5.1	An Overview of GPGPUs, Introduction to CUDA, Introductionto Heterogeneous Computing using OpenCL, An Overview of OpenCL API, Heterogeneous Programming in OpenCL.	[3][4]	
6		**High Performance Computing in the Cloud**		04
	6.1	Virtualization and Containerization, Parallel Computing Frameworks, Scaling, HPC in the Cloud Use Cases.	[5]	
				39

Recommended Books:
1. Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar ―Introduction to Parallel Computing‖, 2nd edition, Addison Wesley, 2003.
2. Shane Cook, Morgan Kaufmann ―CUDA Programming: A Developer's Guide to Parallel Computing with GPUs‖, 2012.
3. M. R. Bhujade ―Parallel Computing‖,2nd edition, New Age International Publishers, 2009.
4. Kai Hwang, Naresh Jotwani, ―Advanced Computer Architecture: Parallelism, Scalability, Programmability‖ McGraw Hill, Second Edition, 2010.
5. Georg Hager, Gerhard Wellein, Chapman ―Introduction to High Performance Computing for Scientists and Engineers‖ Hall/CRC Computational Science Series, 2011.

Useful Links
1. https://nptel.ac.in/courses/112105293
2. https://archive.nptel.ac.in/courses/128/106/128106014/

Course Assessment:
Theory:
ISE-1:
Two hours 20 Marks Activity: Quiz and assignments
ISE-2:
Two hours 20 Marks Activity: Quiz and assignments
MSE:
Two hours 30 Marks written examination based on 50% syllabus.
ESE:
Three hours 100 Marks (30% weightage) written examination based on entire syllabus

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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P		L	T	P	Total
CSDC8023	Social Media Analytics	3	--	--		3	--	--	3
		Examination Scheme							
		ISE1	MSE	ISE2	ESE			Total	
		20	30	20	100 (30% weightage			100	

Pre-requisite		CSC 305, CSC 504, CSL 405
Course Outcomes	CO1	Understand the concept of Social media
	CO2	Understand the concept of social media Analytics and its significance.
	CO3	Learners will be able to analyze the effectiveness of social media

Module No.	Unit No.	Topics	Ref.	Hrs.
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	[1]	06
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.	[1],[2]	06
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	[1],[3]	08

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4		**Social Media Location & Search Engine Analytics**	[2],[3]	06
		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		
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	[2],[3]	06
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	[1],[3]	07
Total				**39**

Recommended Books:

1. Social Media Analytics [2015], Techniques and Insights for Extracting Business Value Out of social media, Matthew Ganis, Avinash Kohirkar, IBM Press
2. Social Media Analytics Strategy_ Using Data to Optimize Business Performance, Alex Gonçalves, A Press Business Team
3. Social Media Data Mining and Analytics, Szabo, G., G. Polatkan, O. Boykin & A. Chalki opoulus (2019), Wiley, ISBN 978-1-118-82485-6

Course Assessment:

Theory:

ISE-1:

Two hours 20 Marks Activity: Quiz and assignments

ISE-2:

Two hours 20 Marks Activity: Quiz and assignments

MSE:

Two hours 30 Marks written examination based on 50% syllabus.

ESE:

Three hours 100 Marks (30% weightage) written examination based on entire syllabus

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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	**T**	**P**		**L**	**T**	**P**	**Total**
ILO 8021	**Project Management**	3	--	--		3	--	--	3
		Examination Scheme							
		ISE1		MSE		ISE2	ESE		Total
		20		30		20	100 (30% weightage		100

Pre-requisite		-------------	
Course Outcomes	CO1	Apply selection criteria and select an appropriate project from different options	
	CO2	Write work break down structure for a project and develop a schedule based on it.	
	CO3	Identify opportunities and threats to the project and decide an approach to deal with them strategically.	

