

DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY,  
CHHATRAPATI SAMBHAJINAGAR.



**CIRCULAR NO.SU/Engg./ME/NEP-2020/44/2024**

It is hereby inform to all concerned that, the syllabus prepared by the Board of Studies and recommended by the Dean, Faculty of Science & Technology, the Hon'ble Vice-Chancellor has accepted the **Following Syllabus as per National Education Policy-2020** run at Affiliated Colleges, in his emergency powers under section 12(7) of the Maharashtra Public Universities Act, 2016 on behalf of the Academic Council as appended herewith.

Sr.No.	Courses	Semester
1.	<b>M.E. Computer Science &amp; Engineering</b>	<b>Ist to IV</b>
2.	<b>M.E. Mechanical Engineering</b>	<b>Ist to IV</b>

This is effective from the Academic Year 2024-25 and onwards.

All concerned are requested to note the contents of this circular and bring the notice to the students, teachers and staff for their information and necessary action.

University Campus,  
Aurangabad-431 004.  
REF.NO.SU/2024/8693-701  
Date:- 14.10.2024.

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*[Signature]*  
**Deputy Registrar,**  
**Academic Section**

**Copy forwarded with compliments to :-**

- 1] **The Principal of all concerned Colleges,**  
Dr. Babasaheb Ambedkar Marathwada University,
- 2] **The Director, University Network & Information Centre, UNIC, with a request to upload this Circular on University Website.**

**Copy to :-**

- 1] **The Director, Board of Examinations & Evaluation,** Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
- 2] The Section Officer,[Engg.Unit] Examination Branch, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
- 3] The Programmer [Computer Unit-1] Examinations, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
- 4] The Programmer [Computer Unit-2] Examinations, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
- 5] The In charge,[E Suvidha Kendra], Rajarshi Shahu Maharaj Pariksha Bhavan, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
- 6] The Public Relation Officer, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
- 7] The Record Keeper, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.


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# SCHEME AND DETAILED SYLLABUS


M.E.(Computer Science and Engineering)

(Effective From Academic Year 2024-2025 & Onwards)



  
Dr. Smita Kasar  
Chairman

**Dr. BABASAHEB AMBEDKAR ARATHWADA  
UNIVERSITY, CHHATRAPATI  
SAMBHAJINAGAR**

  
Dean,  
Faculty of sci. & Tech.

FACULTY OF SCIENCE AND TECHNOLOGY

Proposed Syllabus Structure w.e.f. 2024-2025

M. E. (Computer Science and Engineering)

Semester-I

Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme and Marks							Credits			
		Theory	Practical	Tutorial	MSE-I	MSE-II	TA	ESE	TW	PR/OR	Total	TH	TW/PR	TUT	Total
MCS101	Research Methodology and IPR	3	-	-	15	15	10	60	-	-	100	3	-	-	3
MCS102	Advanced Algorithms	3	-	1	15	15	10	60	-	-	100	3	-	1	4
MCS103	Computer Vision	3	-	1	15	15	10	60	-	-	100	3	-	1	4
MCS104	Advanced Operating System	3	-	1	15	15	10	60	-	-	100	3	-	1	4
MCS121-123	Program Elective-I	3	-	1	15	15	10	60	-	-	100	3	-	1	4
MCS111	Lab -I (Advanced Algorithms)	-	2	-	-	-	-	-	25	-	25	-	1	-	1
MCS112	Lab -II (Advanced Operating System)	-	2	-	-	-	-	-	25	-	25	-	1	-	1
MCS113	Lab-III (Professional Elective-I)	-	2	-	-	-	-	-	25	-	25	-	1	-	1
MCS114	Seminar	-	4	-	-	-	-	-	-	50	50	-	2	-	2
		15	10	4	75	75	50	300	75	50	625	15	5	4	24

Semester-II

Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme and Marks							Credits			
		Theory	Practical	Tutorial	MSE-I	MSE-II	TA	ESE	TW	PR/OR	Total	TH	TW/PR	TUT	Total
MCS141	Optimization Techniques	3	-	1	15	15	10	60	-	-	100	3	-	1	4
MCS142	Machine Learning Techniques	3	-	1	15	15	10	60	-	-	100	3	-	1	4
MCS143	Performance Analysis Methods	3	-	1	15	15	10	60	-	-	100	3	-	1	4
MCS161-163	Program Elective-II	3	-	1	15	15	10	60	-	-	100	3	-	1	4
MCS164-166	Open Elective-I	3	-	-	15	15	10	60	-	-	100	3	-	-	3
MCS151	Lab -I (Machine Learning Techniques)	-	2	-	-	-	-	-	25	-	25	-	1	-	1
MCS152	Lab -II (Data Analytics)	-	2	-	-	-	-	-	25	-	25	-	1	-	1
MCS153	Lab-III (Performance Analysis Methods)	-	2	-	-	-	-	-	25	-	25	-	1	-	1
MCS154	Minor Project	-	4	-	-	-	-	-	-	50	50	-	2	-	2
		15	10	4	75	75	50	300	75	50	625	15	5	4	24

MSE- Mid Semester Exam, ESE- End Semester Exam, TH-Theory, OR- Oral, TA-Teacher Assessment, TW- Term Work, PR- Practical, Tut- Tutorial

Program Elective Courses-I

Group A	Group B	Group C
MCS121 Distributed Computing	MCS122 Embedded Software Development	MCS 123 Network Design and Technologies

Program Elective Courses-II

Group A	Group B	Group C
MCS161 Advance Cloud Computing	MCS162 Advance Internet of Things	MCS163 Industry Oriented Elective

Open Elective-I

Group A	Group B	Group C
MCS164 Ethics and Cyber Security	MCS165 Data Science	MCS165 Introduction to Artificial Intelligence and Machine Learning

Semester-III																	
Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme and Marks							Credits					
		Theory	Practical	Tutorial	MSE-I	MSE-II	TA	ESE	TW	PR/OR	Total	TH	TW/PR	TUT	Total		
		MCSI63	MOOC Courses		-	-						100		-	100	3	-
MCS211	Dissertation-I	-	18	-	-	-	-			50	100	150	-	9	-		9
		3	18	-	15	15	10	60	50	100	250	3	9	-			12

Semester-IV																	
Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme and Marks							Credits					
		Theory	Practical	Tutorial	MSE-I	MSE-II	TA	ESE	TW	PR/OR	Total	TH	TW/PR	TUT	Total		
		MCS251	Dissertation-II	-	24	-	-	-	-			100	200	300	-	12	-
										100	200	300	-	12	-		12

**MSE- Mid Semester Exam, ESE- End Semester Examination, TH-Theory, OR- Oral, TA- Teacher Assessment, TW- Term Work, PR- Practical, Tut- Tutorial**

**Total Credits = SEM I + SEM II + SEM III + SEM IV**

$$= 24 + 24 + 12 + 12$$

$$= 72$$

**Department of Computer Science and Engineering**  
**Syllabus of M. E. (Computer Science and Engineering) Semester-I**

Course Code: MCS101 Course: Research Methodology & IPR Teaching Scheme: Theory: 3 Hrs/week Tutorial: 1 Hr/week	Credits: 3-0-0 (3) Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 03 Hrs.
<b>Prerequisite</b>	Basic Understanding of Research, Academic Writing Skills, Legal Awareness, Business or Innovation Knowledge.
<b>Objectives</b>	<ul style="list-style-type: none"> <li>• To guide students from understanding foundational research concepts to critically formulating research problems, culminating in the adept creation of comprehensive research plans and literature reviews.</li> <li>• To develop a comprehensive understanding of various research methods, both qualitative and quantitative</li> <li>• To facilitate students in analysing, evaluating, and creating research proposals.</li> <li>• To attain mastery in data collection methods, sampling, data analysis techniques, and result interpretation for robust research outcomes.</li> </ul>
<b>Unit 1</b>	<p style="text-align: center;"><b>A. Research Problems and Research Design</b></p> <p>Meaning of research, types of research, steps involved in research process, criteria of good research, importance of ethics in research, codes and policies for research ethics.          Selection of research problem, steps involved in defining research problem, need for research design, types of research designs, basic principles of experimental design, formal and informal experimental design.</p> <p style="text-align: right;"><b>(5 Hrs)</b></p>
	<p style="text-align: center;"><b>B. Sampling Design</b></p> <p>Need for sampling, steps in sampling design, different types of sampling designs, sampling distributions, concept of central limit and standard error, sources of errors, population mean and proportion, sample size calculations, tests of measurements for validity, reliability and practicality.</p> <p style="text-align: right;"><b>(6 Hrs)</b></p>
<b>Unit 2</b>	<p style="text-align: center;"><b>A. Data collection, Processing and Analysis</b></p> <p>Methods for collection of data, selection of data collection method, data processing operations, statistics in research, confidence level, measures of central tendency, dispersion, asymmetry and relationship. Spearman's and Pearson's coefficient of correlation, simple &amp; multiple regression analysis, analysis of variance (ANOVA), factor analysis methods.</p> <p style="text-align: right;"><b>(8 Hrs)</b></p>

