KONGU ENGINEERING COLLEGE

(Autonomous Institution Affiliated to Anna University, Chennai)

PERUNDURAI ERODE – 638 060

TAMILNADU INDIA

Estd : 1984

REGULATIONS, CURRICULUM & SYLLABI - 2020

(CHOICE BASED CREDIT SYSTEM AND OUTCOME BASED EDUCATION)

(For the students admitted during 2020 - 2021 and onwards)

MASTER OF ENGINEERING DEGREE IN COMPUTER SCIENCE AND ENGINEERING

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

KONGU
Assuring the Best

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KONGU ENGINEERING COLLEGE
PERUNDURAI ERODE – 638 060
(Autonomous)

INSTITUTE VISION

To be a centre of excellence for development and dissemination of knowledge in Applied Sciences, Technology, Engineering and Management for the Nation and beyond.

INSTITUTE MISSION

We are committed to value based Education, Research and Consultancy in Engineering and Management and to bring out technically competent, ethically strong and quality professionals to keep our Nation ahead in the competitive knowledge intensive world.

QUALITY POLICY

We are committed to

- Provide value based quality education for the development of students as competent and responsible citizens.
- Contribute to the nation and beyond through research and development
- Continuously improve our services

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

VISION

To be a centre of excellence for nurturing competent computer professionals of high calibre and quality for catering to the ever-changing needs of the industry and society.

MISSION

Department of Computer Science and Engineering is committed to:

MS1:	Develop innovative, competent and ethically strong computer engineers to meet global challenges.
MS2:	Foster consultancy and basic as well as applied research activities to solve real world problems.
MS3:	Endeavour for constant upgradation of technical expertise to cater to the needs of the industry and society.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

Post Graduates of Computer Science and Engineering will

PEO1:	Adapt new computing technologies for attaining professional excellence and contribute to the advancement of computer science
PEO2:	Achieve peer recognition as an individual or in a team through demonstration of good analytical research, design and implementation skills
PEO3:	Thrive to pursue lifelong reflective learning to fulfill their goals

MAPPING OF MISSION STATEMENTS (MS) WITH PEOs

MS\PEO	PEO1	PEO2	PEO3
MS1	3	2	2
MS2	2	3	2
MS3	2	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

PROGRAM OUTCOMES (POs)	
Graduates of Computer Science and Engineering will**:**	
PO1	Apply mathematical foundations, algorithmic principles, and computer science theory in the modelling and design of computer based systems of varying complexity.
PO2	Critically analyze existing literature in an area of specialization and develop innovative and research oriented methodologies to tackle gaps identified.
PO3	Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, ethical, health and safety, and sustainability in the field of computer engineering.
PO4	Apply latest techniques and tools necessary for computing practice and demonstrate advanced knowledge of a selected area within the computer science discipline.
PO5	Function effectively to accomplish a common goal and communicate with a range of audiences and prepare technical documents and make oral presentations.
PO6	Demonstrate an ability to engage in lifelong learning for professional development.

MAPPING OF PEOs WITH POs

PEO\PO	PO1	PO2	PO3	PO4	PO5	PO6
PEO1	3	2	2	3	1	2
PEO2			1		3	3
PEO3	2	2	1	1		1

1 – Slight, 2 – Moderate, 3 – Substantial

KONGU ENGINEERING COLLEGE, PERUNDURAI, ERODE – 638060

(An Autonomous Institution Affiliated to Anna University)

REGULATIONS 2020

CHOICE BASED CREDIT SYSTEM AND OUTCOME BASED EDUCATION

MASTER OF ENGINEERING (ME) / MASTER OF TECHNOLOGY (MTech) DEGREE PROGRAMMES

These regulations are applicable to all candidates admitted into ME/MTech Degree programmes from the academic year 2020 – 2021 onwards.

1. DEFINITIONS AND NOMENCLATURE

In these Regulations, unless otherwise specified:

i. "University" means ANNA UNIVERSITY, Chennai.

ii. "College" means KONGU ENGINEERING COLLEGE.

iii. "Programme" means Master of Engineering (ME) / Master of Technology (MTech) Degree programme

iv. "Branch" means specialization or discipline of ME/MTech Degree programme, like Construction Engineering and Management, Information Technology, etc.

v. "Course" means a Theory / Theory cum Practical / Practical course that is normally studied in a semester like Engineering Design Methodology, Machine Learning Techniques, etc.

vi. "Credit" means a numerical value allocated to each course to describe the candidate's workload required per week.

vii. "Grade" means the letter grade assigned to each course based on the marks range specified.

viii. "Grade point" means a numerical value (0 to 10) allocated based on the grade assigned to each course.

ix. "Principal" means Chairman, Academic Council of the College.

x. "Controller of Examinations" means authorized person who is responsible for all examination related activities of the College.

xi. "Head of the Department" means Head of the Department concerned of the College.

2. PROGRAMMES AND BRANCHES OF STUDY

The following programmes and branches of study approved by Anna University, Chennai and All India Council for Technical Education, New Delhi are offered by the College.

Programme	Branch
ME	Construction Engineering and Management
	Structural Engineering
	Engineering Design
	Mechatronics Engineering
	VLSI Design
	Embedded Systems
	Power Electronics and Drives
	Control and Instrumentation Engineering
	Computer Science and Engineering
MTech	Information Technology
	Chemical Engineering
	Food Technology

3. ADMISSION REQUIREMENTS

Candidates seeking admission to the first semester of the ME/MTech Degree programme shall be required to have passed an appropriate qualifying Degree Examination of Anna University or any examination of any other University or authority accepted by the Anna University, Chennai as equivalent thereto, subject to amendments as may be made by the Anna University, Chennai from time to time. The candidates shall also be required to satisfy all other conditions of admission prescribed by the Anna University, Chennai and Directorate of Technical Education, Chennai from time to time.

4. STRUCTURE OF PROGRAMMES

4.1 Categorisation of Courses

The ME / MTech programme shall have a curriculum with syllabi comprising of theory, theory cum practical, practical courses in each semester and project work, internship,etc that have been approved by the respective Board of Studies and Academic Council of the College. All the programmes have well defined Programme Outcomes (PO) and Programme Educational Objectives (PEOs) as per Outcome Based Education (OBE). The content of each course is designed based on the Course Outcomes (CO). The courses shall be categorized as follows:

i. Foundation Courses (FC)

ii. Professional Core (PC) Courses

iii. Professional Elective (PE) Courses

iv. Open Elective (OE) Courses

v. Employability Enhancement Courses (EC) like Innovative Project, Internship cum Project work in Industry or elsewhere, Project Work

4.2 Credit Assignment

Each course is assigned certain number of credits as follows:

Contact period per week	Credits
1 Lecture / Tutorial Period	1
2 Practical Periods	1
2 Project Work Periods	1
40 Training /Internship Periods	1

The minimum number of credits to complete the ME/MTech programme is 72.

4.3 Employability Enhancement Courses

A candidate shall be offered with the employability enhancement courses like innovative project, internship cum project work and project work during the programme to gain/exhibit the knowledge/skills.

4.3.1 Innovative Project

A candidate shall earn two credits by successfully completing the project by using his/her innovations in second semester during his/her programme.

4.3.2 Internship cum Project Work

The curriculum enables a candidate to go for full time internship during the third semester and can earn credits through it for his/her academics vide clause 7.6 and clause 7.12. Such candidate shall earn the minimum number of credits as mentioned in the third semester of the curriculum other than internship by either fast track mode or through approved courses in online mode or by self study mode. Such candidate can earn the number of credits for the internship same as that of Project Work in the third semester. Assessment procedure is to be followed as specified in the guidelines approved by the Academic Council.

4.3.4 Project Work

A candidate shall earn nine credits by successfully completing the project work in fourth semester during the programme inside the campus or in industries.

4.4 Value Added Courses / Online Courses / Self Study Courses

The candidates may optionally undergo Value Added Courses / Online Courses / Self Study Courses as elective courses.

4.4.1 **Value Added Courses:** Value Added courses each with One / Two credits shall be offered by the college with the prior approval from respective Board of Studies. A candidate can earn a maximum of three credits through value added courses during the entire duration of the programme.

4.4.2 **Online Courses:** Candidates may be permitted to earn credits for online courses, offered by NPTEL / SWAYAM / a University / Other Agencies, approved by respective Board of Studies.

4.4.3 **Self Study Courses:** The Department may offer an elective course as a self study course. The syllabus of the course shall be approved by the respective Board of Studies. However, mode of assessment for a self study course will be the same as that used for other courses. The candidates shall study such courses on their own under the guidance of member of the faculty. Self study course is limited to one per semester.

4.4.4 The elective courses in the final year may be exempted if a candidate earns the required credits vide clause 4.4.1, 4.4.2 and 4.4.3 by registering the required number of courses in advance (up to second semester).

4.4.5 A candidate can earn a maximum of 15 credits through all value added courses, online courses and self study courses.

4.5 Flexibility to Add or Drop Courses

4.5.1 A candidate has to earn the total number of credits specified in the curriculum of the respective programme of study in order to be eligible to obtain the degree. However, if the candidate wishes, then the candidate is permitted to earn more than the total number of credits prescribed in the curriculum of the candidate's programme.

4.5.2 From the second to fourth semesters the candidates have the option of registering for additional elective/Honors courses or dropping of already registered additional elective/Honors courses within two weeks from the start of the semester. Add / Drop is only an option given to the candidates. Total number of credits of such courses during the entire programme of study cannot exceed six.

4.6 Maximum number of credits the candidate can enroll in a particular semester cannot exceed 30 credits.

4.7 The blend of different courses shall be so designed that the candidate at the end of the programme would have been trained not only in his / her relevant professional field but also would have developed to become a socially conscious human being.

4.8 The medium of instruction, examinations and project report shall be English.

5. DURATION OF THE PROGRAMME

5.1 A candidate is normally expected to complete the ME / MTech Degree programme in 4 consecutive semesters (2 Years), but in any case not more than 8 semesters (4 Years).

5.2 Each semester shall consist of a minimum of 90 working days including continuous assessment test period. The Head of the Department shall ensure that every teacher imparts instruction as per the number of periods specified in the syllabus for the course being taught.

5.3 The total duration for completion of the programme reckoned from the commencement of the first semester to which the candidate was admitted shall not exceed the maximum duration specified in clause 5.1 irrespective of the period of break of study (vide clause 11) or prevention (vide clause 9) in order that the candidate may be eligible for the award of the degree (vide clause 16). Extension beyond the prescribed period shall not be permitted.

6. COURSE REGISTRATION FOR THE EXAMINATION

6.1 Registration for the end semester examination is mandatory for courses in the current semester as well as for the arrear courses failing which the candidate will not be permitted to move on to the higher semester. This will not be applicable for the courses which do not have an end semester examination.