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**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)	[1],[2]	06
2		**Initiating Projects:** How to get a project started, Selecting project strategically, Projectselection 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	[1],[2]	08
3		**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).	[1],[2]	06

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4		**Planning Projects:** Crashing project time, Resource loading and levelling, 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	[1],[2]	08
5		**5.1 Executing Projects:** Planning monitoring and controlling cycle, Information needs and reporting, engaging with all stakeholders of the projects, Team management, communication and project meetings **5.2 Monitoring and Controlling Projects:** Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep, Project audit **5.3 Project Contracting** : Project procurement management, contracting and outsourcing,	[1],[2],[3]	08
6		**6.1 Project Leadership and Ethics:** Introduction to project leadership, ethics in projects, Multicultural and virtual projects **6.2 Closing the Project:** 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	[1],[2],[5]	06
Total				**39**

Recommended Books:

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

Course Assessment:

Theory:

ISE-1:
Two hours 20 Marks Activity: Quiz and assignments
ISE-2:
Two hours 20 Marks Activity: Quiz and assignments
MSE:
Two hours 30 Marks written examination based on 50% syllabus.
ESE: Three hours 100 Marks (30% weightage) written examination based on entire syllabus

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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P		L	T	P	Total
ILO 8022	Finance Management	3	--	--		3	--	--	3
		Examination Scheme							
		ISE1	MSE	ISE2	ESE			Total	
		20	30	20	100 (30% weightage)			100	

Pre-requisite	-------------	
Course Outcomes	CO1	Gain comprehension of the Indian financial system and corporate finance
	CO2	Make choices regarding investments, finances, and dividend distribution

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Overview of Indian Financial System**: Characteristics, Components and Functions of Financial System. **Financial Instruments**: Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets**: Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market **Financial Institutions**: Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	[1],[2],[3]	06
2		**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. **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	[1],[2]	06

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3		**Overview of Corporate Finance**: Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. **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.	[1],[2]	09
4		**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, InternalRate of Return (IRR), and Modified Internal Rate of Return (MIRR) **Working Capital Management**: Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's 10 Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories;Management of Receivables; and Management of Cash and Marketable Securities.	[1],[2]	10
5		**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	[1],[2],[3]	05
6		**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	[1],[2],[4]	03
			Total	**39**

Recommended Books:

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: McGrawHill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, NewDelhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) &

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CompanyLimited, New Delhi

Course Assessment:
Theory:

ISE-1:

Two hours 20 Marks Activity: Quiz and assignments

ISE-2:

Two hours 20 Marks Activity: Quiz and assignments

MSE:

Two hours 30 Marks written examination based on 50% syllabus.

ESE:

Three hours 100 Marks (30% weightage) written examination based on entire syllabus

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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P		L	T	P	Total
ILO 8023	Entrepreneurship Development and Management	3	--	--		3	--	--	3
					Examination Scheme				
		ISE1		MSE	ISE2	ESE		Total	
		20		30	20	100 (30% weightage)		100	

Pre-requisite		-------------	
Course Outcomes		CO1	Understand the concept of business plan and ownerships
		CO2	Interpret key regulations and legal aspects of entrepreneurship in India
		CO3	Understand government policies for entrepreneurs

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**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	[1][2]	04
2		**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	[1][2]	09
3		Women's Entrepreneurship Development, Social entrepreneurship- role and need, EDP cell, role of sustainability and sustainabledevelopment for SMEs, case studies, exercises	[1][2][3]	05

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4		**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 organisations, 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	[1][2][3]	08
5		**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	[1][2][4]	08
6		**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	[1][2][4]	05
			Total	**39**

Recommended Books:
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

Course Assessment:
 Theory:
  ISE-1:
  Two hours 20 Marks Activity: Quiz and assignments
  ISE-2:
  Two hours 20 Marks Activity: Quiz and assignments
  MSE:
  Two hours 30 Marks written examination based on 50% syllabus.
  ESE:
  Three hours 100 Marks (30% weightage) written examination based on entire syllabus

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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	**T**	**P**		**L**	**T**	**P**	**Total**
ILO 8024	**Human Resource Management**	3	--	--		3	--	--	3
					Examination Scheme				
		ISE1		**MSE**	**ISE2**	**ESE**		**Total**	
		20		**30**	**20**	**100 (30% weightage)**		**100**	

Pre-requisite	-------------	
Course Outcomes	CO1	Understand the concepts, aspects, techniques and practices of the human resource management.
	CO2	Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective
	CO3	Gain knowledge about the latest developments and trends in HRM