	<p align="center"><b>B. Hypothesis Test and Report Writing</b></p> <p>Concept of research hypothesis, concept of testing of hypothesis, Parametric tests (z, t, F and chi-square tests), Hypothesis testing of means and correlation coefficient, Non parametric tests, significance of research report writing, types of reports, structure of the research report, steps in report writing, precautions and ethics in writing report.</p> <p align="right"><b>(7 Hrs)</b></p>				
Unit 3	<p align="center"><b>A. Introduction to IPR</b></p> <p>Origin and evolution of IPR to its present form and use, Different Tools of IPR and what is the nature of these rights, Balancing Rights and Responsibilities, Societal implications of IPR.</p> <p align="right"><b>(6 Hrs)</b></p>				
	<p align="center"><b>B. Patents</b></p> <p>Concept of inventions/discoveries, patents protect; benchmarks for patentability of inventions; Exceptions to patentability; Patenting issues in Biotechnology and computer based inventions, process to apply for patents in India and in other countries around the world, The steps to granting of a patent; Opposing grant of a patent; term of a patent; rights of a patent holder; challenging validity of a patent licensing of patent rights; using patent rights in the market place; compulsory license.</p> <p align="right"><b>(8 Hrs)</b></p>				
References	Sr. No.	Title	Author	Publication	Edition
	1	Research Methodology: Methods and Techniques	C. R. Kothari and G. Garg	New Age International, 2019	4 <sup>th</sup> Edition
	2	Research Methodology	R. Pannerselvam	PHI Learning, 2014	2 <sup>nd</sup> Edition
	3	Research Methodology- As Theoretical Approach	D. Napoleon & B. Narayan	Laxmi Publications, 2014.	-
	4	Research Methods and Statistics	Bernard C. Beins & Maureen A. McCarthy	Pearson Education Inc., 2012.	-
	5	Research Methods Handbook, CLES	Stuart MacDonald & Nicola Headlam.	-	-
	6	Intellectual Property Rights--Unleashing the Knowledge Economy	Ganguli Prabuddha.	Tata McGrawHill, 2001.	-

	7	Intellectual Property Rights	Neeraj Pandey and Khushdeep Dharni	PHI Learning, 2014	1st Edition
	8	Fundamentals of Intellectual Property Rights	Ramakrishna B Notion	Press, 2017	1st Edition
	9	The Indian Patents Act 1970 (as amended in 2005)	-	-	-

**Department of Computer Science and Engineering**  
**Syllabus of M. E. (Computer Science and Engineering) Semester-I**

Course Code: MCS102 Course: Advanced Algorithms <b>Teaching Scheme:</b> Theory: 3Hrs /week	Credits: 3-0-1 (4) Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 3 Hrs
<b>Prerequisite</b>	Data Structure design and algorithm analysis.
<b>Objectives</b>	<ul style="list-style-type: none"> <li>• To develop the necessary skills from both a theoretical perspective as well as applying their knowledge on various problem sets.</li> <li>• To develop the skills to design, implement and analyze algorithm to solve various problems.</li> </ul>
<b>Unit-I</b>	<b>A. Role of Algorithms in Computing:</b> Introduction, Analysis Design, of algorithm, Asymptotic notations, Different methods for solving recurrences. Divide and Conquer: The maximum- sub array problem, The master method for solving recurrences; Greedy Algorithm: An activity selection problem; Dynamic programming: Rod Cutting. <p style="text-align: right;"><b>(8 Hrs.)</b></p>
	<b>B. Sorting Methods:</b> Merge sort, Quick sort, comparison sort, comparison tree, Radix sort, Analysis of different sorting methods. <p style="text-align: right;"><b>(6 Hrs.)</b></p>
<b>Unit-II</b>	<b>A. Network-flow algorithm and Randomized algorithm:</b> Ford-Fulkerson method, maximum flow, minimum cost flow, Randomized algorithm. <p style="text-align: right;"><b>(6 Hrs.)</b></p>
	<b>B. Number theory algorithms:</b> Polynomial multiplication, Euclid's GCD algorithm, an asymptotically fast algorithm for polynomial GCD, DFT and FFT. <p style="text-align: right;"><b>(6 Hrs.)</b></p>
<b>Unit-III</b>	<b>A. String and Pattern Matching Algorithms:</b> The naïve string-matching algorithm, Rabin Karp algorithm, String matching with finite automata, Knuth-Morris-Pratt algorithm, Boyer-Moore algorithm. <p style="text-align: right;"><b>(6 Hrs.)</b></p>

**B. NP Completeness:**

P and NP classes, Cooks theorem, NP Complete problems: 3 SAT, Clique, Vertex Cover problem, Hamiltonian Cycle, Feedback Edge set problem, Graph color problem.

(8 Hrs.)

	Sr. No.	Title	Author	Publication	Edition
<b>References</b>	1.	Introduction to Algorithms	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein.	MIT Press	3 rd Edition, 2009
	2.	The Design and Analysis of Computer Algorithms.	Aho, Hopcroft, Ulman	Wesley.Pearson.	

**Department of Computer Science and Engineering**  
**Syllabus of M. E. (Computer Science and Engineering) Semester-I**

<p>Course Code: MCS103          Course: Computer Vision</p> <p><b>Teaching Scheme:</b>          Theory: 3Hrs/week</p>	<p>Credits: 3-0-1 (4)</p> <p>Mid Semester Examination-I: 15 Marks          Mid Semester Examination-II: 15 Marks          Teacher Assessment: 10 Marks          End Semester Examination: 60 Marks          End Semester Examination (Duration): 3 Hrs</p>
<b>Prerequisite</b>	Image Processing techniques
<b>Objectives</b>	<ul style="list-style-type: none"> <li>• To review image processing techniques for computer vision.</li> <li>• To understand shape and region analysis.</li> <li>• To understand Hough Transform and its applications to detect lines, circles, ellipses.</li> <li>• To understand three-dimensional image analysis techniques.</li> <li>• To understand motion analysis.</li> <li>• To study some applications of computer vision algorithms.</li> </ul>
<b>Unit-I</b>	<p><b>A. IMAGE PROCESSING FOUNDATIONS</b>            Review of image processing techniques – classical filtering operations – thresholding techniques – edge detection techniques – corner and interest point detection – mathematical morphology – texture. (6 Hrs)</p>
	<p><b>B. SHAPES AND REGIONS</b>            Binary shape analysis – connectedness – object labeling and counting – size filtering – distance functions – skeletons and thinning – deformable shape analysis – boundary tracking procedures – active contours – shape models and shape recognition – centroidal profiles – handling occlusion – boundary length measures – boundary descriptors – chain codes – Fourier descriptors – region descriptors – moments. (8 Hrs)</p>
<b>Unit-II</b>	<p><b>A. HOUGH TRANSFORM</b>            Line detection – Hough Transform (HT) for line detection – foot-of-normal method – line localization – line fitting – RANSAC for straight line detection – HT based circular object detection – accurate center location – speed problem – ellipse detection – Case study:            Human Iris location – hole detection – generalized Hough Transform (GHT) – spatial matched filtering – GHT for ellipse detection – object location – GHT for feature collation. (8Hrs)</p>
	<p><b>B. 3D VISION</b>            Methods for 3D vision – projection schemes – shape from shading – photometric stereo – shape from texture – shape from focus – active range finding – surface representations – point-based representation – volumetric representations – 3D object recognition – 3D reconstruction (6 Hrs)</p>
<b>Unit-III</b>	<p><b>A. STRUCTURE FROM MOTION AND DENSE MOTION ESTIMATION</b>            Introduction to motion – triangulation – bundle adjustment – translational alignment – parametric motion – spline-based motion – optical flow – layered motion. (6 Hrs)</p>
	<p><b>B. APPLICATIONS</b>            Application: Photo album – Face detection – Face recognition – Eigen faces – Active appearance and 3D shape models of faces            Application: Surveillance – foreground-</p>

background separation – particle filters – Chamfer matching, tracking, and occlusion – combining views from multiple cameras – human gait analysis Application: In-vehicle vision system: locating roadway – road markings – identifying road signs – locating pedestrians, (6 Hrs)

**References**

1.	Computer & Machine Vision	E. R. Davies	Academic Press	Fourth Edition, 2012.
2.	Mastering OpenCV with Practical Computer Vision Projects	D. L. Baggio et al.,	Packt Publishing,	2012.
3.	Programming Computer Vision with Python: Tools and algorithms for analyzing images	Jan Erik Solem	O'Reilly Media	2012.
4.	Feature Extraction & Image Processing for Computer Vision	Mark Nixon and Alberto S. Aquado	Academic Press	Third Edition, 2012.
5.	Computer Vision: Algorithms and Applications.	R. Szeliski,	Springer	2011
6.	Computer Vision: Models, Learning, and Inference.	Simon J. D. Prince	Cambridge University Press.	2012.
7	Computer Vision: A Modern Approach.	D. A. Forsyth, J. Ponce,	Pearson Education	
9	Multiple View Geometry in Computer Vision	Richard Hartley and Andrew Zisserman	Cambridge University Press.	