6.2 The candidates who need to reappear for the courses which have only continuous assessment shall enroll for the same in the subsequent semester, when offered next, and repeat the course. In this case, the candidate shall attend the classes, satisfy the attendance requirements (vide clause 8), earn continuous assessment marks. This will be considered as an attempt for the purpose of classification.

6.3 If a candidate is prevented from writing end semester examination of a course due to lack of attendance, the candidate has to attend the classes, when offered next, and fulfill the attendance requirements as per clause 8 and earn continuous assessment marks. If the course, in which the candidate has a lack of attendance, is an elective, the candidate may register for the same or any other elective course in the subsequent semesters and that will be considered as an attempt for the purpose of classification.

7. ASSESSMENT AND EXAMINATION PROCEDURE FOR AWARDING MARKS

7.1 The ME/MTech programmes consist of Theory Courses, Theory cum Practical courses, Practical courses, Innovative Project, Internship cum Project work and Project Work. Performance in each course of study shall be evaluated based on (i) Continuous Assessments (CA) throughout the semester and (ii) End Semester Examination (ESE) at the end of the semester except for the courses which are evaluated based on continuous assessment only. Each course shall be evaluated for a maximum of 100 marks as shown below:

Sl. No.	Category of Course	Continuous Assessment Marks	End Semester Examination
1.	Theory / Practical	50	50
2.	Theory cum Practical	The distribution of marks shall be decided based on the credit weightage assigned to theory and practical components respectively.	
3.	Innovative Project/ Project Work / Internship cum Project Work	50	50
4.	Value Added Course	The distribution of marks shall be decided based on the credit the credit weightage assigned	---
5.	All other Courses		

7.2 Examiners for setting end semester examination question papers for theory courses, theory cum practical courses and practical courses and evaluating end semester examination answer scripts, project works, innovative project and internships shall be appointed by the Controller of Examinations after obtaining approval from the Principal.

7.3 Theory Courses

For all theory courses out of 100 marks, the continuous assessment shall be 50 marks and the end semester examination shall be for 50 marks. However, the end semester examinations shall be conducted for 100 marks and the marks obtained shall be reduced to 50. The continuous assessment tests shall be conducted as per the schedule laid down in the academic schedule. Three tests shall be conducted for 50 marks each and reduced to 30 marks each. The total of the continuous assessment marks and the end semester examination marks shall be rounded off to the nearest integer.

7.3.1 The assessment pattern for awarding continuous assessment marks shall be as follows:

Sl. No.	Type	Max. Marks	Remarks
1.	Test – I	30	Average o f best two
	Test – II	30	
	Test - III	30	
2.	Tutorial	15	Should be of Open Book/Objective Type. Average of best 4 (or more, depending on the nature of the course, as may be approved by Principal)

3.	Assignment / Paper Presentation in Conference / Seminar / Comprehension / Activity based learning / Class notes	05	To be assessed by the Course Teacher based on any one type.
	Total	50	Rounded off to the one decimal place

However, the assessment pattern for awarding the continuous assessment marks may be changed based on the nature of the course and is to be approved by the Principal.

7.3.2 A reassessment test or tutorial covering the respective test or tutorial portions may be conducted for those candidates who were absent with valid reasons (Sports or any other reason approved by the Principal).

7.3.3 The end semester examination for theory courses shall be for duration of three hours.

7.4 Theory cum Practical Courses

For courses involving theory and practical components, the evaluation pattern as per the clause 7.1 shall be followed. Depending on the nature of the course, the end semester examination shall be conducted for theory and the practical components. The apportionment of continuous assessment and end semester examination marks shall be decided based on the credit weightage assigned to theory and practical components approved by Principal.

7.5 Practical Courses

For all practical courses out of 100 marks, the continuous assessment shall be for 50 marks and the end semester examination shall be for 50 marks. Every exercise / experiment shall be evaluated based on the candidate's performance during the practical class and the candidate's records shall be maintained.

7.5.1 The assessment pattern for awarding continuous assessment marks for each course shall be decided by the course coordinator based on rubrics of that particular course, and shall be based on rubrics for each experiment.

7.6 Project Work

7.6.1 Project work shall becarried out individually. Candidates can opt for full time internship (vide clause 7.8) in lieu of project work in third semester. The project work is mandatory for all the candidates.

7.6.2 The Head of the Department shall constitute review committee for project work. There shall be three assessments by the review committee during the semester. The candidate shall make presentation on the progress made by him/her before the committee.

7.6.3 The continuous assessment and end semester examination marks for Project Work and the Viva-Voce Examination shall be distributed as below.

Continuous Assessment (Max. 50 Marks)						End Semester Examination (Max. 50 Marks)			
Review I (Max..10 Marks)		Review II (Max.. 20 Marks)		Review III (Max. 20 Marks)		Report Evaluation (Max. 20 Marks)	Viva - Voce (Max. 30 Marks)		
Rv. Com	Guide	Review Committee (excluding guide)	Guide	Review Committee (excluding guide)	Guide	Ext. Exr.	Guide	Exr. 1	Exr. 2
5	5	10	10	10	10	20	10	10	10

7.6.4 The Project Report prepared according to approved guidelines and duly signed by the Guide and Project Co-ordinator shall be submitted to Head of the Department. A candidate must submit the project report within the specified date as per the academic schedule of the semester. If the project report is not submitted within the specified date then the candidate is deemed to have failed in the Project Work and redo it in the subsequent semester. This applies to both Internship cum Project work and Project work.

7.6.5 If a candidate fails to secure 50% of the continuous assessment marks in the project work, he / she shall not be permitted to submit the report for that particular semester and shall have to redo it in the subsequent semester and satisfy attendance requirements.

7.6.6 Every candidate shall, based on his/her project work, publish a paper in a reputed journal or reputed conference in which full papers are published after usual review. A copy of the full paper accepted and proof for that shall be produced at the time of evaluation.

7.6.7 The project work shall be evaluated based on the project report submitted by the candidate in the respective semester and viva-voce examination by a committee consisting of two examiners and guide of the project work.

7.6.8 If a candidate fails to secure 50 % of the end semester examination marks in the project work, he / she shall be required to resubmit the project report within 30 days from the date of declaration of the results and a fresh viva-voce examination shall be conducted as per clause 7.6.7.

7.6.9 A copy of the approved project report after the successful completion of viva-voce examination shall be kept in the department library.

7.7 Innovative Project

The evaluation method shall be same as that of the Project Work as per clause 7.6 excluding clause 7.6.6.

7.8 Internship cum Project Work

Each candidate shall submit a brief report about the internship undergone and a certificate issued from the organization concerned at the time of Viva-voce examination to the review committee. The evaluation method shall be same as that of the Project Work as per clause 7.6 excluding 7.6.6.

7.9 Value Added Course

Two assessments shall be conducted during the value added course duration by the offering department concerned.

7.10 Online Course

The Board of Studies will provide methodology for the evaluation of the online courses. The Board can decide whether to evaluate the online courses through continuous assessment and end semester examination or through end semester examination only. In case of credits earned through online mode from NPTEL / SWAYAM / a University / Other Agencies approved by Chairman, Academic Council, the credits may be transferred and grades shall be assigned accordingly.

7.11 Self Study Course

The member of faculty approved by the Head of the Department shall be responsible for periodic monitoring and evaluation of the course. The course shall be evaluated through continuous assessment and end semester examination. The evaluation methodology shall be the same as that of a theory course.

7.12 Audit Course

A candidate may be permitted to register for specific course not listed in his/her programme curriculum and without undergoing the rigors of getting a 'good' grade, as an Audit course, subject to the following conditions.

The candidate can register only one Audit course in a semester starting from second semester subject to a maximum of two courses during the entire programme of study. Such courses shall be indicated as 'Audit' during the time of Registration itself. Only courses currently offered for credit to the candidates of other branches can be audited.

A course appearing in the curriculum of a candidate cannot be considered as an audit course. However, if a candidate has already met the Professional Elective and Open Elective credit requirements as stipulated in the curriculum, then, a Professional Elective or an Open Elective course listed in the curriculum and not taken by the candidate for credit can be considered as an audit course.

Candidates registering for an audit course shall meet all the assessment and examination requirements (vide clause 7.3) applicable for a credit candidate of that course. Only if the candidate obtains a performance grade, the course will be listed in the semester Grade Sheet and in the Consolidated Grade Sheet along with the grade SF (Satisfactory). Performance grade will not be shown for the audit course.

Since an audit course has no grade points assigned, it will not be counted for the purpose of GPA and CGPA calculations.

8. REQUIREMENTS FOR COMPLETION OF A SEMESTER

8.1 A candidate who has fulfilled the following conditions shall be deemed to have satisfied the requirements for completion of a semester and permitted to appear for the examinations of that semester.

8.1.1 Ideally, every candidate is expected to attend all classes and secure 100 % attendance. However, a candidate shall secure not less than 80 % (after rounding off to the nearest integer) of the overall attendance taking into account the total number of working days in a semester.

8.1.2 A candidate who could not satisfy the attendance requirements as per clause 8.1.1 due to medical reasons (hospitalization / accident / specific illness) but has secured not less than 70 % in the current semester may be permitted to appear for the current semester examinations with the approval of the Principal on payment of a condonation fee as may be fixed by the authorities from time to time. The medical certificate needs to be submitted along with the leave application. A candidate can avail this provision only twice during the entire duration of the degree programme.

8.1.3 In addition to clause 8.1.1 or 8.1.2, a candidate shall secure not less than 60 % attendance in each course.

8.1.4 A candidate shall be deemed to have completed the requirements of study of any semester only if he/she has satisfied the attendance requirements (vide clause 8.1.1 to 8.1.3) and has registered for examination by paying the prescribed fee.

8.1.5 Candidate's progress is satisfactory.

8.1.6 Candidate's conduct is satisfactory and he/she was not involved in any indisciplined activities in the current semester.

8.2. The candidates who do not complete the semester as per clauses from 8.1.1 to 8.1.6 except 8.1.3 shall not be permitted to appear for the examinations at the end of the semester and not be permitted to go to the next semester. They have to repeat the incomplete semester in next academic year.

8.3 The candidates who satisfy the clause 8.1.1 or 8.1.2 but do not complete the course as per clause 8.1.3 shall not be permitted to appear for the end semester examination of that course alone. They have to repeat the incomplete course in the subsequent semester when it is offered next.

9. REQUIREMENTS FOR APPEARING FOR END SEMESTER EXAMINATION

9.1 A candidate shall normally be permitted to appear for end semester examination of the current semester if he/she has satisfied the semester completion requirements as per clause 8, and has registered for examination in all courses of that semester. Registration is mandatory for current semester examinations as well as for arrear examinations failing which the candidate shall not be permitted to move on to the higher semester.