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction to HR** • 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	[1][2]	05
2		**Organizational Behaviour (OB)** • Introduction to OB Origin, Nature and Scope of Organizational Behaviour, 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 Decisionmaking, Attitude and Behaviour • Motivation: Theories of Motivation and their Applications for Behavioural Change (Maslow, Herzberg, McGregor); • Group Behaviour and Group Dynamics: Work groups	[1][2]	07

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		formal and informal groups and stages of group development, Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. • Case study		
3		**Organizational Structure & Design** • Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. • 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.	[1][2][3]	06
4		**Human resource Planning** • Recruitment and Selection process, Job-enrichment, Empowerment - Job Satisfaction, employee morale • Performance Appraisal Systems: Traditional & modern methods, Performance Counselling, Career Planning • Training & Development: Identification of Training Needs, Training Methods	[1][2][3]	05
5		**Emerging Trends in HR** • 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	[[2][3][4][5]	06
6		**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 **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 **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	[[2][3][4][6]	10
			Total	**39**

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Recommended Books:
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, 15thedition, 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

Course Assessment:
 Theory:
> ISE-1:
> Two hours 20 Marks Activity: Quiz and assignments
> ISE-2:
> Two hours 20 Marks Activity: Quiz and assignments
> MSE:
> Two hours 30 Marks written examination based on 50% syllabus.
> ESE:
> Three hours 100 Marks (30% weightage) written examination based on entire syllabus

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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P		L	T	P	Total
ILO 8025	**Professional Ethics and Corporate Social Responsibility (CSR)**	3	--	--		3	--	--	3
		Examination Scheme							
		ISE1	MSE	ISE2	ESE		Total		
		20	30	20	100 (30% weightage)		100		

Pre-requisite		-------------	
Course Outcomes	CO1	Understand rights and duties of business	
	CO2	Distinguish different aspects of corporate social responsibility	
	CO3	Demonstrate professional ethics	

Module No.	Unit No.	Topics	Ref.	Hrs.
1		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	[1][2]	04
2		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	[1][2]	08
3		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.	[1][2] [3]	06
4		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	[1][2] [3]	05

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5		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	[1][2] [3][4]	08
6		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.	[1][2] [3][4]	08
			Total	**39**

Recommended Books:
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

Course Assessment:
Theory:
ISE-1:
Two hours 20 Marks Activity: Quiz and assignments
ISE-2:
Two hours 20 Marks Activity: Quiz and assignments
MSE:
Two hours 30 Marks written examination based on 50% syllabus.
ESE:
Three hours 100 Marks (30% weightage) written examination based on entire syllabus

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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	**T**	**P**		**L**	**T**	**P**	**Total**
ILO 8026	**Research Methodology**	**3**	**--**	**--**		**3**	**--**	**--**	**3**
		Examination Scheme							
		ISE1		**MSE**	**ISE2**	**ESE**		**Total**	
		20		**30**	**20**	**100 (30% weightage)**		**100**	

Pre-requisite		-------------	
Course Outcomes		CO1	Prepare a preliminary research design for projects in their subject matter areas
		CO2	Accurately collect, analyze and report data
		CO3	Present complex data or situations clearly

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Introduction and Basic Research Concepts 1.1. Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle.Research methods vs Methodology 1.2. Need of Research in Business and Social Sciences 1.3. Objectives of Research 1.4. Issues and Problems in Research 1.5. Characteristics of Research:Systematic, Valid, Verifiable,Empirical and Critical	[1][2]	09
2		Types of Research 2.1. Basic Research 2.2. Applied Research 2.3. Descriptive Research 2.4. Analytical Research 2.5. Empirical Research 2.6. Qualitative and Quantitative Approaches	[1][2]	07
3		Research Design and Sample Design 3.1. Research Design – Meaning, Types and Significance 3.2. Sample Design – Meaning and Significance Essentials of a goodsampling Stages in Sample Design Sampling methods/techniques Sampling Errors	[1][2][3]	07