**Department of Computer Science and Engineering**  
**Syllabus of M. E. (Computer Science and Engineering) Semester-I**

<p>Course Code: MCS104</p> <p>Course: Advanced Operating System</p> <p><b>Teaching Scheme:</b></p> <p>Theory: 03Hrs /Week</p>	<p>Credits: 3-0-1 (4)</p> <p>Mid Semester Examination-I: 15 Marks</p> <p>Mid Semester Examination-II: 15 Marks</p> <p>Teacher Assessment: 10 Marks</p> <p>End Semester Examination: 60 Marks</p> <p>End Semester Examination (Duration): 3 Hrs</p>
<b>Prerequisite</b>	Operating Systems, System Programming, Unix/Linux
<b>Objectives</b>	<ul style="list-style-type: none"> <li>• To get a comprehensive knowledge of the architecture of distributed system.</li> <li>• To understand the deadlock and shared memory issues and their solution in distributed environments.</li> <li>• To know the security issues and protection mechanisms for distributed environments.</li> <li>• To get a knowledge of multiprocessor operating system and database operating systems.</li> </ul>
<b>Unit-I</b>	<p style="text-align: center;"><b>A. Architectures of Distributed System:</b></p> <p>System Architecture types – Issues in distributed operating systems – communication networks- communication primitives. Theoretical Foundations – inherent limitations of a distributed system – lamp ports logical clocks – vector clocks – casual ordering of message – global state- cuts of a distributed computation – termination detection. Distributed Mutual Exclusion – Introduction – the classification of mutual exclusion and associate d algorithms – a comparative performance analysis.</p> <p style="text-align: right;"><b>(6 Hrs)</b></p> <hr/> <p style="text-align: center;"><b>B. Distributed Deadlock Direction:</b></p> <p>Introduction – deadlock handling strategies in distributed systems – issues in deadlock detection and resolution - control organization for distributed deadlock detection – centralized and distributed deadlock detection algorithms – hierarchical deadlock detection algorithms. Agreement protocols – introduction the system model, a classification or agreement problems, solution to the Byzantine agreement problem, application of agreement algorithms. Distributed resource management – introduction-architecture – mechanisms for building distributed file systems – design issues log structured file systems.</p> <p style="text-align: right;"><b>(8Hrs)</b></p>
<b>Unit-II</b>	<p style="text-align: center;"><b>A. Distributed shared memory:</b></p> <p><b>Architecture</b> – algorithms for implementing DSM- memory coherence and protocols – design issues. Distributed Scheduling – introduction – issues in load distributing – components of a load distributing algorithm-stability-load distributing algorithm-performance comparison-selecting a suitable load sharing algorithm-requirements for load</p>

	distributing-task migration and associated issues. <b>(8 Hrs.)</b>				
	<p><b>B. Multiprocessor Operating Systems:</b>  <b>Basic</b> multiprocessor system architectures – inter connection networks for multiprocessor systems – caching-hypercube architecture. Multiprocessor Operating System- Structure of multiprocessor operating system, operating system design issues –threads-process synchronization and scheduling.  <b>(6 Hrs)</b></p>				
<b>Unit-III</b>	<p><b>A. Database Operating System:</b>  Introduction requirements of database operating system Concurrency control : theoretical aspects – introduction, database systems – a concurrency control model of database systems, the problem of concurrency control – serializability theory – distributed database systems, consequence control algorithms – introduction, basic synchronization primitives, lock based algorithms- timestamp based algorithms.  <b>(6 Hrs.)</b></p>				
	<p><b>B. Failure Recovery and Fault Tolerance:</b>  Failure Recovery and Fault tolerance :Introduction-basic concepts – classification of failures – backward and forward error recovery, backward error recovery- recovery in concurrent systems consistent set of check points – synchronous and asynchronous check pointing and recovery check pointing for distributed database systems – recovery in replicated distributed databases.  <b>(6 Hrs)</b></p>				
<b>References</b>	<b>Sr. No.</b>	<b>Title</b>	<b>Author</b>	<b>Publication</b>	<b>Edition</b>
	1.	Advanced Concepts in operating systems	Mukesh Singhal, Niranjan G. Shivaratri,	Tata McGraw Hill	2001
	2.	Modern operating system	Andrew S. Tannenbaum	P H I	2003
	3.	Distributed operating system- Concepts and design	Pradeep K. Sinha	P H I	2003
	4.	Distributed operating system	Andres S. Tannenbaum	Person Education	2003
	5.	Advanced Concepts in operating systems	Mukesh Singhal, Niranjan G. Shivaratri,	Tata McGraw Hill	2001

**Department of Computer Science and Engineering**  
**Syllabus of M. E. (Computer Science and Engineering) Semester-I**

<p>Course Code: MCS121</p> <p>Course: Program Elective-I</p> <p>Distributed Computing System</p> <p><b>Teaching Scheme:</b></p> <p>Theory: 3 Hrs /week</p>	<p>Credits: 3-0-1 (4)</p> <p>Mid Semester Examination-I: 15 Marks</p> <p>Mid Semester Examination-II: 15 Marks</p> <p>Teacher Assessment: 10 Marks</p> <p>End Semester Examination: 60 Marks</p> <p>End Semester Examination (Duration): 3 Hrs</p>
<b>Prerequisite</b>	Computer Networks, Operating Systems, Basic Understanding of Cloud Computing.
<b>Objectives</b>	<ul style="list-style-type: none"> <li>• To understand the basics of Computing Systems and its functionalities to interface memory and peripherals with embedded systems.</li> <li>• To study distributed Computing system concepts agreement protocols and Create models for distributed Computing systems.</li> <li>• To learn basics of agreement problem along with its solution</li> <li>• To learn concurrency control and properties of transaction in Distributed Computing systems.</li> </ul>
<b>Unit-I</b>	<p><b>A.</b></p> <p>Introduction to Distributed Computing Systems, System Models, and Issues in Designing a Distributed Operating System, Examples of distributed systems <b>(6 Hrs.)</b></p>
	<p><b>B.</b></p> <p>Features of Message Passing System, Synchronization and Buffering, Introduction to RPC and its models, Transparency of RPC, Implementation Mechanism, Stub Generation and RPC Messages <b>(8 Hrs.)</b></p>
<b>Unit-II</b>	<p><b>A.</b></p> <p>Server Management, Call Semantics, Communication Protocols and Client Server Binding. <b>(6 Hrs.)</b></p>
	<p><b>B.</b></p> <p>Introduction, Design and implementation of DSM system. Granularity and Consistency Model, Advantages of DSM, Clock Synchronization, Event Ordering, Mutual exclusion, Deadlock, Election Algorithms. <b>(6 Hrs.)</b></p>
<b>Unit-III</b>	<p><b>A.</b></p> <p>Task Assignment Approach, Load Balancing Approach, Load Sharing Approach, Process Migration and Threads <b>(8Hrs.)</b></p>
	<p><b>B.</b></p> <p>File Models, File Accessing Models, File Sharing Semantics, File Caching Schemes, File Replication, Atomic Transactions, Cryptography, authentication, Access control and Digital Signatures. <b>(6 Hrs.)</b></p>

**References**

Sr. No.	Title	Author	Publication	Edition
1	“Distributed Operating Systems: Concepts and Design”.,	Pradeep. K. Sinha:	PHI, 2007.	
2	“Distributed Systems”, Concept and Design,	George Coulouris, Jean Dollimore, Tim Kindberg:	Pearson Education, 2005.	3rd Edition,
3	“Distributed Computing: Principles, Algorithms, and Systems”.	A.D. Kshem kalyani, M. Singhal	ISBN: 9780521189842, paperback edition, Cambridge University Press,	
4.	“Distributed Computing: Fundamentals, Simulations, and Advanced Topics”.	MarchHagitAtti ya, Jennifer Welch ,	Wiley	

**Department of Computer Science and Engineering**  
**Syllabus of M. E. (Computer Science and Engineering) Semester-I**

<p>Course Code: MCS122</p> <p>Course: Program Elective-I</p> <p>Embedded Software Development</p> <p><b>Teaching Scheme:</b></p> <p>Theory: 3 Hrs /week</p>	<p>Credits: 3-0-1 (4)</p> <p>Mid Semester Examination-I: 15 Marks</p> <p>Mid Semester Examination-II: 15 Marks</p> <p>Teacher Assessment: 10 Marks</p> <p>End Semester Examination: 60 Marks</p> <p>End Semester Examination (Duration): 3 Hrs</p>
<b>Prerequisite</b>	Programming Skills ,Microcontrollers and Microprocessors,Computer Architecture,Embedded Systems Basics.
<b>Objectives</b>	<ul style="list-style-type: none"> <li>• To understand the architecture of embedded processor, microcontroller and Peripheral devices.</li> <li>• To interface memory and peripherals with embedded systems.</li> <li>• To study the embedded network environment.</li> <li>• To understand challenges in Real time operating systems.</li> <li>• To study, analyze and design applications on embedded systems.</li> </ul>
<b>Unit-I</b>	<p><b>A. INTRODUCTION</b></p> <p>Embedded systems overview, Design challenge – optimizing design metrics, Embedded processor technology, IC technology, Design technology. <b>(6 Hrs.)</b></p>
	<p><b>B. EMBEDDED PROCESSORS</b></p> <p>Embedded Computers - Characteristics of Embedded Computing Applications - Challenges in Embedded Computing System Design – Embedded System Design Process- Formalism for System Design - Structural Description - Behavioral Description - ARM Processor - Intel ATOM Processor. <b>(8 Hrs.)</b></p>
<b>Unit-II</b>	<p><b>A. EMBEDDED COMPUTING PLATFORM</b></p> <p>CPU Bus Configuration - Memory Devices and Interfacing – Input /Output Devices and Interfacing - System Design - Development and Debugging – Emulator – Simulator - JTAG Design Example – Alarm Clock - Analysis and Optimization of Performance - Power and Program Size. <b>(6 Hrs.)</b></p>
	<p><b>B. EMBEDDED NETWORK ENVIRONMENT</b></p> <p>Distributed Embedded Architecture - Hardware And Software Architectures - Networks for Embedded Systems - I2C - CAN Bus - SHARC Link Supports – Ethernet – Myrinet – Internet - Network-based Design - Communication Analysis - System Performance Analysis - Hardware Platform Design - Allocation and Scheduling - Design Example - Elevator Controller. <b>(6 Hrs.)</b></p>