9.2 When a candidate is deputed for a National / International Sports event during End Semester examination period, supplementary examination shall be conducted for such a candidate on return after participating in the event within a reasonable period of time. Such appearance shall be considered as first appearance.

9.3 A candidate who has already appeared for a course in a semester and passed the examination is not entitled to reappear in the same course for improvement of letter grades / marks.

10. PROVISION FOR WITHDRAWAL FROM EXAMINATIONS

10.1 A candidate may, for valid reasons, be granted permission to withdraw from appearing for the examination in any regular course or all regular courses registered in a particular semester. Application for withdrawal is permitted only once during the entire duration of the degree programme.

10.2 The withdrawal application shall be valid only if the candidate is otherwise eligible to write the examination (vide clause 9) and has applied to the Principal for permission prior to the last examination of that semester after duly recommended by the Head of the Department.

10.3 The withdrawal shall not be considered as an appearance for deciding the eligibility of a candidate for First Class with Distinction/First Class.

10.4 If a candidate withdraws a course or courses from writing end semester examinations, he/she shall register the same in the subsequent semester and write the end semester examinations. A final semester candidate who has withdrawn shall be permitted to appear for supplementary examination to be conducted within reasonable time as per clause 14.

10.5 The final semester candidate who has withdrawn from appearing for project viva-voce for genuine reasons shall be permitted to appear for supplementary viva-voce examination within reasonable time with proper application to Controller of Examinations and on payment of prescribed fee.

11. PROVISION FOR BREAK OF STUDY

11.1 A candidate is normally permitted to avail the authorised break of study under valid reasons (such as accident or hospitalization due to prolonged ill health or any other valid reasons) and to rejoin the programme in a later semester. He/She shall apply in advance to the Principal, through the Head of the Department, stating the reasons therefore, in any case, not later than the last date for registering for that semester examination. A candidate is permitted to avail the authorised break of study only once during the entire period of study for a maximum period of one year. However, in extraordinary situation the candidate may apply for additional break of study not exceeding another one year by paying prescribed fee for the break of study.

11.2 The candidates permitted to rejoin the programme after break of study / prevention due to lack of attendance shall be governed by the rules and regulations in force at the time of rejoining.

11.3 The candidates rejoining in new Regulations shall apply to the Principal in the prescribed format through Head of the Department at the beginning of the readmitted semester itself for prescribing additional/equivalent courses, if any, from any semester of the regulations in-force, so as to bridge the curriculum in-force and the old curriculum.

11.4 The total period of completion of the programme reckoned from the commencement of the semester to which the candidate was admitted shall not exceed the maximum period specified in clause 5 irrespective of the period of break of study in order to qualify for the award of the degree.

11.5 If any candidate is prevented for want of required attendance, the period of prevention shall not be considered as authorized break of study.

11.6 If a candidate has not reported to the college for a period of two consecutive semesters without any intimation, the name of the candidate shall be deleted permanently from the college enrollment. Such candidates are not entitled to seek readmission under any circumstances.

12. PASSING REQUIREMENTS

12.1 A candidate who secures not less than 50 % of total marks (continuous assessment and end semester examination put together) prescribed for the course with a minimum of 50 % of the marks prescribed for the end semester examination in all category of courses vide clause 7.1 except for the courses which are evaluated based on continuous assessment only shall be declared to have successfully passed the course in the examination.

12.2 A candidate who secures not less than 50 % in continuous assessment marks prescribed for the courses which are evaluated based on continuous assessment only shall be declared to have successfully passed the course. If a candidate secures less than 50% in the continuous assessment marks, he / she shall have to re-enroll for the same in the subsequent semester and satisfy the attendance requirements.

12.3 For a candidate who does not satisfy the clause 12.1, the continuous assessment marks secured by the candidate in the first attempt shall be retained and considered valid for subsequent attempts. However, from the fourth attempt onwards the marks scored in the end semester examinations alone shall be considered, in which case the candidate shall secure minimum 50 % marks in the end semester examinations to satisfy the passing requirements, but the grade awarded shall be only the lowest passing grade irrespective of the marks secured.

13. REVALUATION OF ANSWER SCRIPTS

A candidate shall apply for a photocopy of his / her semester examination answer script within a reasonable time from the declaration of results, on payment of a prescribed fee by submitting the proper application to the Controller of Examinations. The answer script shall be pursued and justified jointly by a faculty member who has handled the course and the course coordinator and recommended for revaluation. Based on the recommendation, the candidate can register for revaluation through proper application to the Controller of Examinations. The Controller of Examinations will arrange for revaluation and the results will be intimated to the candidate concerned. Revaluation is permitted only for Theory courses and Theory cum Practical courses where end semester examination is involved.

14. SUPPLEMENTARY EXAMINATION

If a candidate fails to clear all courses in the final semester after the announcement of final end semester examination results, he/she shall be allowed to take up supplementary examinations to be conducted within a reasonable time for the courses of final semester alone, so that he/she gets a chance to complete the programme.

15. AWARD OF LETTER GRADES

Range of % of Total Marks	Letter Grade	Grade Point
91 to 100	O (Outstanding)	10
81 to 90	A+ (Excellent)	9
71 to 80	A (Very Good)	8
61 to 70	B+ (Good)	7
50 to 60	B (Average)	6
Less than 50	RA (Reappear)	0
Satisfactory	SF	0
Withdrawal	W	-
Absent	AB	-
Shortage of Attendance in a course	SA	-

The Grade Point Average (GPA) is calculated using the formula:

$$\text{GPA} = \frac{\sum[(\text{course credits}) \times (\text{grade points})] \text{ for all courses in the specific semester}}{\sum(\text{course credits}) \text{ for all courses in the specific semester}}$$

The Cumulative Grade Point Average (CGPA) is calculated from first semester (third semester for lateral entry candidates) to final semester using the formula

$$\text{CGPA} = \frac{\sum[(\text{course credits}) \times (\text{grade points})] \text{ for all courses in all the semesters so far}}{\sum(\text{course credits}) \text{ for all courses in all the semesters so far}}$$

The GPA and CGPA are computed only for the candidates with a pass in all the courses.

The GPA and CGPA indicate the academic performance of a candidate at the end of a semester and at the end of successive semesters respectively.

A grade sheet for each semester shall be issued containing Grade obtained in each course, GPA and CGPA.

A duplicate copy, if required can be obtained on payment of a prescribed fee and satisfying other procedure requirements.

Withholding of Grades: The grades of a candidate may be withheld if he/she has not cleared his/her dues or if there is a disciplinary case pending against him/her or for any other reason.

16. ELIGIBILITY FOR THE AWARD OF DEGREE

A candidate shall be declared to be eligible for the award of the ME / MTech Degree provided the candidate has

i. Successfully completed all the courses under the different categories, as specified in the regulations.

ii. Successfully gained the required number of total credits as specified in the curriculum

corresponding to the candidate's programme within the stipulated time (vide clause 5).

iii. Successfully passed any additional courses prescribed by the respective Board of Studies whenever readmitted under regulations other than R-2020 (vide clause 11.3)

iv. No disciplinary action pending against him / her.

17. CLASSIFICATION OF THE DEGREE AWARDED

17.1 First Class with Distinction:

17.1.1 A candidate who qualifies for the award of the degree (vide clause 16) and who satisfies the following conditions shall be declared to have passed the examination in First class with Distinction:

- Should have passed the examination in all the courses of all the four semesters in the **First Appearance** within four consecutive semesters excluding the authorized break of study (vide clause 11) after the commencement of his / her study.
- Withdrawal from examination (vide clause 10) shall not be considered as an appearance.
- Should have secured a CGPA of not less than 8.50

(OR)

17.1.2 A candidate who joins from other institutions on transfer or a candidate who gets readmitted and has to move from one regulation to another regulation and who qualifies for the award of the degree (vide clause 16) and satisfies the following conditions shall be declared to have passed the examination in First class with Distinction:

- Should have passed the examination in all the courses of all the four semesters in the **First Appearance** within four consecutive semesters excluding the authorized break of study (vide clause 11) after the commencement of his / her study.
- Submission of equivalent course list approved by the respective Board of studies.
- Withdrawal from examination (vide clause 10) shall not be considered as an appearance.
- Should have secured a CGPA of not less than 9.00

17.2 First Class:

A candidate who qualifies for the award of the degree (vide clause 16) and who satisfies the following conditions shall be declared to have passed the examination in First class:

- Should have passed the examination in all the courses of all four semesters within six consecutive semesters excluding authorized break of study (vide clause 11) after the commencement of his / her study.
- Withdrawal from the examination (vide clause 10) shall not be considered as an appearance.
- Should have secured a CGPA of not less than 7.00

17.3 Second Class:

All other candidates (not covered in clauses 17.1 and 17.2) who qualify for the award of the degree (vide clause 16) shall be declared to have passed the examination in Second Class.

17.4 A candidate who is absent for end semester examination in a course / project work after having registered for the same shall be considered to have appeared for that examination for the purpose of classification.

18. MALPRACTICES IN TESTS AND EXAMINATIONS

If a candidate indulges in malpractice in any of the tests or end semester examinations, he/she shall be liable for punitive action as per the examination rules prescribed by the college from time to time.

19. AMENDMENTS

Notwithstanding anything contained in this manual, the Kongu Engineering College through the Academic council of the Kongu Engineering College, reserves the right to modify/amend without notice, the Regulations, Curricula, Syllabi, Scheme of Examinations, procedures, requirements, and rules pertaining to its ME / MTech programme.