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4		Research Methodology
		  4.1. Meaning of Research Methodology
		  4.2. Stages in Scientific Research Process:
		     a. Identification and Selection of Research Problem
		     b. Formulation of Research Problem
		     c. Review of Literature
		     d. Formulation of Hypothesis\ Formulation of research Design
		     e. Sample Design
		     f. Data Collection
		     g. Data Analysis
		     h. Hypothesis testing and Interpretation of Data
		     i. Preparation of Research Report
			[1][2][3]	08

5		Formulating Research Problem 5.1. Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	[1][2][3]	04

6		Outcome of Research
		  6.1. Preparation of the report on conclusion reached
		  6.2. Validity Testing & Ethical Issues
		  6.3. Suggestions and Recommendation
			[1][2][3]	04

			Total	**39**

Recommended Books:
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

<u>Course Assessment:</u>
 Theory:
    <u>ISE-1:</u>
    Two hours 20 Marks Activity: Quiz and assignments
    <u>ISE-2:</u>
    Two hours 20 Marks Activity: Quiz and assignments
    <u>MSE:</u>
    Two hours 30 Marks written examination based on 50% syllabus.
    <u>ESE:</u>
    Three hours 100 Marks (30% weightage) written examination based on entire syllabus

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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	**T**	**P**		**L**	**T**	**P**	**Total**
ILO 8027	**IPR and Patenting**	3	--	--		3	--	--	3
				Examination Scheme					
		ISE1	MSE	ISE2	ESE		Total		
		20	**30**	**20**	**100 (30% weightage)**		**100**		

Pre-requisite	-------------	
Course Outcomes	CO1	Understand Intellectual Property assets
	CO2	Assist individuals and organizations in capacity building
	CO3	Work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**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	[1][2]	05
2		**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.	[1][2]	07
3		**Emerging Issues in IPR:** Challenges for IP in digital economy, e- commerce, human genome, biodiversity and traditional knowledge etc	[1][2]	05

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4		**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	[2][3][4]	07
5		**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.)	[3][4][5][6]	08
6		**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, Time frame and cost, Patent Licensing, Patent Infringement **Patent databases:** Important websites, Searching international databases	[3][4][5][6]	07
		Total		**39**

Recommended Books:
1 Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, TheInstitute 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, TradeMarks and Allied Right, 7th Edition, Sweet & Maxwell
6 Lous Harns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO

Course Assessment:
 Theory:
   ISE-1:
   Two hours 20 Marks Activity: Quiz and assignments
   ISE-2:
   Two hours 20 Marks Activity: Quiz and assignments
   MSE:
   Two hours 30 Marks written examination based on 50% syllabus.
   ESE:
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P		L	T	P	Total
ILO 8028	Digital Business Management	3	--	--		3	--	--	3
		Examination Scheme							
		ISE1		MSE	ISE2	ESE		Total	
		20		30	20	100 (30% weightage)		100	

Pre-requisite	------------------	
Course Outcomes	CO1	Identify drivers of digital business
	CO2	Illustrate various approaches and techniques for E-business and management
	CO3	Prepare E-business plan

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction to Digital Business**	[1][2]	09
		Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy Drivers of digital business- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things (digitally intelligent machines/services) Opportunities and Challenges in Digital Business		
2		**Overview of E-Commerce**	[1][2]	06
		E-Commerce- Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement 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 Other E-C models and applications, innovative EC System-From Egovernment and learning to C2C, mobile commerce and pervasive computing 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		
3		**Digital Business Support services**	[1][2] [3]	06
		ERP as e –business backbone, knowledge Tope Apps, Information and referral system Application Development: Building Digital Business Applications and Infrastructure		

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4		**Managing E-Business**		06
		Managing Knowledge, Management skills for ebusiness, 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	[1][2] [3][5] [6]	
5		**E-Business Strategy**	[5][6] [7][8]	04
		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)		
6		**Materializing e-business:** From Idea to Realization -Business plan preparation **Case Studies and presentations**		08
			Total	**39**

Recommended Books:

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

Course Assessment:

Theory:
ISE-1:
Two hours 20 Marks Activity: Quiz and assignments
ISE-2:
Two hours 20 Marks Activity: Quiz and assignments
MSE:
Two hours 30 Marks written examination based on 50% syllabus.
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Course Code	Course Name	Teaching Scheme (Hrs/week)				Credits Assigned			
		L	T	P		L	T	P	Total
ILO 8029	**Environmental Management**	3	--	--		3	--	--	3
		Examination Scheme							
		ISE1	MSE	ISE2	ESE			Total	
		20	30	20	100 (30% weightage)			100	