<b>Unit-III</b>	<b>A. REAL-TIME CHARACTERISTICS</b> Clock Driven Approach - Weighted Round Robin Approach - Priority Driven Approach - Dynamic versus Static Systems - Effective Release Times and Deadlines - Optimality of the Earliest Deadline First (EDF) Algorithm - Challenges in Validating Timing Constraints in Priority Driven Systems - Off-Line versus On-Line Scheduling. <b>(8Hrs.)</b>				
	<b>B. UNIT V SYSTEM DESIGN TECHNIQUES</b> Design Methodologies - Requirement Analysis – Specification - System Analysis and Architecture Design - Quality Assurance - Design Examples - Telephone PBX - Ink jet printer - Personal Digital Assistants - Set-Top Boxes. <b>(6 Hrs.)</b>				
<b>References</b>	<b>Sr. No.</b>	<b>Title</b>	<b>Author</b>	<b>Publication</b>	<b>Edition</b>
	1	Embedded System Design: A Unified Hardware/Software Introduction	Frank Vahid and Tony Givargis	John Wiley & Sons.	
	2	Arm system developers guide	Andrew N Sloss, D. Symes, C. Wright	Morgan Kaufman/Elsevier	2006
	3	Internet of Things: A Hands-on-Approach	ArshdeepBahga, Vijay Madiseti	VPT First Edition	2014
	4.	Real-Time Systems	C. M. Krishna and K. G. Shin	McGraw-Hill	1997
	5.	Designing the Internet of Things	Adrian McEwen, Hakim Cassimally	Wiley Publication	First edition, 2013

**Department of Computer Science and Engineering**  
**Syllabus of M. E. (Computer Science and Engineering) Semester-II**

Course Code: MCS123

Credits: 3-0-1 (4)

Course: Program Elective-I

Mid Semester Examination-I: 15 Marks

Network Design and Technologies

Mid Semester Examination-II: 15 Marks

**Teaching Scheme:**

Teacher Assessment: 10 Marks

Theory: 3 Hrs /week

End Semester Examination: 60 Marks

End Semester Examination (Duration): 3 Hrs

**Prerequisite**      Computer Networks

**Objectives**

- To understand the principles required for network design
- To explore various technologies in the wireless domain
- To study about 3G and 4G cellular networks
- To understand the paradigm of Software defined networks

**Unit-I**

**A. History of Computer Networks and the Internet**

Protocol Layers and Their Service Models , Review of OSI and TCP/IP Delay, Loss, and Throughput in Packet-Switched Networks.

**(6Hrs)**

**B. Network Design**

Advanced multiplexing – Code Division Multiplexing, DWDM and OFDM – Shared media networks – Switched networks – End to end semantics – Connectionless, Connection oriented, Wireless Scenarios – Applications, Quality of Service – End to end level and network level solutions. LAN cabling topologies – Ethernet Switches, Routers, Firewalls and L3 switches – Remote Access Technologies and Devices – Modems and DSLs – SLIP and PPP – Core networks, and distribution networks.      **(6Hrs)**

**Unit-II**

**A. Wireless Networks**

IEEE802.16 and WiMAX – Security – Advanced 802.16 Functionalities – Mobile WiMAX -802.16e – Network Infrastructure – WLAN – Configuration – Management Operation – Security – IEEE 802.11e and WMM – QoS – Comparison of WLAN and UMTS – Bluetooth – Protocol Stack – Security – Profiles IEEE802.16 and WiMAX **(8Hrs)**

**B. Cellular Networks**

GSM – Mobility Management and call control – GPRS – Network Elements – Radio Resource Management – Mobility Management and Session Management – Small Screen Web Browsing over GPRS and EDGE – MMS over GPRS – UMTS – Channel Structure on the Air Interface – UTRAN –Core and Radio Network Mobility Management – UMTS Security **(8Hrs)**

**Unit-III**

**A. 4G Networks**

LTE – Network Architecture and Interfaces – FDD Air Interface and Radio Networks – Scheduling – Mobility Management and Power Optimization – LTE Security Architecture – Interconnection with UMTS and GSM – LTE Advanced (3GPP Release 10) - 4G

	<p>Networks and Composite Radio Environment – Protocol Boosters – Hybrid 4G Wireless Networks Protocols – Green Wireless Networks – Physical Layer and Multiple Access – Channel Modeling for 4G – Introduction to 5G <b>(8Hrs)</b></p> <p><b>B. Software Defined Networks</b></p> <p>Introduction – Centralized and Distributed Control and Data Planes – Open Flow – SDN Controllers – General Concepts – VLANs – NVGRE – Open Flow – Network Overlays – Types – Virtualization – Data Plane – I/O – Design of SDN Framework. <b>(6Hrs)</b></p>				
<b>References</b>	<b>Sr. No.</b>	<b>Title</b>	<b>Author</b>	<b>Publication</b>	<b>Edition</b>
	1.	Advanced Wireless Networks-4G Technologies	Savo G. Glisic	Wiley.	-
	2.	From GSM to LTE: An introduction to mobile networks and mobile broadband	Martin Sauter	Wiley	2011
	3.	Computer Networks: An open source approach	Ying-Dar Lin Ren-Hung Hwang Fred Baker	McGraw Hill	2012

**Department of Computer Science and Engineering**  
**Syllabus of M. E. (Computer Science and Engineering) Semester-I**

Course Code: MCS111	Credits: 0-0-1 (1)
Course: Lab –I (Advanced Algorithms)	Term Work: 25 Marks
<b>Teaching Scheme:</b>	Total Examination Marks: 25 Marks
Practical: 2 Hrs/week	
Experiments/ Project/ Assignment of Lab-I shall be based on the subject Advanced Algorithms.	

The assessment of term work shall be done based on the following.

- Continuous assessment
- Performing the experiments in the laboratory
- Oral examination conducted on the syllabus and term work mentioned above.

**Department of Computer Science and Engineering**  
**Syllabus of M. E. (Computer Science and Engineering) Semester-I**

Course Code: MCS112

Credits: 0-0-1 (1)

Course: Lab –II (Advanced Operating System)

Term Work: 25 Marks

**Teaching Scheme:**

Total Examination Marks: 25 Marks

Practical: 2 Hrs/week

Experiments/ Project/ Assignment of Lab-II shall be based on the subject Advanced Operating System.

The assessment of term work shall be done based on the following.

- Continuous assessment
- Performing the experiments in the laboratory
- Oral examination conducted on the syllabus and term work mentioned above.

**Department of Computer Science and Engineering**  
**Syllabus of M. E. (Computer Science and Engineering) Semester-I**

Course Code: MCS113

Course: Lab –III (Program Elective-I)

**Teaching Scheme:**

Practical: 2 Hrs/week

Credits: 0-0-1 (1)

Term Work: 25 Marks

Total Examination Marks: 25 Marks

Experiments/ Project/ Assignment of Lab-III shall be based on the course Professional Elective-I.

The assessment of term work shall be done based on the following.

- Continuous assessment
- Performing the experiments in the laboratory
- Oral examination conducted on the syllabus and term work mentioned above.

**Department of Computer Science and Engineering**  
**Syllabus of M. E. (Computer Science and Engineering) Semester-I**

Course Code: MCS114

Course: Seminar

**Teaching Scheme:**

Practical: 4Hrs/week

Credits: 0-0-2 (2)

Practical/ Oral: 50 Marks

Total Examination Marks: 50 Marks

The students will deliver a talk on their experience during the semester referring to at least two research papers and will deliver a seminar on topic of current interest in Information Technology, Computer Science and Engineering Field.

**Department of Computer Science and Engineering**  
**Syllabus of M. E. (Computer Science and Engineering) Semester-II**

Course Code: MCS141 Course: Optimization Techniques <b>Teaching Scheme:</b> Theory: 03Hrs	Credits: 3-0-1 (4) Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 3 Hrs
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**Prerequisite** Basic concepts of Mathematics and Statistics.