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CURRICULUM BREAKDOWN STRUCTURE						
Summary of Credit Distribution						
Category	**Semester**				**Total number of credits**	**Curriculum Content (% of total number of credits of the program)**
	I	**II**	**III**	**IV**		
FC	**7**				**7**	**9.7**
PC	**12**	**15**			**27**	**37.5**
PE	**3**	**6**	**3**	**6**	**18**	**25**
EC		**2**	**9**	**9**	**20**	**27.8**
Semesterwise Total	**22**	**23**	**12**	**15**	**72**	**100.00**

Category	Abbreviation
Lecture hours per week	**L**
Tutorial hours per week	**T**
Practical, Project work, Internship, Professional Skill Training, Industrial Training hours per week	**P**
Credits	**C**

CATEGORISATION OF COURSES							
FOUNDATION COURSES (FC)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	20AMT15	Advanced Mathematics for Computing	3	1	0	4	I
2.	20GET11	Introduction to Research	2	1	0	3	I
Total Credits to be earned						**7**	

PROFESSIONAL CORE (PC)

S. No.	Course Code	Course Name	L	T	P	C	Sem
1.	20MST11	Network Design and Technologies	3	1	0	4	I
2.	20MST12	Data Structures and Analysis of Algorithms	3	0	0	3	I
3.	20MST13	Advanced Database Technology	3	0	0	3	I
4.	20MSL11	Data structures and algorithms Laboratory	0	0	2	1	I

5.	20MSL12	Database Technology laboratory	0	0	2	1	I
6.	20MST21	Machine Learning Techniques	3	0	0	3	II
7.	20MST22	Multicore Architectures	3	1	0	4	II
8.	20MST23	Security in Computing	3	1	0	4	II
9.	20MST24	Data Science	3	0	0	3	II
10.	20MSL21	Machine Learning Laboratory	0	0	2	1	II
Total Credits to be earned						27	

S. No.	Course Code	Course Name	L	T	P	C	Sem
		Elective – I					
1.	20MSE01	Data mining Techniques	3	0	0	3	I
2.	20MSE02	Business Intelligence	3	0	0	3	I
3.	20MSE03	Cloud Computing	3	0	0	3	I
4.	20MSE04	Compiler Design Techniques	2	0	2	3	I
		Elective – II					
5.	20MSE05	Blockchain Technologies	3	0	0	3	2
6.	20MSE06	Internet of Things	2	0	2	3	2
7.	20MSE07	Big Data Analytics	3	0	0	3	2
8.	20MSE08	Modern Information Retrieval Techniques	3	0	0	3	2
		Elective - III					
9.	20MSE09	Information Storage Management	3	0	0	3	2
10.	20MSE10	Randomized Algorithms	3	0	0	3	2
11.	20MSE11	Social Network Analysis	3	0	0	3	2
12.	20MSE12	Deep Learning Techniques	2	0	2	3	2
		Elective – IV					
13.	20MSE13	Speech and natural language processing	3	0	0	3	3
14.	20MSE14	Intelligent system Design	3	0	0	3	3
15.	20MSE15	Mobile and Pervasive computing	3	0	0	3	3
16.	20MSE16	Nature Inspired Optimization Techniques	3	0	0	3	3
		Elective – V					
26.	20MSE17	Digital Image Processing and Computer Vision	3	0	0	3	4

27.	20MSE18	Software Defined Networking	3	0	0	3	4
28.	20MSE19	Reinforcement Learning	3	0	0	3	4
29.	20MSE20	Virtualization Techniques	3	0	0	3	4
		Elective – VI					
30.	20MSE21	User Interface Design	2	0	2	3	4
31.	20MSE22	Advanced Parallel Architecture and Programming	2	0	2	3	4
32.	20GET13	Innovation Entrepreneurship and venture Development	3	0	0	3	4
Total Credits to be earned						**18**	

EMPLOYABILITY ENHANCEMENT COURSES (EC)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
1.	20MSP21	Innovative Project	0	0	4	2	II
2.	20MSP31	Internship cum Project Work	0	0	27	9	III
3.	20MSP41	Project Work 2	0	0	27	9	IV
Total Credits to be earned						**20**	

KEC R2020: SCHEDULING OF COURSES – ME (Computer Science and Engineering) Total Credits: 72

Semester	Theory/ Theory cum Practical / Practical						Internship & Projects	Special Courses	Credits
	1	2	3	4	5	6	7	8	9
I	20AMT15 Advanced Mathematics for computing (PC-3-1-0-4)	20GET11 Introduction to Reasearch (PC-2-1-0-3)	20MST11 Network design and technologies (PC-3-1-0-4)	20MST12 Data Structures and Analysis of Algorithms (PC-3-0-0-3)	20MST13 Advanced Database Technology (PC-3-0-0-3)	Professional Elective I (PE-3-0-0-3)	20MSL11 Data Structures and Analysis of Algorithms Laboratory (PC-0-0-3-1)	20MSL12 Database Technology Laboratory (PC-0-0-3-1)	22
II	20MST21 Machine Learning Techniques (PC-3-0-0-3)	20MST22 Multicore Architecture (PC-3-1-0-4)	20MST23 Security in computing (PC-3-1-0-4)	20MST24 Data Science (PC-3-0-0-3)	Professional Elective II (PE-3-0-0-3)	Professional Elective III (PE-3-0-0-3)	20MSL21 Machine Learning Techniques Laboratory (PC-0-0-3-1)	20MSP21 Innovative Project (PR-0-0-4-2)	23
III	Professional Elective IV (PE-3-0-0-3)						20MSP31 Intern cum Project Work (PR-0-0-27-9)		12
IV	Professional Elective V (PE-3-0-0-3)	Professional Elective VI (PE-3-0-0-3)					20MSP41 Project Work 2 (PR-0-0-27-9)		15

Total Credits: 72

MAPPING OF COURSES WITH PROGRAM OUTCOMES

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6
1	20AMT15	Advanced Mathematics for Computing	✓	✓	✓			
1	20GET11	Introduction to Research	✓	✓	✓			
1	20MST11	Network Design and Technologies	✓	✓	✓	✓		
1	20MST12	Data Structures and Analysis of Algorithms	✓	✓		✓		
1	20MST13	Advanced Database Technology	✓	✓		✓		
1	20MSL11	Data structures and algorithms Laboratory	✓	✓		✓		
1	20MSL12	Database Technology laboratory	✓	✓		✓		
2	20MST21	Machine Learning Techniques	✓		✓	✓		✓
2	20MST22	Multicore Architectures	✓	✓	✓			
2	20MST23	Security in Computing	✓	✓	✓	✓		
2	20MST24	Data Science	✓	✓	✓	✓		
2	20MSL21	Machine Learning Laboratory	✓		✓			
1	20MSE01	Data mining Techniques	✓		✓	✓		✓
1	20MSE02	Business Intelligence	✓	✓	✓	✓		
1	20MSE03	Cloud Computing	✓	✓	✓	✓		
1	20MSE04	Compiler Design Techniques	✓	✓	✓	✓		
2	20MSE05	Blockchain Technologies	✓	✓	✓	✓		
2	20MSE06	Internet of Things	✓	✓	✓	✓		
2	20MSE07	Big Data Analytics	✓	✓	✓	✓		
2	20MSE08	Modern Information Retrieval Techniques	✓	✓	✓	✓		
2	20MSE09	Information Storage Management	✓	✓	✓	✓		
2	20MSE10	Randomized Algorithms	✓	✓	✓			
2	20MSE11	Social Network Analysis	✓	✓	✓			
2	20MSE12	Deep Learning Techniques	✓	✓	✓	✓		

Sem.	Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6
3	20MSE13	Speech and natural language processing	✓	✓	✓	✓		
3	20MSE14	Intelligent system Design	✓	✓	✓	✓		
3	20MSE15	Mobile and Pervasive computing	✓	✓	✓	✓		
3	20MSE16	Nature Inspired Optimization Techniques	✓	✓	✓			
4	20MSE17	Digital Image Processing and Computer Vision	✓	✓	✓			
4	20MSE18	Software Defined Networking	✓	✓	✓			
4	20MSE19	Reinforcement Learning	✓	✓	✓			
4	20MSE20	Virtualization Techniques	✓	✓	✓	✓		
4	20MSE21	User Interface Design	✓	✓	✓	✓		
4	20MSE22	Advanced Parallel Architecture and Programming	✓	✓	✓	✓		
4	GE	Innovation Entrepreneurship and venture Development						

M.E. COMPUTER SCIENCE AND ENGINEERING CURRICULUM – R2020

SEMESTER – I									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
20AMT15	Advanced Mathematics for Computing	3	1	0	4	50	50	100	FC
20GET11	Introduction to Research	2	1	0	3	50	50	100	FC
20MST11	Network Design and Technologies	3	1	0	4	50	50	100	PC
20MST12	Data Structures and Analysis of Algorithms	3	0	0	3	50	50	100	PC
20MST13	Advanced Database Technology	3	0	0	3	50	50	100	PC
	Professional Elective I	3	0	0	3	50	50	100	PE
Practical / Employability Enhancement									
20MSL11	Data structures and algorithms Laboratory	0	0	2	1	50	50	100	PC
20MSL12	Database Technology laboratory	0	0	2	1	50	50	100	PC
Total Credits to be earned					22				

SEMESTER – II									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
20MST21	Machine Learning Techniques	3	0	0	3	50	50	100	PC
20MST22	Multicore Architectures	3	1	0	4	50	50	100	PC
20MST23	Security in Computing	3	1	0	4	50	50	100	PC
20MST24	Data Science	3	0	0	3	50	50	100	PC
	Professional Elective II	3	0	0	3	50	50	100	PE
	Professional Elective III	3	0	0	3	50	50	100	PE
Practical / Employability Enhancement									
20MSL21	Machine Learning Laboratory	0	0	2	1	50	50	100	PC
20MSP21	Innovative Project	0	0	4	2	50	50	100	EC
Total Credits to be earned					23				

SEMESTER – III									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Practical / Employability Enhancement									
	Professional Elective IV	3	0	0	3	50	50	100	PE
20MSP31	Industrial Project	0	0	18	9	50	50	100	EC
Total Credits to be earned					**12**				

SEMESTER – IV									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
	Professional Elective-V	3	0	0	3	50	50	100	PE
	Professional Elective-VI	3	0	0	3	50	50	100	PE
Practical / Employability Enhancement									
20MSP41	Project Work	0	0	18	9	50	50	100	EC
Total Credits to be earned					**15**				

20AMT15 - ADVANCED MATHEMATICS FOR COMPUTING

Programme & Branch	M.E. Computer Science and Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	I	FC	3	1	0	4

Preamble	This course is designed to provide the solid foundation on mathematical and statistical knowledge for designing various concepts in computing, managing databases, artificial intelligence, compiler and design.	
Unit - I	**Estimation Theory:**	**9+3**
Point Estimation - Characteristics of estimators - Unbiased estimators - Methods or Estimation: Method of Maximum Likelihood Estimation - Method of Moments - Correlation - Regression.		
Unit - II	**Multivariate Analysis**:	**9+3**
Random vectors and matrices – Mean vectors and covariance matrices – Multivariate normal density and its properties – Principal components – Population principal components – Principal components from standardized variables.		
Unit - III	**Vector Spaces**:	**9+3**
Definition – Subspaces – Linear dependence and independence – Basis and dimension – Row space, Column space and Null Space – Rank and nullity.		
Unit - IV	**Number Theory:**	**9+3**
Divisibility - Prime numbers - Fundamental theorem of arithmetic - Fermat's Little theorem - GCD - Euclid's algorithm - Congruence - Solution of Congruences - Chinese remainder theorem.		
Unit - V	**Automata Theory:**	**9+3**
Formal Languages: Introduction - Phrase structure grammar - Types of Grammar - Finite state machine - Finite state automata - Deterministic and Non-deterministic FSA - Equivalence of DFA to NFA - Push down automata - Languages accepted by PDA - Equivalence of Pushdown Automata and Context Free Languages - Turing Machine.		