Pre-requisite		------------------------	
Course Outcomes		CO1	Understand the concept of environmental management
		CO2	Understand ecosystem and interdependence, food chain etc.
		CO3	Understand and interpret environment related legislations

Module No.	Unit No.	Topics	Ref.	Hrs.
1		Introduction and Definition of Environment Significance of Environment Management for contemporary managers, Career opportunities, Environmental issues relevant toIndia, Sustainable Development, the Energy scenario	[1][2]	10
2		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.	[1][2]	06
3		Concepts of Ecology Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc	[2][3][4]	05
4		Scope of Environment Management, Role and functions of Government as a planning and regulating agency Environment Quality Management and Corporate Environmental Responsibility	[2][3][4][5]	10
5		Total Quality Environmental Management, ISO-14000, EMS certification.		05
6		General overview of major legislations like Environment ProtectionAct, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc	[3][4][5][6]	03
			Total	**39**

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Recommended Books:
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 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, Maclillan India, 2000
6 Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

Course Assessment:
Theory:

ISE-1:
Two hours 20 Marks Activity: Quiz and assignments
ISE-2:
Two hours 20 Marks Activity: Quiz and assignments
MSE:
Two hours 30 Marks written examination based on 50% syllabus.
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Three hours 100 Marks (30% weightage) written examination based on entire syllabus

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
CSL801	**Distributed Computing Lab**	--	--	2	--	--	1	1
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	--	--	--	--	--	
		Lab	25	--	25	--	50	

Pre-requisite Course Codes		CSC 503, CSC 404
Course Outcomes	CO1	Develop test and debug using Message-Oriented Communication or RPC/RMI based client-server programs.
	CO2	Implement techniques for clock synchronization.
	CO3	Implement techniques for Election Algorithms.
	CO4	Demonstrate mutual exclusion algorithms and deadlock handling.
	CO5	Implement techniques of resource and process management
	CO6	Describe the concepts of distributed File Systems with some case studies

Sr. No.	Unit No.	Topics
1		Inter-process communication
2		Client/Server using RPC/RMI
3		Group Communication
4		Clock Synchronization algorithms
5		Election Algorithm
6		Mutual Exclusion Algorithm
7		Deadlock Management in Distributed System
8		Load Balancing
9		Distributed shared Memory
10		Distributed File System (AFS/CODA)
11		Case Study: CORBA
12		Case Study: Android Stack

Course Assessment:

Lab:

ISE:

1. **ISE-1** Quizzes/Assignments/Paper Presentation/Article Discussion Quizzes/Assignments based on 50% experiments.
2. **ISE-2** Quizzes/Assignments/Paper Presentation/Article Discussion Quizzes/Assignments based on 50% experiments.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
CSDL8021	**Deep Learning Lab**	**Examination Scheme**						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	--	--	--	--	--	
		Lab	25	--	25	--	50	

Pre-requisite Course Codes		CSL 405,CSC 401, CSC 301, CSC 401
Course Outcomes	CO1	Implement basic neural network models to learn logic functions.
	CO 2	Design and train feedforward neural networks using various learning algorithms.
	CO 3	Build and train deep learning models such as Autoencoders, CNNs, RNN, LSTM etc

Sr. No.	Topics
1	Based on Module 1 (Any two) using Virtual Lab 1 Implement Mc-Culloch Pitts model for binary logic functions. 2 Implement Perceptron algorithm to simulate any logic gate. 3 Implement Multilayer Perceptron algorithm to simulate XOR gate. 4 To explore python libraries for deep learning e.g. Theano, 5 TensorFlow etc.
2	Module 2 (Any Two) 6 Apply any of the following learning algorithms to learn the parameters of the supervised single layer feed forward neural network. a. Stochastic Gradient Descent b. Mini Batch Gradient Descent c. Momentum GD d. Nestorev GD e. Adagrad GD f. AdamLearning GD 7 Implement a backpropagation algorithm to train a DNN with atleast 2 hidden layers. 8 Design and implement a fully connected deep neural network with at least 2 hidden layers for a classification application. Use appropriate Learning Algorithm, output function and loss function.