- Objectives**
- To introduce various optimization techniques
  - To understand nature inspired optimization
  - Learn efficient computational procedures to solve optimization problems in various domains

**Unit-I**

**A. Introduction to Optimization**

Engineering application of Optimization, Statement of an Optimization problem, Design Vector, Design Constraints, Objective function, Engineering Optimization Problems, Classification of Optimization problem, Linear and Non-linear optimization (6Hrs)

**B. Single-variable Optimization Algorithms**

Optimality Criteria, Bracketing Methods, Region-Elimination Methods, Point-Estimation Method, Gradient-based Methods, Root-finding Using Optimization Techniques (6Hrs)

**A. Multivariable and Constrained Optimization Algorithms**

Optimality Criteria, Unidirectional Search, Direct Search Methods, Gradient-based Methods, Kuhn-Tucker Conditions, Lagrangian Duality Theory, Sensitivity Analysis (8Hrs)

**Unit-II**

**B. Dynamic Programming**

Sequential optimization; Representation of multistage decision process; Types of multistage decision problems; Concept of sub optimization and the principle of optimality, Computational Procedure in Dynamic Programming, Computational Procedure in Dynamic Programming, Linear Programming as a Case of Dynamic Programming, Continuous Dynamic Programming. (8Hrs)

**Unit-III**

**A. Nature inspired optimization**

Genetic Algorithms, Basic Description, Chromosomes and Representation Schemes, Selection and Evolution, Analysis of Genetic Algorithms, Real-Number Genetic Algorithms, Ant colony optimization, Particle swarm optimization, Bacterial foraging

	optimization <b>(6Hrs)</b>				
	<b>B. Optimization for Machine Learning</b> Support Vector Machines, Regularized Optimization, Convex Optimization with Sparsity-Inducing Norms, Generic Methods, Proximal Methods, Coordinate Descent Algorithms, Working-Set Methods, Quantitative Evaluation <b>(6Hrs)</b>				
<b>References</b>	<b>Sr. No.</b>	<b>Title</b>	<b>Author</b>	<b>Publication</b>	<b>Edition</b>
	1	Engineering Optimization: Theory and Practice	Singiresu Rao	Wiley	4 <sup>th</sup> Edition
	2	Optimization for Machine Learning	Suvrit Sra Sebastian Nowozin Stephen J. Wright	The MIT Press Cambridge, Massachusetts London, England	1 <sup>st</sup> Edition
	3	Optimization for Engineering Design- Algorithms and Examples	Kalyanmoy Deb	Prentice Hall	1st Edition
	4	Nature-Inspired Optimization Algorithms	Xin-She Yang	Elsevier ISBN: 9780124167452	1st Edition

**Department of Computer Science and Engineering**  
**Syllabus of M. E. (Computer Science and Engineering) Semester-II**

Course Code: MCS142 Course: Machine Learning Techniques <b>Teaching Scheme:</b> Theory: 03Hrs /Week	Credits: 3-0-1 (4) Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 3 Hrs
<b>Prerequisite</b>	Mathematics (Linear Algebra, Calculus, Probability, and Statistics)
<b>Objectives</b>	<ul style="list-style-type: none"> <li>• To learn the concepts and analyze various machine learning algorithms.</li> <li>• To explore supervised and unsupervised learning paradigms of machine learning</li> <li>• To study various dimensionality reduction techniques</li> </ul>
<b>Unit-I</b>	<b>A. Introduction to Machine Learning</b> - Well-posed learning problems, Designing a learning system, Perspectives and issues in machine learning, Concept learning and the general to specific ordering – Introduction, A concept learning task, Concept learning as search, Find-S: finding a maximally specific hypothesis, Version spaces and the candidate elimination algorithm, Remarks on version spaces and candidate elimination, Inductive bias <p style="text-align: right;"><b>(8 Hrs.)</b></p>
	<b>B. Linear Regression, Logistic Regression, Bayesian learning</b> – Introduction, Bayes theorem, , Maximum likelihood and least squared error hypotheses, Maximum likelihood hypotheses for predicting probabilities, Minimum description length principle, Bayes optimal classifier, Naïve Bayes classifier , Expectation Maximization algorithm <p style="text-align: right;"><b>(6 Hrs.)</b></p>
<b>Unit-II</b>	<b>A. Decision Tree learning</b> –The basic decision tree learning algorithm, Hypothesis space search in decision tree learning, Inductive bias in decision tree learning, Issues in decision tree learning <b>Artificial Neural Networks</b> – Neural network representation, Gradient descent, Multilayer networks and the back-propagation algorithm, feed forward network <p style="text-align: right;"><b>(6 Hrs.)</b></p>

	<p><b>B. Support Vector Machines</b> – linear, nonlinearity and kernels, Introduction to Hidden Markov Model, Clustering – k-Means, Techniques for Dimensionality Reduction – Feature Selection methods, Matrix Factorization</p> <p style="text-align: right;"><b>(6 Hrs.)</b></p>				
Unit-III	<p><b>A. Evaluating Hypotheses</b> –Error, Sample error, true error, confidence intervals for observed hypothesis error, Estimators, Binomial distribution, Normal distribution, Central Limit Theorem, Paired t tests, Comparing learning methods <b>Instance-Based Learning</b>- Introduction, k -Nearest Neighbour Learning, Locally Weighted Regression, Radial Basis Functions, Case-Based Reasoning, Remarks on Lazy and Eager Learning</p> <p style="text-align: right;"><b>(8 Hrs.)</b></p>				
	<p><b>B. Deep Learning</b> – Introduction to Auto-encoders, Introduction to Convolutional Neural Networks, Image-Net, Introduction to Recurrent Neural Network, Long Short Term Memory (LSTM)</p> <p style="text-align: right;"><b>(6 Hrs.)</b></p>				
References	<b>Sr. No.</b>	<b>Title</b>	<b>Author</b>	<b>Publication</b>	<b>Edition</b>
	1.	Machine Learning	Tom M. Mitchell	McGraw Hill	1 <sup>st</sup> edition
	2.	Machine Learning: A Probabilistic Perspective	Kevin P. Murphy	MIT Press	1 <sup>st</sup> edition
	3.	Pattern Recognition and Machine Learning	Christopher Bishop.	Springer	1 <sup>st</sup> edition
	4.	Introduction to Artificial Neural Systems	Jacek M. Zurada	Hall of India	1 <sup>st</sup> edition
	5.	Deep Learning	Amlan Chakrabarti, Amit Kumar Das, Saptarsi Goswami, Pabitra Mitra	Pearson	1 <sup>st</sup> edition

**Department of Computer Science and Engineering**  
**Syllabus of M. E. (Computer Science and Engineering) Semester-II**

Course Code: MCS143 Course: Performance Analysis Methods <b>Teaching Scheme:</b> Theory: 03Hrs		Credits: 3-0-1 (4) Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 3 Hrs
<b>Prerequisite</b>	Basic concepts of Mathematics and Computer Systems	
<b>Objectives</b>	<ul style="list-style-type: none"> <li>• To be familiar with the fundamental techniques in performance evaluation of Computer Systems</li> <li>• To understand and implement various performance analysis techniques</li> <li>• To apply various performance analysis techniques to systematically evaluate the performance</li> </ul>	
<b>Unit-I</b>	<b>A. An overview of Performance Evaluation</b> The art of performance evaluation, common mistakes in performance evaluation, a systematic approach to performance evaluation, selecting an evaluation technique, selecting performance metrics, utility classification of performance metrics, setting performance requirements <p style="text-align: right;"><b>(6Hrs)</b></p>	
	<b>B. Measurement Techniques and Tools</b> Types of workloads-addition instruction, instruction mixes, kernels, Benchmarks, the art of workload selection-services exercised, level of detail, representatives, timeliness, other considerations in workload selection, workload characterization techniques: Averaging, specifying dispersion, single parameter histograms, multiparameter histograms, Principal component analysis, Markov models, Clustering <p style="text-align: right;"><b>(6Hrs)</b></p>	
<b>Unit-II</b>	<b>A. Probability Theory and Statistics</b> Summarizing measured data: basic probability and statistics concepts, summarizing data by a single number, selecting among the mean, median and mode, common misuses of means, geometric mean, harmonic mean, mean of a ratio, summarizing variability, selecting index of dispersion, determining distribution of data, comparing systems using sample data: sample versus population, determining sample size, confidence interval for the mean, testing for a zero mean <p style="text-align: right;"><b>(8Hrs)</b></p>	
	<b>B. Simple Linear Regression Models</b> Definition of a good model, estimation of model parameters, allocation of variation,	

standard deviation of errors, confidence intervals for regression parameters, confidence intervals for predictions, visual tests for verifying the regression assumptions (6Hrs)

**A. Simulation and Random-Number Generation**

Introduction to simulation, common mistakes in simulation, selecting a language for simulation, types of simulation

Desired Properties of a Good Generator mLinear-Congruential Generators, TauswortheGenerators, Extended Fibonacci Generators, Combined Generators, A Survey of Random-Number Generators, Seed Selection, Testing Random-Number Generators: Chi-Square Test, Kolmogorov-Smirnov Test

(8Hrs)

**B. Commonly Used Distributions**

Bernoulli Distribution, Beta Distribution, Binomial Distribution, Chi-Square Distribution, Erlang Distribution, Exponential Distribution, F Distribution, Gamma Distribution, Geometric Distribution, Lognormal Distribution, Negative Binomial Distribution, Normal Distribution, Pareto Distribution, Pascal Distribution, Poisson Distribution, Student's T Distribution, Uniform Distribution (Continuous), Uniform Distribution (Discrete), Weibull Distribution, Relationships Among Distributions

(6Hrs)