Lecture: re45, Tutorial: 15, Total: 60

REFERENCES:

1.	Gupta S.C. and Kapoor V.K. "Fundamentals of Mathematical Statistics", Sultan and Sons, Eleventh edition, 2011.
2.	Richard A. Johnson and Dean W. Wichern, "Applied Multivariate Statistical Analysis", 5th Edition, Pearson Education, Asia, 2002.
3.	Howard Anton, "Elementary Linear Algebra", 10th Edition, John Wiley & Sons, 2010.
4.	Victor Shoup, "A Computational Introduction to Number Theory and Algebra", Cambridge University Press, Second Edition, 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	use a sample to compute point estimate.	Applying (K3)
CO2	perform exploratory analysis of multivariate data.	Applying (K3)
CO3	apply the concepts of linear algebra to solve practical problems.	Applying (K3)
CO4	handle network security related problems using number theory concepts.	Applying (K3)
CO5	model different kinds of machines using finite state automata.	Applying (K3)

Mapping of COs with POs s						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1					
CO2	1		1			
CO3	2					
CO4	2	1	1			
CO5	3	1	2			
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy						

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	20	70	-	-	-	100
CAT2	10	20	70	-	-	-	100
CAT3	10	20	70	-	-	-	100
ESE	10	20	70	-	-	-	100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20GET11 INTRODUCTION TO RESEARCH

(Common to Engineering and Technology Branches)

Programme & Branch	M.E Computer Science and Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	FC	2	1	0	3

Preamble	Preamble: This course will familiarize the fundamental concepts/techniques adopted in research, problem formulation and patenting. Also will disseminate the process involved in collection, consolidation of published literature and rewriting them in a presentable form using latest tools.	
Unit - I	**Concept of Research**	**6**
Meaning and Significance of Research: Skills, Habits and Attitudes for Research - Time Management - Status of Research in India. Why, How and What a Research is? - Types and Process of Research - Outcome of Research - Sources of Research Problem - Characteristics of a Good Research Problem - Errors in Selecting a Research Problem - Importance of Keywords - Literature Collection – Analysis - Citation Study - Gap Analysis - Problem Formulation Techniques.		
Unit - II	**Research Methods and Journals**	**6**
Interdisciplinary Research - Need for Experimental Investigations - Data Collection Methods - Appropriate Choice of Algorithms / Methodologies / Methods - Measurement and Result Analysis - Investigation of Solutions for Research Problem - Interpretation - Research Limitations. Journals in Science/Engineering - Indexing and Impact factor of Journals - Citations - h Index - i10 Index - Journal Policies - How to Read a Published Paper - Ethical issues Related to Publishing - Plagiarism and Self-Plagiarism.		
Unit - III	**Paper Writing and Research Tools**	**6**
Types of Research Papers - Original Article/Review Paper/Short Communication/Case Study - When and Where to Publish? - Journal Selection Methods. Layout of a Research Paper - Guidelines for Submitting the Research Paper - Review Process - Addressing Reviewer Comments. Use of tools / Techniques for Research - Hands on Training related to Reference Management Software - EndNote, Software for Paper Formatting like LaTeX/MS Office. Introduction to Origin, SPSS, ANOVA etc., Software for detection of Plagiarism.		
Unit - IV	**Effective Technical Thesis Writing/Presentation**	**6**
How to Write a Report - Language and Style - Format of Project Report - Use of Quotations - Method of Transcription Special Elements: Title Page - Abstract - Table of Contents - Headings and Sub-Headings - Footnotes - Tables and Figures - Appendix - Bibliography etc. - Different Reference Formats. Presentation using PPTs.		
Unit - V	**Nature of Intellectual Property**	**6**
Patents - Designs - Trade and Copyright. Process of Patenting and Development: Technological research - innovation - patenting - development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents.		

Lecture: 30, Tutorial:15, Total:45

REFERENCES:

1	DePoy, Elizabeth, and Laura N. Gitlin, “Introduction to Research-E-Book: Understanding and Applying Multiple Strategies”, Elsevier Health Sciences, 2015.
2	Walliman, Nicholas, “Research Methods: The basics”,Routledge, 2017.
3.	Bettig Ronald V., “Copyrighting culture: The political economy of intellectual property”,Routledge, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	list the various stages in research and categorize the quality of journals.	Analyzing (K4)
CO2	formulate a research problem from published literature/journal papers	Evaluating (K5)
CO3	write, present a journal paper/ project report in proper format	Creating (K6)
CO4	select suitable journal and submit a research paper.	Applying (K3)
CO5	compile a research report and the presentation	Applying (K3)

Mapping of COs with POs					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	1		
CO2	3	2	3		
CO3	3	3	1		
CO4	3	2	1		
CO5	3	2	1		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy					

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1		30	40	30			100
CAT2		30	40	30			100
CAT3			30	40	30		100
ESE		30	40	30			100

*** ±3% may be varied**

20MST11 – NETWORK DESIGN AND TECHNOLOGIES

Programme & Branch	M.E Computer Science and Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Computer Networks	**I**	**PC**	**3**	**1**	**0**	**4**

Preamble	This course provides an introduction to fundamentals of Network design, tools for monitoring the network and analyzing the performance. Further this course also focuses on variants of wireless networks, 4G and 5G networks and Software-Defined Networks.	
Unit - I	**Network Design Fundamentals:**	**9+3**
Introduction -Cooperative communications -The OSI model -The TCP/IP model -The Internet protocols-Networking hardware-Physical connectivity-Virtual connectivity.		
Unit - II	**Network monitoring and Analysis:**	**9+3**
An effective network monitoring LAN and WAN - Monitoring your network -The dedicated monitoring server – monitoring various network parameters - characteristics of monitoring tools - Types of monitoring tools-Spot check tools-Log analysers-Trending tools-Realtime tools-Benchmarking-Interpret the traffic graph - Monitoring RAM and CPU usage.		
Unit - III	**Wireless Networks:**	**9+3**
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.		
Unit - IV	**4G and 5G Networks**:	**9+3**
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 (3GPPP Release 10)-4G Networks and Composite Radio Environment – Protocol Boosters – Hybrid 4G Wireless Networks Protocols – Green Wireless Networks – Physical Layer and Multiple Access – Introduction to 5G.		
Unit - V	**Software Defined Networks:**	**9+3**
Introduction – Centralized and Distributed Control and Data Planes – Open Flow – SDN Controllers – Data centre concepts and constructs. Design of simple SDN network.		

Lecture: 45, Tutorial:15, Total: 60

REFERENCES:

1.	Martin Sauter, “From GSM to LTE, An Introduciton to Mobile Networks and Mobile Broadband”, 1st Edition, Wiley, 2014
2.	Thoman D. Nadeau, and Ken Gray, “SDN - Software Defined Networks”, 1st Edition, O’Reilly Publishers, 2013.(Unit V)
3.	Flickenger R., Belcher M., Canessa E., Zennaro M., “How To Accelerate Your Internet A Practical Guide to Bandwidth Management and Optimisation using Open Source Software”, 1st Edition, BMO Book Sprint Team, 2006.(Unit I , II)

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	identify the components required for designing a network	Applying (K3)
CO2	analyze the usage of appropriate tools for network monitoring	Analyzing (K4)
CO3	determine a suitable wireless networking technology for a given communication scenario	Applying (K3)
CO4	identify the features of LTE, 4G and 5G networks	Applying (K3)
CO5	design simple software defined networks with simulation tools	Applying (K3)

Mapping of COs with POs s						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	1	3		
CO2	3	3	1	3		
CO3	3	2	1	3		
CO4	3	2	1	3		
CO5	3	2	1	3		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy						

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	15	60	25				100
CAT2	15	70	15				100
CAT3	15	70	15				100
ESE	10	70	20				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MST12 - DATA STRUCTURES AND ANALYSIS OF ALGORITHMS

Programme & Branch	M.E & Computer Science and Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	PC	3	0	0	3

Preamble	Provides insight into the intrinsic nature of the problem as well as possible solution techniques, independent of programming language / programming paradigm/computer hardware/ implementation aspect.	
Unit - I	**Data Structures:**	**9**
The Role of Algorithms in Computing- Growth of Functions - Analysis of Recursive and Non-recursive Functions – Lists - Heap Sort – Quick Sort – Sorting in Linear Time.		
Unit - II	**Advanced Data Structures:**	**9**
Binary Search Trees-Red-Black Trees-Augmenting Data Structures - B- Tress – Binomial Heaps - Fibonacci Heaps.		
Unit - III	**Algorithm Design Techniques:**	**9**
Overview of Basic Design Techniques: Divide and Conquer (Strassen's Matrix Multiplication) – Dynamic Programming (Rod Cutting) - Greedy Algorithms(Huffman Codes) - String Matching: Naïve Algorithm - Rabin Karp Algorithm - String matching with finite automata - Knuth-Morris-Pratt Algorithm - Computational Geometry: Line Segment Properties - Determining segments intersection – Convex Hull – Closest pair of points.		
Unit - IV	**Graph Algorithms:**	**9**
Elementary Graph Algorithms - Minimum Spanning Trees - Single Source Shortest Paths - All Pairs Shortest Paths - Maximum Flow.		
Unit - V	**NP and Approximation Algorithm:**	**9**
NP-Completeness: Polynomial Time verification, NP Completeness and Reducibility - NP Completeness Proofs - NP Complete Problems - Approximation Algorithms: Traveling Salesman Problem - Sum of Subset Problem - Vertex Cover Problem.		