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3	Module 3 (Any One)
	9 Design the architecture and implement the autoencoder model for Image Compression. 9. Design the architecture and implement the autoencoder model for Image denoising
4	Module 4 (Any One) 10 Design and implement a CNN model for digit recognition application. 11. Design and implement a CNN model for image classification.
5	Module 5 (Any One) 11. Design and implement LSTM for Sentiment Analysis. 12. Design and implement GRU for classification on text data. 13. 14. Design and implement RNN for classification of temporal data.

Course Assessment:

Lab:

ISE:

1. **ISE-1** Quizzes/Assignments/Paper   Presentation/Article   Discussion/Quizzes/Assignments based on 50% experiments
2. **ISE-2** Quizzes/Assignments/Paper   Presentation/Article   Discussion/Quizzes/Assignments based on 50% experiments

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
CSDL8022	**Digital Forensics Lab**	Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	--	--	--	--	--	
		Lab	25	--	25	--	50	

Pre-requisite Course Codes		CSC 503, CSC 602
Course Outcomes	CO1	Explore various forensics tools and use them to acquire, duplicate and analyze data and recover deleted data.
	CO2	Implement penetration testing using forensics tools
	CO3	Explore various forensics tools and use them to acquire and analyze live and static data.
	CO4	Verification of source and content authentication of emails and browsers.
	CO5	Demonstrate Timeline Report Analysis using forensics tools.
	CO6	Discuss real time crime forensics investigations scenarios.

Sr. No.	Topics
1	Analysis of forensic images using open source tools. • FTK Imager • Autopsy
2	Explore forensics tools in kali linux for acquiring, analyzing and duplicating data. • dd • dc fldd
3	Performing penetration testing using Metasploit - kali Linux.
4	Performing RAM Forensic to analyze memory images to find traces of an attack. • Capturing RAM Using the DumpIt Tool • Volatility tool
5	Network forensics using Network Miner.
6	Windows Recycle Bin Forensics
7	Data Carving using open source tools • Foremost • Scalpel • Jpeg carver

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8	USB Device Forensics using
	• USB Deview
	• USB Detective
9	Web Browser Forensics using DB Browser for SQLite
10	Generate a Timeline Report Using Autopsy
11	Email Analysis
12	Case Study

Course Assessment:

Lab:

ISE:

1. **ISE-1**

   Quizzes/Assignments/Paper Presentation/Article Discussion
   Quizzes/Assignments based on 50% experiments

2. **ISE-2**

   Quizzes/Assignments/Paper Presentation/Article Discussion
   Quizzes/Assignments based on 50% experiments

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
CSL8023	Applied Data Science Lab	**Examination Scheme**						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	--	--	--	--	--	
		Lab	25	--	25	--	50	

Pre-requisite Course Codes		CSC 301, CSC 401, CSC 701, FEL 204, CSL 304, CSL 405
Course Outcomes	CO1	Apply various stages of the data science lifecycle for the selected case study.
	CO2	Demonstrate data preparation, exploration and visualization techniques.
	CO3	Implement and evaluate different supervised and unsupervised techniques.

Sr. No.	Topics
1	Explore the descriptive and inferential statistics on the given dataset.
2	Apply data cleaning techniques (e.g. Data Imputation).
3	Explore data visualization techniques
4	Implement and explore performance evaluation metrics for Data Models (Supervised/Unsupervised Learning)
5	Use SMOTE technique to generate synthetic data. (to solve the problem of class imbalance)
6	Outlier detection using distance based/density-based method
7	Implement time series forecasting.

Illustrate data science lifecycle for selected case study. (Prepare case study document for the selected case study)
Suggested Case Studies:
1. Customer Segmentation
2. Fraud Detection
3. House Price prediction
4. Product Recommendation
5. Stock price prediction
6. Weather prediction

Suggested Assignment list
Assignments can be given on self-learning Topics or data deployment tools

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Course Assessment:

Lab:

ISE:

1. **ISE-1**
   Quizzes/Assignments/Paper Presentation/Article Discussion
   Quizzes/Assignments based on 50% experiments.