**Unit-III**

**References**

Sr. No.	Title	Author	Publication	Edition
1.	The Art of Computer System Performance Analysis	Raj Jain	Wiley India Publication	2 <sup>nd</sup> Edition
2.	Measuring Computer Performance-A Practitioner's Guide	David J.Lilja	Cambridge University Press	1st Edition

**Department of Computer Science and Engineering**  
**Syllabus of M. E. (Computer Science and Engineering)**  
**Semester-II**

Course Code: MCS162 Course: Program Elective Course-II <b>Advance Cloud Computing</b> <b>Teaching Scheme:</b> Theory: 3 Hrs / week		Credits: 3-0-1 (3) Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 3 Hrs
<b>Prerequisite</b>	Basic Cloud Computing Knowledge, Computer Networks and Security, DevOps Practices.	
<b>Objectives</b>	<ul style="list-style-type: none"> <li>• To install cloud computing environments.</li> <li>• To study a survey on cloud building blocks and technologies.</li> <li>• To perform cloud computing admin and programming using open source tools.</li> <li>• Identify real time cloud applications in different scenarios appropriate to society</li> </ul>	
<b>Unit-I</b>	<b>Section A</b> Introduction, Roots of Cloud Computing: From mainframe to Cloud, Benefits of Cloud Computing SOA, Web services, Web 2.0, Mashups, Grid computing, Utility computing, Hardware virtualization, Essentials of Cloud characteristics, Challenges, Cloud economics, Role of Networks in Cloud Computing: Cloud types and service models, (6 Hrs)	
	<b>Section B</b> , Cloud computing platforms :Openstack, Opennimbus, Eucalyptus Primary Cloud Service models, Cloud Services brokerage, Primary cloud deployment models, cloud computing reference model, The greenfield and brownfield deployment options (6 Hrs)	
<b>Unit-II</b>	<b>Section A</b> Introduction, Characteristics of Virtualized environments, Taxonomy of Virtualization techniques, Pros and Cons of Virtualization, Technology examples: Xen, KVM, Vmware, Microsoft Hyper-V Infrastructure as Service, best-of breed cloud infrastructure components, cloud ready converged infrastructure, Virtual machine provisioning and migration services, Anatomy of Cloud infrastructure, Distributed management of virtual infrastructure, scheduling techniques, SLA Commitment(8Hrs)	
	<b>Section B</b> Storage system architecture, Big data, Virtualize data centre(VDC) architecture, VDC Environment, server, storage, networking, desktop and application virtualization techniques and benefits, Virtual Machine Components and Process of converting physical to VMs, Block and file level storage virtualization, Virtual Provisioning, and automated storage tiering, VLAN, VSAN and benifits, Network traffic management techniques in VDC, Cloud file systems: GFS and HDFS, BigTable, IIBase and Dynamo. Features and comparisons among GFS,HDFS. (6 Hrs)	

**Unit-III****Section A**

Introduction and architecture for federated cloud computing, Performance prediction for HPC on Cloud. SLA management: Types of SLA, Life cycle of SLA, Traditional approaches of SLA. service catalog, service ordering process, management and functional interfaces of services , cloud portal and its functions, cloud interface standards along with SOAP and REST, system integration and work flow modeling, cloud service life-cycle phases: service planning, service creation, service operation, and service termination Control layer, its functions and benefits,element and unified manager, software defined approach and techniques for managing IT resources (8 Hrs)

**Section B**

Introduction, Global Risk and Compliance aspects in cloud environments and key security terminologies, Technologies for Data security, Data security risk, Cloud computing and identity, Digital identity and access management, Content level security, Security-As-A-Cloud Service(6 Hrs)

**References**

Sr. No.	Title	Author	Publication	Edition
1.	. "Cloud computing principles and paradigms",	RajkumarBuyya,	Wiley	
2.	Enterprise Cloud Computing,	Gautam Shroff,	Cambridge	
3.	. Handbook of Cloud Computing,		Springer Publication	
4.	Cloud Computing: A Practical Approach,	. Anthony T. Velte,	Tata McGraw Hill, 2009, ISBN: 070683514	

**Department of Computer Science and Engineering**  
**Syllabus of M. E. (Computer Science and Engineering) Semester-II**

Course Code: MCS162		Credits: 3-0-1 (3)	
Course: Program Elective Course-II		Mid Semester Examination-I: 15 Marks	
Advance Internet of Things		Mid Semester Examination-II: 15 Marks	
<b>Teaching Scheme:</b>		Teacher Assessment: 10 Marks	
Theory: 3 Hrs / week		End Semester Examination: 60 Marks	
		End Semester Examination (Duration): 3 Hrs	
<b>Prerequisite</b>	Basic IoT Knowledge, Microcontroller and Microprocessor Programming, Networking and Communication Protocols.		
<b>Objectives</b>	<ul style="list-style-type: none"> <li>• To understand the fundamentals of Internet of Things</li> <li>• To learn about the basics of IOT protocols</li> <li>• To build a small low cost embedded system using Raspberry Pi.</li> <li>• To apply the concept of Internet of Things in the real world scenario.</li> </ul>		
<b>Unit-I</b>	<b>Section A</b> <b>INTRODUCTION TO IOT</b> Internet of Things - Physical Design- Logical Design- IoT Enabling Technologies - IoT Levels & Deployment Templates. <span style="float: right;"><b>(6 Hrs)</b></span>		
	<b>Section B</b> Domain Specific IoTs - IoT and M2M - IoT System Management with NETCONF-YANG- IoT Platforms Design Methodology <span style="float: right;"><b>(6 Hrs)</b></span>		
<b>Unit-II</b>	<b>Section A</b> <b>IOT ARCHITECTURE</b> M2M high-level ETSI architecture - IETF architecture for IoT - OGC architecture - IoT reference model - Domain model - information model - functional model - communication model - IoT reference architecture <span style="float: right;"><b>(8Hrs)</b></span>		
	<b>Section B</b> <b>IOT PROTOCOLS</b> Protocol Standardization for IoT – Efforts – M2M and WSN Protocols– SCADA and RFID Protocols – Unified Data Standards – Protocols – IEEE 802.15.4 – BACNet Protocol – Modbus– Zigbee Architecture – Network layer – 6LowPAN - CoAP – Security. <span style="float: right;"><b>(6 Hrs)</b></span>		
<b>Unit-III</b>	<b>Section A</b> <b>BUILDING IOT WITH RASPBERRY PI &amp; ARDUINO</b> Building IOT with RASPERRY PI- IoT Systems - Logical Design using Python – IoT Physical Devices & Endpoints - IoT Device -Building blocks -Raspberry Pi -Board - Linux on Raspberry Pi - Raspberry Pi Interfaces -Programming Raspberry Pi with Python - Other		

	IoT Platforms - Arduino. <span style="float: right;">(8 Hrs)</span>				
	<b>Section B</b> <b>CASE STUDIES AND REAL-WORLD APPLICATIONS</b> Real world design constraints - Applications - Asset management, Industrial automation, smart grid, Commercial building automation, Smart cities - participatory sensing - Data Analytics for IoT – Software & Management Tools for IoT Cloud Storage Models & Communication APIs - Cloud for IoT - Amazon Web Services for IoT. <span style="float: right;">(6 Hrs)</span>				
<b>References</b>	<b>Sr. No.</b>	<b>Title</b>	<b>Author</b>	<b>Publication</b>	<b>Edition</b>
	1.	Internet of Things – A hands-on approach.	ArshdeepBahga, Vijay Madiseti	Universities Press	2015
	2.	Architecting the Internet of Things.	Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds),	Springer	2011
	3.	The Internet of Things in the Cloud: A Middleware Perspectivel	Honbo Zhou	CRC Press	2012
	4.	From Machine to the Internet of Things - Introduction to a New Age of Intelligence	Jan Ho" ller, VlasiosTsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David Boyle	Elsevier	2014.
	5.	The Internet of Things – Key applications and Protocols	Olivier Hersent, David Boswarthick, Omar Elloumi	Wiley	2012

**Department of Computer Science and Engineering**  
**Syllabus of M. E. (Computer Science and Engineering) Semester-II**

Course Code: MCS163	Credits: 3-0-1(3)
Course: Program Elective Course-II	Mid Semester Examination-I: 15 Marks
<b>Industry Oriented Elective</b>	Mid Semester Examination-II: 15 Marks
<b>Teaching Scheme:</b>	Teacher Assessment: 10 Marks
Theory: 3 Hrs / week	End Semester Examination: 60 Marks
	End Semester Examination (Duration): 3 Hrs
Experiments/ Project/ Assignment of Lab-I shall be based on the subject <b>Industry Oriented Elective</b>	

The Syllabus shall be framed based on the following guidelines.

**Industry Oriented Electives** are specialized courses or subjects offered within an academic curriculum to provide students with skills and knowledge tailored to meet the demands of specific industries. These electives bridge the gap between theoretical knowledge and practical industry applications, enabling students to become job-ready by the time they graduate.