Lecture: 45, Total: 45

REFERENCES:

1.	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, "Introduction to Algorithms", 3rd Edition, MIT Press, USA, 2009.
2.	Levitin A., "Introduction to The Design and Analysis of Algorithms", 2nd Edition, Addison Wesley, New York, 2007.
2.	Weiss Mark Allen, "Data Structures and Algorithm Analysis in C++", 3rd Edition, Pearson Education, New Delhi, 2007.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	analyze algorithms and prove their correctness for searching and sorting	Analyzing (K4)
CO2	choose appropriate data structure as applicable to specified problem definition	Applying (K3)
CO3	design algorithms using different Algorithm Design Techniques and apply them to real world problem	Applying (K3)
CO4	summarize the major graph algorithms and apply on standard problems	Applying (K3)
CO5	outline the significance of NP-completeness and APPLY Approximation algorithm	Applying (K3)

Mapping of COs with POs s						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3		3		
CO2	3	2		3		
CO3	3	2		3		
CO4	3	2		3		
CO5	2	1		2		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy						

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	7	10	73	10			100
CAT2	10	15	75				100
CAT3	10	15	75				100
ESE	7	13	80				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MST13 - ADVANCED DATABASE TECHNOLOGY

Programme & Branch	M.E & Computer Science and Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	PC	3	0	0	3

Preamble	To acquire knowledge on advanced databases like parallel and distributed database, object oriented database, active database, temporal database, spatial database, mobile database, multimedia database, XML database and cloud database to effectively store the data for real time applications.	
Unit - I	**Parallel and Distributed Databases:**	**9**
Database System Architectures: Centralized and Client-Server Architectures - Server System Architectures - Parallel Systems - Distributed Systems - Parallel Databases: I/O Parallelism - Inter and Intra Query Parallelism - Inter and Intraoperation Parallelism - Design of Parallel Systems - Distributed Database Concepts - Distributed Data Storage - Distributed Transactions - Commit Protocols - Concurrency Control - Distributed Query Processing - Case Studies.		
Unit - II	**Object Oriented Databases:**	**9**
Object Oriented Databases - Introduction - Weakness of RDBMS - Object Oriented Concepts - Storing Objects in Relational Databases - Next Generation - Database Systems - Object Oriented Data models - OODBMS Perspectives - Persistence - Issues in OODBMS - Object Oriented Database Management System Manifesto - Advantages and Disadvantages of OODBMS - Object Oriented Database Design - OODBMS Standards and Systems - Object Management Group - Object Database Standard ODMG - Object Relational DBMS - Postgres - Comparison of ORDBMS and OODBMS.		
Unit - III	**Intelligent Databases:**	**9**
Active Databases: Syntax and Semantics (Starburst, Oracle, DB2) – Taxonomy – Applications - Design Principles for Active Rules - Temporal Databases: Overview of Temporal Databases - TSQL2 - Deductive Databases: Logic of Query Languages - Datalog - Recursive Rules - Syntax and Semantics of Datalog Languages - Implementation of Rules and Recursion - Recursive Queries in SQL - Spatial Databases - Spatial Data Types - Spatial Relationships - Spatial Data Structures - Spatial Access Methods - Spatial DB Implementation.		
Unit - IV	**Advanced Data Models:**	**9**
Mobile Databases: Location and Handoff Management - Effect of Mobility on Data Management -Location Dependent Data Distribution - Mobile Transaction Models - Concurrency Control - Transaction Commit Protocols - Multimedia Databases - Information Retrieval - Data Warehousing - Data Mining - Text Mining.		
Unit - V	**Emerging Technologies:**	**9**
XML Databases: XML Data Model - DTD - XML Schema - XML Querying - Web Databases - Geographic Information Systems - Biological Data Management - Cloud Based Databases: Data Storage Systems on the Cloud - Cloud Storage Architectures - Cloud Data Models - Query Languages - Introduction to Big Data - Storage - Analysis.		

Lecture: 45, Total: 45

REFERENCES:

1. Elmasri R., Navathe S.B., "Fundamentals of Database Systems", 5th Edition, Pearson Education/Addison Wesley, 2010
2. Thomas Cannolly and Carolyn Begg, "Database Systems, A Practical Approach to Design, Implementation and Management", 3rd Edition, Pearson Education, 2007.
3. Henry F. Korth, Abraham Silberschatz S., Sudharshan, "Database System Concepts", 5th Edition, McGraw Hill, 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	select the appropriate high performance database like parallel and distributed database	Applying (K3)
CO2	model and represent the real world data using object oriented database	Applying (K3)
CO3	design a semantic based database to meaningful data access	Applying (K3)
CO4	embed the rule set in the database to implement intelligent databases	Applying (K3)
CO5	represent the data using XML database for better interoperability	Applying (K3)

Mapping of COs with POs s						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3		3		
CO2	3	2		3		
CO3	3	2		3		
CO4	3	2		3		
CO5	2	1		2		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy						

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	50	40				100
CAT2	10	50	40				100
CAT3	10	50	40				100
ESE	10	50	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MSL11 - DATA STRUCTURES AND ALGORITHMS LABORATORY

Programme & Branch	M.E & Computer Science and Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	PC	0	0	3	1
Preamble	Provides insight into the intrinsic nature of the problem as well as possible solution techniques, independent of programming language / programming paradigm/computer hardware/ implementation aspect.						

List of Exercises / Experiments:

1.	Implement any two sorting algorithm
2.	Apply Binary Search Trees
3.	Apply Red-Black trees – insertion and Display
4.	Apply Binomial Heap and Fibonacci heaps algorithms
5.	Implement Strassen‘s matrix multiplication algorithm using Algorithm Design Techniques
6.	Implement Huffman code using Algorithm Design Techniques
7.	Implement String Matching algorithms (any two)
8.	Implement Graph algorithms
9.	Solve NP Problems sum of Subset Problem
10.	Implement Travelling sales person problem

Practical: 30, Total: 30

REFERENCES/MANUAL/SOFTWARE:

1.	Lab manuals

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	identify the appropriate data structure for solving the given problem	Applying (K3), Precision (S3)
CO2	choose and employ appropriate data structure to represent complex data structure	Applying (K3), Precision (S3)
CO3	synthesize operations like searching, insertion, deletion and traversing on various data structures	Applying (K3), Precision (S3)

Mapping of COs with POs s

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2		3		
CO2	3	2		3		
CO3	3	2		3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom’s Taxonomy

20MSL12 - DATABASE TECHNOLOGY LABORATORY

Programme & Branch	M.E & Computer Science and Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	PC	0	0	3	1
Preamble	To acquire knowledge on advanced databases like parallel and distributed database, object oriented database, active database, temporal database, spatial database, mobile database, multimedia database, XML database and cloud database to effectively store the data for real time applications.						

List of Exercises / Experiments:

1.	Distributed Database for Bookstore
2.	Deadlock Detection Algorithm for distributed database using wait- for graph
3.	Object Oriented Database – Extended Entity Relationship (EER)
4.	Parallel Database – University Counselling for Engineering colleges
5.	Parallel Database – Implementation of Parallel Join & Parallel Sort
6.	Active Database – Implementation of Triggers & Assertions for Bank Database
7.	Deductive Database – Constructing Knowledge Database for Kinship Domain (Family Relations)
8.	Study and Working of WEKA Tool
9.	Query Processing – Implementation of an Efficient Query Optimizer
10.	Designing XML Schema for Company Database

Practical: 30, Total: 30

REFERENCES/MANUAL/SOFTWARE:

1.	Lab manuals

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	design an effective query processing for parallel and distributed database	Applying (K3), Precision (S3)
CO2	design an online system for various applications	Applying (K3), Precision (S3)
CO3	design an application using advanced data models	Applying (K3), Precision (S3)

Mapping of COs with POs s

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2		3		
CO2	3	2		3		
CO3	3	2		3		

1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy

20MST21 - MACHINE LEARNING TECHNIQUES

Programme & Branch	M.E. & Computer Science and Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	2	PC	3	0	0	3

Preamble	Provides a concise introduction to the fundamental concepts of machine learning and popular machine learning algorithms.	
Unit - I	**Supervised Learning:**	**9**
Definition of Machine Learning - Examples of Machine Learning Applications. Supervised Learning: Learning a Class from Examples - VC Dimension - PAC Learning - Noise - Learning Multiple Classes - Regression - Model Selection and Generalization - Dimensions of a Supervised Machine Learning Algorithm. Dimensionality Reduction: Introduction - Subset Selection – Principal Component Analysis- Feature Embedding - Factor Analysis.		
Unit - II	**Tree And Probabilistic Models:**	**9**
Learning with Trees – Decision Trees – Constructing Decision Trees – Classification and Regression Trees – Different ways to Combine Classifiers – Boosting – Bagging –– Gaussian Mixture Models – Nearest Neighbor Methods – Unsupervised Learning – K means Algorithm.		
Unit - III	**Multilayer Perceptrons:**	**9**
Introduction - The Perceptron - Training a Perceptron - Learning Boolean Functions - Multilayer Perceptrons - MLP as a Universal Approximator - Backpropagation Algorithm - Training Procedures - Tuning the Network Size - Dimensionality Reduction - Learning Time		
Unit - IV	**Kernel Machines:**	**9**
Introduction - Optimal Separating Hyperplane - Soft Margin Hyperplane - v-SVM - Kernal Trick - Vectorial Kernels - Defining Kernels - Multiple Kernel Learning - Multiclass Kernel Machines - One class Kernel Machines - Kernel Dimensionality Reduction.		
Unit - V	**Reinforcement Learning:**	**9**
Introduction - Single State Case-Elements of Reinforcement Learning - Model-Based Learning - Temporal Difference Learning - Generalization - Partially Observable States. Design of Machine Learning Experiments: Introduction - Factors, Response, and Strategy of Experimentation - Response Surface Design - Randomization, Replication, and Blocking - Guidelines for Machine Learning Experiments.		

Lecture: 45, Total: 45

REFERENCES:

1.	Ethem Alpaydin, “Introduction to Machine Learning”, 3rd Edition, Prentice Hall of India, 2014.
2.	Christopher Bishop, “Pattern Recognition and Machine Learning”, 2nd Edition, Springer, 2011.
3.	Willi Richert, Luis Pedro Coelho, “Building Machine Learning Systems with Python”, 2nd Edition, Packt Publishing Ltd., 2015.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	illustrate the foundations of machine learning and apply suitable dimensionality reduction techniques for an application	Applying (K3)
CO2	make use of supervised methods to solve the given problem	Applying (K3)
CO3	apply neural networks to solve real world problems	Applying (K3)
CO4	solve real world problems using kernel machines	Applying (K3)
CO5	summarize the concepts of reinforcement learning and design machine learning experiments	Analyzing (K4)

Mapping of COs with POs s						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3		2			
CO2	3		2			1
CO3	3			2		1
CO4	3			2		1
CO5	2		3			1
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy						

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	22	58	10			100
CAT2	10	18	62	10			100
CAT3	15	10	65	10			100
ESE	10	18	62	10			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MST22 - MULTICORE ARCHITECTURES

Programme & Branch	M.E & Computer Science and Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Computer Architecture and Organization	**2**	**PC**	**3**	**1**	**0**	**4**