2. **ISE-2**
   Quizzes/Assignments/Paper Presentation/Article Discussion
   Quizzes/Assignments based on 50% experiments.

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
CSDL8021	**Optimization in Machine Learning Lab**	L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	--	--	--	--	--	
		Lab	25	--	25	--	50	

Pre-requisite Course Codes		CSC 303, CSC 401
Course Outcomes	CO1	To implement derivative-based optimization techniques
	CO2	To implement evolutionary optimization
	CO3	To implement advanced evolutionary optimization
	CO4	To apply efficient optimization algorithm for real world applications

Sr. No.	Topics
1	To implement Gradient Descent algorithm
2	To implement the Stochastic Gradient Descent algorithm
3	To implement Newton method
4	To apply Genetic Algorithm for real world problem
5	To compare and implement different selection mechanism using genetic algorithm
6	To implement various mutation and crossover mechanisms
7	To implement Particles Swarm optimization
8	To implement Ant colony optimization

Course Assessment:

Lab:

ISE:

1. **ISE-1**

   Quizzes/Assignments/Paper Presentation/Article Discussion
   Quizzes/Assignments based on 50% experiments.

2. **ISE-2**

   Quizzes/Assignments/Paper Presentation/Article Discussion
   Quizzes/Assignments based on 50% experiments.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
CSDL8022	**High Performance Computing Lab**	**Examination Scheme**						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	--	--	--	--	--	
		Lab	25	--	25	--	50	

Pre-requisite Course Codes		FEL 204
Course Outcomes	CO1	Perform Linux based commands on remote machine
	CO2	Compare the performance of sequential algorithms with parallel algorithm in terms of execution time, speedup and throughput.
	CO3	Implement parallel program using OpenMP library and analyze its performance
	CO4	Implement parallel program using MPI platform and analyze its performance
	CO5	Implement parallel program using OpenCL framework and analyze its performance
	CO6	Implement parallel program using CUDA framework and analyze its performance

Sr. No.	Topics
	Suggested Experiments: Students are required to complete at least 8 experiments. Star (*) marked experiments are compulsory.
1*	To analyse the Linux based computer systems using following commands: a. top , b.ps , c. kill, d. cat /proc/cpuinfoe. vmstat Hardware/Software Requirement: Linux Operating System
2*	To setup SSH passwordless logins for two or more Linux based machines and execute commands on a remote machine. Hardware/Software Requirement: Linux Operating System, Multi-core computer systems

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3*	Write a program in C to multiply two matrices of size 10000 x 10000each and find it's execution-time using "time" command. Try to run this program on two or more machines having different configurations and compare execution-times obtained in each run. Comment on which factors affect the performance of the program. Hardware/Software Requirement: Linux Operating System, gcc compiler, Multi-core computer systems
4*	Write a "Hello World" program using OpenMP library also display number of threads created during execution. Hardware/Software Requirement: Linux Operating System, gcc compiler, Dual core with HT or Quad-core or higher computer system.
5*	Write a parallel program to calculate the value of PI/Area of Circle using OpenMP library. Hardware/Software Requirement: Linux Operating System, gcc compiler, Dual core with HT or Quad-core or higher computer system
6*	Write a parallel program to multiply two matrices using openMP library and compare the execution time with its serial version. Alsochange the number of threads using omp_set_num_threads() function and analyse how thread count affects the execution time.Hardware/Software Requirement: Linux Operating System, gcc compiler,Dual core with HT or Quad-core or higher computer system
7*	Install MPICH library and write a "Hello World" program for the same. Hardware/Software Requirement: Linux Operating System, MPICH, Multi-processor systems or MPI Cluster.
8*	Write a parallel program to multiply two matrices using MPI library and compare the execution-time with it's OpenMP and serial version. Hardware/Software Requirement: Linux Operating System, MPICH, gcc, Multiprocessor systems, or MPI Cluster.
9*	Install MPICH on two and more machines and create a MPI cluster.Execute MPI programs on this cluster and check the performance. Hardware/Software Requirement: Linux Operating System, MPICH, Multi-processor systems or MPI Cluster.
10*	Implement a program to demonstrate balancing workload on MPIplatform. Hardware/Software Requirement: Linux Operating System, MPICH, Multi-processor systems or MPI Cluster.
11	Implement a parallel program to demonstrate the cube of N number within a set range using MPI/OpenMP/OpenCL/CUDA. Hardware/Software Requirement: Linux Operating System, MPICH,Multi-processor systems or MPI Cluster. A CUDA-capable GPU,A supported version of Microsoft Windows,A supported version of Microsoft Visual Studio, The NVIDIA CUDA Toolkit