**Key Features of Industry Oriented Electives:**

1. **Industry Relevance:** The electives are designed based on current industry trends, needs, and technologies. They focus on practical skills that employers in specific sectors are looking for.
2. **Hands-on Training:** These courses often include hands-on projects, case studies, and practical exercises that allow students to apply their learning in real-world contexts.
3. **Collaboration with Industry:** Some electives are developed in collaboration with industry partners, where professionals from relevant fields may participate as guest lecturers or mentors.
4. **Skill Development:** These electives focus on technical and soft skills that are highly valued in the workforce, such as communication, problem-solving, project management, and technology-specific tools.
5. **Internships and Fieldwork:** Many industry-oriented electives include internships, fieldwork, or live projects with companies, providing students with valuable work experience.

**Department of Computer Science and Engineering**  
**Syllabus of M. E. (Computer Science and Engineering) Semester-II**

<p>Course Code: MCS164</p> <p>Course: Open Elective</p> <p>Ethics and Cyber Security</p> <p><b>Teaching Scheme:</b></p> <p>Theory: 03Hrs</p>	<p>Credits: 3-0- (3)</p> <p>Mid Semester Examination-I: 15 Marks</p> <p>Mid Semester Examination-II: 15 Marks</p> <p>Teacher Assessment: 10 Marks</p> <p>End Semester Examination: 60 Marks</p> <p>End Semester Examination (Duration): 3 Hrs</p>
<b>Prerequisite</b>	Basic concepts of Professional Ethics and Cyber Law
<b>Objectives</b>	<ul style="list-style-type: none"> <li>• Apply Philosophical and Professional Ethics to solve Ethical Dilemma &amp; identify their Professional Responsibilities</li> <li>• Study Intellectual Property Rights in Cyberspace.</li> <li>• Summarize Cyber Forensics and its role in Cyber Laws</li> <li>• Evaluate Cyber Crimes and its severity, and measures for Incident detection and response</li> </ul>
<b>Unit-I</b>	<p><b>A. Computer and Philosophical ethics:</b></p> <p>Moral v/s Ethics, Why Computer Ethics, Philosophical Ethics: Distinguishing Descriptive and Normative Claims, Ethical Relativism, Utilitarianism, Deontological Theories, Rights, Virtue Ethics, (6Hrs)</p>
	<p><b>B. Professional Ethics:</b></p> <p>Why Professional Ethics, Characteristics of Professionals, The System of Professionals, is Computing a Profession., Professional Relationships, Code of Ethics and Professional Conduct, Steps in Ethical Decision Making.(6Hrs)</p>
<b>Unit-II</b>	<p><b>A.Ethics&amp; Internet:</b></p> <p>Three Morally Significant Characteristics, Hacking &amp; Hacker Ethics, Netiquette Intellectual property issues in cyberspace: Introduction to intellectual property Protections via Trade Secrets, Trademarks, Patents, Etc. Contracting to protect intellectual property, Protection options - Encryption / PGP, copyright on web-content, Copyright on software, digital contracts, digital signatures. (8Hrs)</p>
	<p><b>B.Data and Evidence Recovery:</b></p> <p>Introduction to Deleted File Recovery, Formatted Partition Recovery, Data Recovery Tools, Data Recovery Procedures and Ethics, Preserve and safely handle original media, Document a "Chain of Custody", Complete time line analysis of computer files based on file creation, file modification and file access, Recover Internet Usage Data, Recover Swap Files/Temporary Files/Cache Files, Introduction to Encase Forensic Edition, Forensic Tool Kit (FTK) etc, Use computer forensics software tools to cross validate findings in computer</p>

evidence-related cases. (6Hrs)

**A.Cyber Forensics Investigation:**

Introduction to Cyber Forensic Investigation, Investigation Tools, eDiscovery, Digital Evidence Collection, Evidence Preservation, EMail Investigation, E-Mail Tracking, IP Tracking, Email Recovery, Encryption and Decryption methods, Search and Seizure of Computers, Recovering deleted evidences, Password Cracking. (8Hrs)

**Unit-III**

**B.Cyber Security:**

Introduction to Cyber Security, Implementing Hardware Based Security, Software Based Firewalls, Security Standards, Assessing Threat Levels, Types of incidents, Stages of incident response Threats in cyberspace, Blended Attacks, incident prevention and detection, Forming an Incident Response Team, Reporting Cyber crime, Operating System Attacks, Application Attacks, Reverse Engineering & Cracking Techniques and Financial Frauds.Information technology Act 2000: Scope, jurisdiction, offence and contraventions, powers of police, adjudication. (6Hrs)

References	Sr. No.	Title	Author	Publication	Edition
	3.	Computers, Ethics, And Social Values,	Johnson and Nissenbaum,	1994 Prentice Hall	
	4.	2. Cyber security operations Handbook,	John Rittinghouse,William	Hancock	
	5.	3. Computer ethics, ,	Deborah G.Johnson	Pearson education	third edition,

**Department of Computer Science and Engineering**  
**Syllabus of M. E. (Computer Science and Engineering) Semester-II**

Course Code: MCS165		Credits: 3-0- (3)			
Course: Open Elective		Mid Semester Examination-I: 15 Marks			
Data Science		Mid Semester Examination-II: 15 Marks			
<b>Teaching Scheme:</b>		Teacher Assessment: 10 Marks			
Theory: 03Hrs		End Semester Examination: 60 Marks			
		End Semester Examination (Duration): 3 Hrs			
<b>Prerequisite</b>	Identify and explain fundamental ingredients that constitute a Data collection and management.				
<b>Objectives</b>	<ul style="list-style-type: none"> <li>• Explain how data is collected, managed and stored for data science.</li> <li>• Understand the key concepts in data science, including their real-world applications and the toolkit used by data scientists.</li> <li>• To understand the mathematical foundations required</li> <li>• To evaluate data science frameworks with a practical case study.</li> </ul>				
<b>Unit-I</b>	<b>A. Introduction to core concepts and technologies:</b> Introduction, Terminology, data(6Hrs)				
	<b>B. Data collection and management:</b> Introduction, Sources of data, Data collection and APIs, Exploring and fixing data, Data storage and management, Using multiple data sources.(6Hrs)				
<b>Unit-II</b>	<b>A. Data analysis:</b> Introduction, Terminology and concepts, Introduction to statistics, Central tendencies and distributions, Variance, Distribution properties and Unit 4 arithmetic, Samples/CLT.(8Hrs)				
	<b>B. Machine Learning Algorithms:</b> Basic machine learning algorithms, Linear regression, SVM, Naive Bayes, Random Forest.(6Hrs)				
<b>Unit-III</b>	<b>A. Data Visualisation Using Matplotlib &amp; Seaborn libraries :</b> Scatter plot, line plot, bar plot, histogram, box plot, pie chart, pair plot. (8Hrs)				
	<b>B.</b> Case Study Regression and Classification (use of any case study using a dataset ) Regression datasets - Crime_in_india, Salary_Classification, Income_Data, Classification Datasets - Shopping_Mall, Social_Network_Ads(6Hrs)				
<b>References</b>	<b>Sr. No.</b>	<b>Title</b>	<b>Author</b>	<b>Publication</b>	<b>Edition</b>
	6.	1. Doing Data Science,	Cathy O'Neil and Rachel Schutt	Straight Talk From The Frontline.	
	7.	2. Mining of Massive Datasets. v2.1, 3.	Jure Leskovek, Anand	Cambridge University Press.	

		Rajaraman and Jeffrey Ullman.		
8.	3. Mastering Python for data science	Samir Madhavan		
9.	Introduction to linear algebra -	Gilbert Strang		

**Department of Computer Science and Engineering**  
**Syllabus of M. E. (Computer Science and Engineering) Semester-II**

Course Code: MCS166  
 Course: Open Elective  
 Introduction to Artificial Intelligence and Machine Learning  
**Teaching Scheme:**  
 Theory: 03Hrs

Credits: 3-0- (3)  
 Mid Semester Examination-I: 15 Marks  
 Mid Semester Examination-II: 15 Marks  
 Teacher Assessment: 10 Marks  
 End Semester Examination: 60 Marks  
 End Semester Examination (Duration): 3 Hrs

**Prerequisite** Mathematics Linear Algebra, Calculus, Probability, and Statistics

- Objectives**
- Understand the Fundamental Concepts of AI and Machine .
  - **Master Core Algorithms and Techniques in Machine Learning.**
  - Develop the Ability to Handle and Preprocess Data
  - Apply AI and ML in Real-World Problem Solving
  - Explore Neural Networks and Deep Learning.