Preamble	This course will introduce the students to the world of multi-core computer architectures and focuses on delivering an in-depth exposure in memory-subsystems and interconnects and few introductory sessions on advanced superscalar processors.	
Unit - I	**Fundamentals of Quantitative Design and Analysis:**	**9+3**
Classes of Computers – Trends in Technology, Power, Energy and Cost – Dependability – Measuring, Reporting and Summarizing Performance – Quantitative Principles of Computer Design – Classes of Parallelism – ILP, DLP, TLP and RLP – Multi Threading – SMT and CMP Architectures – Limitations of Single Core Processors – The MultiCore era – Case Studies of Multi Core Architectures.		
Unit - II	**Memory Hierarchy Design:**	**9+3**
Introduction – Optimizations of Cache Performance – Memory Technology and Optimizations – Protection: Virtual Memory and Virtual Machines – Design of Memory Hierarchies – Case Studies.		
Unit - III	**Data-Level Parallelism in Vector, SIMD, and GPU Architectures :**	**9+3**
Introduction – Vector Architectures – SIMD Instruction Set Extensions for Multimedia – Graphics Processing Units – Detecting and Enhancing Loop Level Parallelism – Comparison of a GPU and a MIMD With Multimedia SIMD – Case Studies.		
Unit - IV	**TLP and Multiprocessors:**	**9+3**
Centralized Shared-Memory Architectures – Performance of Symmetric Shared-Memory Multiprocessors – Distributed Shared-Memory and Directory-Based Coherence – Synchronization basics – Models of Memory Consistency introduction – Inter Connection Networks – Buses, Crossbar and Multi-stage interconnection networks – Performance and Energy Efficiency of the Intel i7 920 Multicore.		
Unit - V	**RLP and DLP in Warehouse Scale Computers:**	**9+3**
Programming Models and Workloads for Warehouse scale Computers – Computer Architecture of Warehouse-Scale Computers – Domain Specific Architectures: Introduction – Guidelines for DSAs – Example Domain: Deep Neural Network – Google's Tensor Processing Unit, an interface Data Center Accelerator.		

Lecture: 45, Tutorial: 15, Total:60

REFERENCES:

1	John L. Hennessey and David A. Patterson, "Computer Architecture – A Quantitative Approach", 6th Edition, Morgan Kaufmann, Elsevier, 2019.
2.	Kai Hwang, "Advanced Computer Architecture", Tata McGraw-Hill Education, 2003.
3	Richard Y. Kain, "Advanced Computer Architecture: A Systems Design Approach", Prentice Hall, 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	investigate the limitations of ILP and the need for multi core architectures	Analyzing (K4)
CO2	analyse the importance of memory hierarchy and benefits of cache memory	Analyzing (K4)
CO3	explain the architecture of Vector/GPU processor and make use of loop level parallelism to achieve Data Level Parallelism	Applying (K3)
CO4	critically analyze cache coherence issues using different memory architectures and different types of inter connection networks	Analyzing (K4)
CO5	inspect the architectures of GPUs, Warehouse scale computers and Domain specific architecture	Analyzing (K4)

Mapping of COs with POs s						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	2			
CO2	3	3	2			
CO3	3	2	1			
CO4	3	3	2			
CO5	3	3	2			
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy						

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	30	20	20			100
CAT2	20	20	40	20			100
CAT3	20	40	40				100
ESE	10	30	30	30			100

*** ±3% may be varied**

20MST23 -SECURITY IN COMPUTING

Programme & Branch	M.E Computer Science and Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Computer Networks	**2**	**PC**	**3**	**1**	**0**	**4**

Preamble	Able to learn the basic concepts in computer security including software vulnerability analysis and defense, networking and wireless security, applied cryptography, as well as ethical, legal, social and economic facets of security.	
Unit - I	**Introduction to Mathematical Foundations of Cryptography:**	**9+3**
Integer arithmetic, Modular arithmetic, Congruence and Matrices - Algebraic Structures – Primes Chinese Remainder Theorem.		
Unit - II	**Symmetric Encryption Techniques and Key Management:**	**9+3**
Substitution Ciphers – Transposition Ciphers – Classical Ciphers – DES – AES – Modes of operation - Key Channel Establishment for symmetric Cryptosystems		
Unit - III	**Asymmetric Cryptosystems:**	**9+3**
The Diffie-Hellman Key Exchange Protocol - Discrete Logarithm Problem- - Public-key Cryptosystems: RSA Cryptosystem and cryptanalysis – rabin cryptosystem - ElGamal Cryptosystem -Need for Stronger Security notions for Public-key Cryptosystems. Combination of Asymmetric and Symmetric Cryptography. Key Channel Establishment for Public key Cryptosystems.		
Unit - IV	**Authentication:**	**9+3**
Authentication Protocols Principles – Authentication protocols for Internet Security – SSH Remote login protocol – Kerberos Protocol – SSL and TLS – Message Integrity-Message Authentication– Attacks on Digital Signature - Digital Signature Schemes.		
Unit - V	**Management and Incidents**:	**9+3**
Security planning - Incident response and business continuity planning - Risk analysis -Handling natural and human-caused disasters **Legal and Ethical issues in Security:** Protecting Programs and Data – Information and the Law – Rights of Employees and Employers – Software Failures – Computer Crime – Privacy – Ethical Issues in Computer Security.		

Lecture:45, Tutorial:15, Total:60

REFERENCES:

1	Mao W., “Modern Cryptography – Theory and Practice”, 1st Edition, Pearson Education, 2004.
2	Behrouz A.Forozan, - Cryptography and Network Security, Tata McGraw-Hill, Special Indian Edition,2007
3	Charles P. Pfleeger, Shari Lawrence Pfleeger, “Security in Computing”, 5th Edition, Prentice Hall, 2018. (V unit)

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply the mathematical foundations in security principles	Applying (K3)
CO2	Make use of symmetric encryption techniques for security problems	Applying (K3)
CO3	Employ different asymmetric encryption techniques for enhancing security	Applying (K3)
CO4	apply authentication protocols in the design of the secured applications	Applying (K3)
CO5	Analyse the legal and ethical issues of security and management	Analysing (K4)

Mapping of COs with POs s						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2		3		
CO2	3	2	1	1		
CO3	3	2	1	1		
CO4	3	2	1	1		
CO5	3	3	1			
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy						

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	20	70				100
CAT2	10	25	65				100
CAT3	10	25	30	35			100
ESE	10	20	50	20			100

*** ±3% may be varied**

20MST24 – DATA SCIENCE

Programme & Branch	M.E. & Computer Science and Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	**2**	**PC**	**3**	**0**	**0**	**3**

Preamble	This course provides a broad introduction to different ways that the data scientists learn from data, including statistical reasoning, mathematical model computation and communication.	
Unit - I	**Introduction:**	**9**
Data Science - Computer Science, Data Science, and Real Science – Properties of Data – Classification and Regression - Data Munging - Languages for Data Science - Collecting Data - Cleaning Data – Crowdsourcing		
Unit - II	**Scores and Rankings:**	**9**
The Body Mass Index (BMI) - Developing Scoring Systems - Z-scores and Normalization - Advanced Ranking Techniques - Arrow's Impossibility Theorem - Statistical Analysis - Statistical Distributions - Sampling from Distributions - Statistical Significance - Permutation Tests and P-values - Bayesian Reasoning		
Unit - III	**Visualizing Data:**	**9**
Exploratory Data Analysis - Developing a Visualization Aesthetic - Chart Types - Great Visualizations- Reading Graphs - Interactive Visualization.		
Unit - IV	**Mathematical Models:**	**9**
Philosophies of Modeling - A Taxonomy of Models - Baseline Models - Evaluating Models -Evaluation Environments - Linear Algebra - The Power of Linear Algebra - Visualizing Matrix Operations - Factoring Matrices - Eigenvalues and Eigenvectors - Eigenvalue Decomposition		
Unit - V	**Linear and Logistic Regression:**	**9**
Linear Regression - Better Regression Models - Regression as Parameter Fitting - Simplifying Models through Regularization - Classification and Logistic Regression - Issues in Logistic Classification - Distance and Network Methods - Measuring Distances - Nearest Neighbor Classification - Graphs, Networks, and Distances – PageRank – Clustering.		

Lecture: 45, Total: 45

REFERENCES:

1.	Steven S. Skiena, “The Data Science Design Manual”, 1st Edition, Springer, 2017.
2.	Igual, Laura, and Santi Seguí. “Introduction to Data Science.” Introduction to Data Science. Springer, Cham, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	make use of the concepts of data science and data munging for building applications	Applying (K3)
CO2	utilize statistical methods for solving problems	Applying (K3)
CO3	apply appropriate data visualization technique for communicating the result	Applying (K3)
CO4	experiment with mathematical model for data science applications	Applying (K3)
CO5	apply different the machine learning techniques available for solving the given problem and propose an optimized solution	Applying (K3)

Mapping of COs with POs s						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1				
CO2	3	2				
CO3	3	2	1	1		
CO4	3	1				
CO5	3	3	1	1		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy						

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	50	30				100
CAT2	20	20	60				100
CAT3	20	20	60				100
ESE	20	20	60				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MSL21-MACHINE LEARNING LABORATORY

Programme & Branch	M.E. & Computer Science and Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	2	PC	0	0	3	1
Preamble	To acquire knowledge on advanced databases like parallel and distributed database, object oriented database, active database, temporal database, spatial database, mobile database, multimedia database, XML database and cloud database to effectively store the data for real time applications.						

List of Exercises / Experiments:

1.	Implementation of linear regression
2.	Implementation of Decision tree
3.	Implementation of k-means clustering
4.	Implementation of k-NN
5.	Implementation of Backpropagation algorithm
6.	Comparison of linear regression and decision tree algorithm for the given dataset
7.	Comparison of kernel functions of Support Vector Machine for the given dataset

Practical: 30,Total: 30

REFERENCES/MANUAL/SOFTWARE:

1.	Lab manuals

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	implement various supervised algorithms and evaluate the performance	Analyzing (K4), Precision (S3)
CO2	implement the unsupervised algorithms and evaluate the performance	Analyzing (K4), Precision (S3)
CO3	implement and compare the performance of different algorithms	Analyzing (K4), Precision (S3)

Mapping of COs with POs s						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3		2			
CO2	3		2			
CO3	3		2			
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy						

20MSE01 – DATAMINING TECHNIQUES

Programme & Branch	M.E. & Computer Science and Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Database Management Systems	**1**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides students with an overview of the data mining process and techniques for preprocessing. It also make the students to gain knowledge of various data mining techniques and also prepare them for taking research in the area of data mining and its applications.	
Unit - I	**Introduction:**	**9**
Data Mining - Steps in Knowledge Discovery Process- Kinds of Data and Patterns – Technologies used-Targeted applications - Major issues in Data Mining - Data objects and attribute types - Statistical descriptions of data - Data Visualization- Measuring data similarity and dissimilarity.		
Unit - II	**Data Preprocessing:**	**9**
Data Cleaning, Integration, Reduction, Transformation and Discretization, Mining Frequent Patterns - Frequent Itemset Mining Methods.		
Unit - III	**Classification:**	**9**
Decision Tree Induction-Bayesian Classification - Rule based Classification - classification by Back Propagation – Support Vector Machines – Lazy Learners – Model Evaluation and Selection - Techniques to improve Classification Accuracy - k-Nearest Neighbor Classifier.		
Unit - IV	**Clusters Analysis:**	**9**
Partitioning Methods – Hierarchical Methods – Density based Methods - Grid based Methods - Evaluation of Clustering – Outliers and Outlier analysis - Outlier detection Methods - Statistical Approaches.		
Unit - V	**Applications:**	**9**
Mining Complex data types - Statistical Data Mining - Data Mining foundations - Visual and Audio Data Mining – Applications - Ubiquitous and invisible Data Mining - Social impacts of Data Mining.		