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12	Implement DFT computation of vector using OpenCL/CUDA/ ParallelMatlab Hardware/Software Requirement: A CUDA-capable GPU,A supported version of Microsoft Windows, A supported version of Microsoft Visual Studio, The NVIDIA CUDA Toolkit
13	Implement Two Vector addition using OpenCL/CUDA/ Parallel Matlab Hardware/Software Requirement: A CUDA-capable GPU, A supported version of Microsoft Windows, A supported version of Microsoft Visual Studio, The NVIDIA CUDA Toolkit
14	Implement even-odd/Bucket /Radix /Shell sort using OpenCL/CUDA/ Parallel Matlab **Hardware/Software Requirement:** A CUDA-capable GPU, A supported version of Microsoft Windows, A supported version of Microsoft Visual Studio, The NVIDIA CUDA Toolkit

Course Assessment:
Lab:
ISE:

1. **ISE-1**
    Quizzes/Assignments/Paper Presentation/Article Discussion
    Quizzes/Assignments based on 50% experiments
2. **ISE-2**
    Quizzes/Assignments/Paper Presentation/Article Discussion
    Quizzes/Assignments based on 50% experiments

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
		--	--	2	--	--	1	1
CSDL8023	**Social Media Analytics Lab**	**Examination Scheme**						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	--	--	--	--	--	
		Lab	25	--	25	--	50	

Pre-requisite Course Codes		CSC 305, CSC 504, CSC 702
Course Outcomes	CO1	Acquire hands on skills needed to work with social media data.
	CO2	Demonstrate data collection from different social media platforms.
	CO3	Analyse & Visualize social media data from multiple platforms.
	CO4	Develop content and structure based SMA model.
	CO5	Design and implement social media analytics applications for business.

Sr. No.	Topics
1	Study various - i) Social Media platforms (Facebook, twitter, YouTube etc) 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)

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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
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.

Recommended 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, byRaghav 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

Course Assessment:
Lab:
ISE:
1. **ISE-1**
    Quizzes/Assignments/Paper Presentation/Article Discussion
    Quizzes/Assignments based on 50% experiments.
2. **ISE-2**
    Quizzes/Assignments/Paper Presentation/Article Discussion
    Quizzes/Assignments based on 50% experiments.

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
CSP801	**Major Project 2**	--	--	12	--	--	6	6
		Examination Scheme						
			ISE1	MSE	ISE2	ESE	Total	
		Theory	--	--	--	--	--	
		Lab	50	--	50	50	150	

Pre-requisite Course Codes		
Course Outcomes	CO1	Implement solutions for the selected problem by applying technical and professional skills.
	CO2	Analyze impact of solutions in societal and environmental context for sustainable development.
	CO3	Explore and apply various modern tools to solve the chosen problem.
	CO4	Develop proficiency in oral and written communication with effective leadership and teamwork.
	CO5	Nurture professional and ethical behavior and develop expertise in life-long learning.
	CO6	Gain expertise that helps in building lifelong learning experience.

Guidelines:
1. Internal guide has to keep track of the progress of the project and also has to maintainattendance 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 Set up
   - Results and Discussion
   - Conclusion and Future Work
   - References
   - Appendix – List of Publications or certificates

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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. Internal Assessment:

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. **End Semester exam**:

Oral &Practical examination (Final Project Evaluation) of Project 2 should be conducted by the Internal examiners 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 team work

Course Assessment:

ISE:

ISE-1

Mid-term presentation will be carried out and evaluation is based on rubrics decided by the department.

ISE-2

Mid-term presentation will be carried out and evaluation is based on rubrics decided by the department.

ESE –

Oral examination will be carried out at the end of the semester by the panel of the department.