- Unit-I**
- A.Introduction to Artificial Intelligence and Machine Learning**
- **Overview of AI and Machine Learning**
    - What is Artificial Intelligence (AI)?
    - History and Evolution of AI
    - Introduction to Machine Learning (ML)
    - Types of AI: Weak vs. Strong AI
    - Applications of AI and ML in various industries
    - Overview of AI subfields (NLP, Computer Vision, Robotics, etc.)
  - **Types of Machine Learning**
    - Supervised Learning
    - Unsupervised Learning
    - Semi-Supervised Learning
    - Reinforcement Learning
    - Key Differences Between AI, ML, and Deep Learning
  - **Linear Algebra and Matrix Operations**
    - Vectors and Matrices
    - Matrix Multiplication
    - Eigenvalues and Eigenvectors
    - Singular Value Decomposition (SVD)
  - **Probability and Statistics**
    - Basic Probability Theory
    - Conditional Probability and Bayes' Theorem

- Probability Distributions: Gaussian, Binomial, etc.
- Hypothesis Testing
- Expectation, Variance, and Covariance

- **Calculus for Machine Learning**

- Derivatives and Partial Derivatives
- Chain Rule and Gradient Computation
- Gradient Descent Optimization

(6Hrs)

**B.Supervised Learning**

- **Regression**

- Linear Regression
- Polynomial Regression
- Ridge and Lasso Regression
- Evaluation Metrics: MSE, RMSE, R-Squared

- **Classification**

- Logistic Regression
- Decision Trees
- Random Forests
- k-Nearest Neighbors (k-NN)
- Support Vector Machines (SVMs)
- Naive Bayes Classifier

- **Model Evaluation and Validation**

- Cross-Validation Techniques (K-fold, Leave-One-Out)
- Confusion Matrix, Precision, Recall, F1-Score
- ROC-AUC Curves
- Overfitting and Underfitting
- Bias-Variance Tradeoff

(6Hrs)

**A.Unsupervised Learning**

- **Clustering**

- k-Means Clustering
- Hierarchical Clustering
- Density-Based Spatial Clustering (DBSCAN)
- Evaluation Metrics for Clustering (Silhouette Score)

- **Dimensionality Reduction**

- Principal Component Analysis (PCA)
- Linear Discriminant Analysis (LDA)
- t-SNE (t-distributed Stochastic Neighbor Embedding)
- Feature Extraction and Selection

- **Anomaly Detection**

- Unsupervised Anomaly Detection
- One-Class SVM
- Isolation Forest
- Applications: Fraud Detection, Network Security

(8Hrs)

**B.Neural Networks and Deep Learning**

**Unit-II**

- **Basics of Neural Networks**
  - Introduction to Neural Networks
  - Activation Functions (Sigmoid, Tanh, ReLU)
  - Feedforward Networks
  - Backpropagation Algorithm
  - Training Neural Networks
- **Deep Learning Architectures**
  - Convolutional Neural Networks (CNNs)
  - Recurrent Neural Networks (RNNs)
  - Long Short-Term Memory (LSTM) Networks
  - Generative Adversarial Networks (GANs)
  - Deep Reinforcement Learning
- **Deep Learning Frameworks**
  - Introduction to TensorFlow
  - Introduction to PyTorch
  - Building Deep Learning Models using Keras
  - Transfer Learning and Pre-trained Models (e.g., ResNet, VGG, BERT)

**A. AI in Computer Vision**

- **Introduction to Computer Vision**
  - Image Preprocessing Techniques (Resizing, Normalization, Data Augmentation)
  - Image Classification with CNNs
  - Object Detection (YOLO, R-CNN)
  - Image Segmentation (U-Net, Mask R-CNN)
- **Advanced Topics in Computer Vision**
  - Generative Models for Image Synthesis (GANs, Variational Autoencoders)
  - Deepfakes and Ethical Implication

(8Hrs)

**B. Advanced Topics in AI**

- **Explainable AI (XAI)**
  - Interpretability vs. Explainability
  - LIME and SHAP
  - Model-Agnostic Explanation Techniques
  - Ethical Considerations in AI
- **AI in Real-World Applications**
  - AI for Healthcare (Medical Image Analysis, Drug Discovery)
  - AI for Autonomous Systems (Self-Driving Cars, Robotics)
  - AI for Finance (Algorithmic Trading, Risk Management)
- **Machine Learning Model Deployment(6Hrs)**

**Unit-III**

**References**

Sr. No.	Title	Author	Publication	Edition
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1	Introduction to Machine Learning	Ethem Alpaydin	MIT Press, Prentice Hall of India	Third Edition
2	Foundations of Machine Learning	Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar.	MIT Press	
3	"Data Classification Algorithms and Applications	Charu C. Aggarwal	CRC Press	
4	Jiawei Han and Micheline Kamber and Jian Pei,	Data Mining Concepts and Techniques	Morgan Kaufman Publications	3rd edition
5	Machine Learning	Tom M. Mitchell		
6	Deep Learning	Ian Goodfellow, Yoshua Bengio, and Aaron Courville		
7	Artificial Intelligence: A Modern Approach	Stuart Russell and Peter Norvig		

**Department of Computer Science and Engineering**  
**Syllabus of M. E. (Computer Science and Engineering) Semester-II**

Course Code: MCS151

Course: Lab -I (Machine Learning Techniques)

**Teaching Scheme:**

Practical: 2 Hrs/week

Credits: 0-0-1 (1)

Term Work: 25 Marks

Total Examination Marks: 25 Marks

Experiments/ Project/ Assignment of Lab-I shall be based on the subject Machine Learning Techniques

The assessment of term work shall be done based on the following.

- Continuous assessment
- Performing the experiments in the laboratory
- Oral examination conducted on the syllabus and term work mentioned above.

**Department of Computer Science and Engineering**  
**Syllabus of M. E. (Computer Science and Engineering) Semester-II**

Course Code: MCS152

Course: Lab -II (Data Analytics)

Teaching Scheme:

Practical: 2 Hrs/week

Credits: 0-0-1 (1)

Term Work: 25 Marks

Total Examination Marks: 25 Marks

Experiments/ Project/ Assignment of Lab-II shall be based on the subject Data Analytics

The assessment of term work shall be done based on the following.

- Continuous assessment
- Performing the experiments in the laboratory
- Oral examination conducted on the syllabus and term work mentioned above.

**Department of Computer Science and Engineering**  
**Syllabus of M. E. (Computer Science and Engineering) Semester-II**

Course Code: MCS153	Credits: 0-0-1 (1)
Course: Lab –III (Performance Analysis Methods)	Term Work: 25 Marks
<b>Teaching Scheme:</b>	Total Examination Marks: 25 Marks
Practical: 2 Hrs/week	
Experiments/ Project/ Assignment of Lab-III shall be based on the subject Performance Analysis Methods	

The assessment of term work shall be done based on the following.

- Continuous assessment
- Performing the experiments in the laboratory
- Oral examination conducted on the syllabus and term work mentioned above.

**Department of Computer Science and Engineering**  
**Syllabus of M. E. (Computer Science and Engineering) Semester-II**

Course Code: MCS154

Course: Minor Project

**Teaching Scheme:**

Practical: 4Hrs/week

Credits: 0-0-2 (2)

Practical/ Oral: 50 Marks

Total Examination Marks: 50 Marks

The students will do minor project based on their experience during the semester referring to at least four research papers and will deliver a seminar on minor project.

**Department of Computer Science and Engineering**  
**Syllabus of M. E. (Computer Science and Engineering) Semester-III**

Course Code: MCS163

Course: MOOC Course

**Teaching Scheme:**

Theory: 3 Hrs / week

Credits: 3-0-0 (3)

Mid Semester Examination-I: 15 Marks

Mid Semester Examination-II: 15 Marks

Teacher Assessment: 10 Marks

End Semester Examination: 60 Marks

End Semester Examination (Duration): 3 Hrs

It is mandatory for the student to complete one MOOC course related to the program of study. The student will have to complete the MOOC course which will be available on the SWAYAM portal (Free online education portal). Registered MOOC courses should not have similar or overlapping content to that of the regular courses in the curriculum of the program. The credits can be given to the students after successful completion of the MOOC course of 12 weeks or more.

The credits will be transferred by the evaluation in terms of assignments or examinations or viva-voce. In case the student is unable to clear the MOOC Course examination, the student will have to appear for an institute-level examination for the respective MOOC course.

**Department of Computer Science and Engineering**  
**Syllabus of M. E. (Computer Science and Engineering) Semester-III**

Course Code: MCS211

Course: Dissertation-I

**Teaching Scheme:**

Practical: 18Hrs/week

Credits: 0-0-9 (9)

Term Work: 50 Marks

Practical/ Oral: 100 Marks

Total Examination Marks: 150 Marks

The students are required to complete the details like Introduction, Literature Survey, and system/ problem definition. The stage of implementation needs to be started in this semester. Project report must be submitted in the prescribed format only. The dissertation will consist of a type written report covering the work completed so far. The work will be judged by two examiners (one internal guide and one external) by taking viva-voce and marks will be given accordingly.

**Department of Computer Science and Engineering**  
**Syllabus of M. E. (Computer Science and Engineering) Semester-VI**

Course Code: MCS251

Course: Dissertation-II

**Teaching Scheme:**

Practical: 24Hrs/week

Credits: 0-0-12 (12)

Term Work: 100 Marks

Practical/ Oral: 200 Marks

Total Examination Marks: 300 Marks

The students need to complete the dissertation work taken in semester-III. They should complete the remaining work till the conclusion. The term work marks will be awarded based on the dissertation work completed till then. The work will be judged by two examiners (one internal guide and done external) by taking viva-voce and marks will be given accordingly. The dissertation will consist of a type written report covering the work completed

Question Paper structure for All Theory Courses shall be as per following format

Q. 1 shall be based on complete syllabus and should have MCQs, Fill in the blank, one sentence, Match the pair, type of questions for 10 marks. It should be compulsory question

Remaining 7 Questions shall be of 10 Marks each. Out of these 7 questions 5 questions should be solved.

These questions may have one question of 10M or two questions of 5M each based on the syllabus.