Lecture: 45, Total: 45

REFERENCES:

1.	Han Jiawei and Kamber Micheline, “Data Mining: Concepts and Techniques”, 3rd Edition, Morgan Kaufmann Publishers, 2012.
2.	Berson Alex, and Smith Stephen J., “Data Warehousing, Data Mining and OLAP”, 13th Reprint, Tata McGraw Hill, New Delhi, 2013.
3.	Gupta G.K., “Introduction to Data Mining with Case Studies”, 2nd Edition, Prentice Hall India, New Delhi, 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	describe the different data mining techniques and identify different types of data	Applying (K3)
CO2	apply data preprocessing and frequent itemset mining methods for the given problem	Applying (K3)
CO3	summarize the characteristics of classification methods and use them for solving a problem	Applying (K3)
CO4	summarize and demonstrate the working of different clustering and outlier methods	Applying (K3)
CO5	apply data mining concepts in various applications	Applying (K3)

Mapping of COs with POs s						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3			2		1
CO2	3		2			1
CO3	3			2		1
CO4			3			2
CO5			3			2
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy						

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	35	40				100
CAT2	15	25	60				100
CAT3	20	30	50				100
ESE	10	30	60				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MSE02 – BUSINESS INTELLIGENCE

Programme & Branch	M.E. & Computer Science and Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Database , SQL Queries	**1**	**PE**	**3**	**0**	**0**	**3**

Preamble	Improved application development and high scale deployment.	
Unit - I	**Introduction to Business Intelligence:**	**9**
Introduction to Digital Data and its Types – Structured, Semi-structured and Unstructured Data - Introduction to OLTP and OLAP – Architectures – Data Models – Role of OLAP in BI – OLAP Operations – Business Intelligence - BI Definition and Evolution – BI Concepts - BI Component Framework – BI Process, Users, Applications – BI Roles – BI Best Practices– Popular BI Tools.		
Unit - II	**Data Integration:**	**9**
Need for Data Warehouse – Definition of Data Warehouse – Data Mart – Ralph Kimball's Approach vs. W.H.Inmon's Approach – Goals of Data Warehouse – ETL Process – Data Integration Technologies – Data Quality – Data Profiling – Case Study from Healthcare domain – Kettle Software: Introduction to ETL using Pentaho Data Integration.		
Unit - III	**Multidimensional Data Modeling:**	**9**
Basics of Data Modeling – Types of Data Model – Data Modeling Techniques – Fact Table – Dimension Table – Dimensional Models- Dimensional Modeling Life Cycle – Designing the Dimensional Model - Measures, Metrics, KPIs and Performance Management – Understanding Measures and Performance – Measurement System - Role of metrics – KPIS - Analyze Data using MS Excel 2010.		
Unit - IV	**Basics of Enterprise Reporting:**	**9**
Reporting Perspectives - Report Standardization and Presentation Practices– Enterprise Reporting Characteristics - Balanced Scorecard - Dashboards - Creating Dashboards- Scorecards Vs Dashboards - Analysis - Enterprise Reporting using MS Access / MS Excel.		
Unit - V	**BI Applications and Case Studies:**	**9**
Understanding Business Intelligence and Mobility – Business Intelligence and Cloud Computing – Business Intelligence for ERP Systems – Social CRM and Business Intelligence - Case Studies : Good Life HealthCare Group, Good Food Restaurants Inc., Ten To Ten Retail Stores.		

Lecture: 45, Total: 45

REFERENCES:

1.	Prasad N., Seema Acharya, "Fundamentals of Business Analytics", 2nd Edition, Wiley-India Publication, 2016.
2.	Efraim Turban, Ramesh Sharda, Dursun Delen, David King, "Business Intelligence: A Managerial Approach", 2nd Edition, Pearson Education, 2014.
3.	David Loshin, "Business Intelligence", 5th Edition, Morgan Kaufmann Publishers, San Francisco, 2007.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply the key elements of data warehouse and business intelligence in BI tools	Applying (K3)
CO2	apply the concepts and technology of BI space in any domain	Applying (K3)
CO3	explain about analysis, integration and reporting services and apply for an application	Applying (K3)
CO4	summarize the functionalities of key performance indicators and make use in an application	Applying (K3)
CO5	apply BI to mobile, cloud, ERP and social CRM systems	Applying (K3)

Mapping of COs with POs s						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	1			
CO2	2	3	1	2		
CO3	3	2	2	2		
CO4	3	2	2	2		
CO5			1	3		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy						

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	40	40				100
CAT2	20	40	40				100
CAT3	10	40	50				100
ESE	15	40	45				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MSE03 – CLOUD COMPUTING

Programme & Branch	M.E. & Computer Science and Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	PE	3	0	0	3

Preamble	This course gives the idea of evolution of cloud computing and its services available today, which may led to the design and development of simple cloud service. It also focuses on key challenges and issues around cloud computing.	
Unit - I	**Cloud Computing Basics:**	**9**
Defining Cloud computing – Cloud Types - Characteristics of Cloud computing- Cloud Architecture - Cloud Computing Stack - Infrastructure as a service- Platform as a Service - Software as a Service – Identity as a Service - Compliance as a Service.		
Unit - II	**Platforms and Virtualization:**	**9**
Abstraction and Virtualization – Load Balancing and Virtualization – Hypervisors – Machine Imaging – Porting Applications – Capacity Planning		
Unit - III	**Managing and Securing the Cloud:**	**9**
Administrating the cloud – Cloud Management Products – Cloud Management Standards - Securing the cloud – Securing Data – Establishing Identity and Presence.		
Unit - IV	**Cloud Based Storage:**	**9**
Digital Universe- Provisioning Cloud Storage – Cloud Backup Solutions – Cloud Storage Interoperability. Mobile Cloud: Mobile Market – Smartphones with the cloud – Mobile web services – Service types – Service Discovery.		
Unit - V	**Cloud based services and Tools:**	**9**
Openstack – Overview of services - Conceptual architecture - Controller - Compute - Block Storage - Object Storage – Networking - Environment – Security - Identity service - Image service - Installation - Google Web Services- Amazon Web Services- Microsoft Cloud Services.		

Lecture: 45, Total: 45

REFERENCES:

1.	Barrie Sosinsky, “Cloud Computing Bible”, 1st Edition, Wiley Publishing, 2015.
2.	Kai Hwang, Geoffrey C. Fox, Jack G. Dongarra, “Distributed and Cloud Computing, From Parallel Processing to the Internet of Things”, 1st Edition, Morgan Kaufmann Publishers, 2012.
3.	www.openstack.org

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	describe the main concepts, key technologies, strengths and limitations of cloud computing and apply the same for internet computing	Applying (K3)
CO2	outline the underlying principle of abstraction, virtualization, load balancing, capacity planning and apply in virtual resource management	Applying (K3)
CO3	identify the core issues in cloud security and apply remedial measures	Applying (K3)
CO4	Analyze the various interoperability and storage issues in modern cloud platforms	Analyze (K4)
CO5	Examine and use appropriate open stack components to set up a private cloud environment and explore cloud based services	Analyze (K4)

Mapping of COs with POs s						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3					
CO2	3	1		1		
CO3	3	2				
CO4	3	2				
CO5	3	2	2	2		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy						

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	70	20				100
CAT2	10	70	20				100
CAT3	10	60	15	15			100
ESE	10	45	30	15			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MSE04 – COMPILER DESIGN TECHNIQUES

Programme & Branch	M.E.- Computer Science and Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Programming Languages	**1**	**PE**	**2**	**0**	**2**	**3**

Preamble	The course is intended to make the students learn the basic techniques that underlie the practice of Compiler Construction and to introduce the theory and tools that can be used to perform syntax-directed translation of a high-level programming language into an executable code with optimization techniques.	
Unit - I	**Introduction:**	**6**
Language Processors - Structure of a compiler – Evolution of Programming Languages- Applications of Compiler Technology – Programming Language Basics - The Lexical Analyzer Generator -Parser Generator- Compiler Tools: Lex and YACC. Intermediate Code Generation techniques: Variants of Syntax trees-Three Address Code.		
Unit - II	**Optimization:**	**6**
Introduction - Early Optimizations: Constant-Expression Evaluation - Scalar Replacement of Aggregates-Algebraic Simplifications and Reassociation -Value Numbering - Copy Propagation-Sparse Conditional Constant Propagation. Redundancy Elimination: Common Subexpression Elimination - Invariant Code Motion- Partial-Redundancy Elimination- Redundancy Elimination and Reassociation- Code Hoisting. Loop Optimizations: Induction Variable Optimizations - Unnecessary Bounds Checking Elimination.		
Unit - III	**Instruction Level Parallelism:**	**6**
Processor Architectures **-** Code-Scheduling Constraints - Basic-Block Scheduling -Global Code Scheduling -Software Pipelining.		
Unit - IV	**Optimizing for Parallelism and Locality:**	**6**
Basic Concepts**-** Matrix-Multiply-An Example - Iteration Spaces - Affine Array Indexes - Data Reuse -Array data dependence Analysis**-** Finding Synchronization - Free Parallelism- Pipelining.		
Unit - V	**Interprocedural Analysis and Register Allocation:**	**6**
Basic Concepts – Need for Inter procedural Analysis – A Logical Representation of Data Flow – A Simple Pointer-Analysis Algorithm. Register Allocation: Register allocation and Assignment-Local Methods-Graph Coloring.		
List of Exercises / Experiments :		
1	Develop a lexical analyser to recognize a few patterns in c (ex. Identifers, constants, comments, operators etc.)	
2	Implementation of Scanner using LEX	
3	Implementation of Predictive Parser	
4	Implementation of bottom up parser	
5	Generation of Intermediate code for the given source code	
6	Implement type checking	
7	Implement control flow analysis and data flow analysis.	
8	Convert the BNF rules into YACC form and write code to generate abstract syntax tree.	
9	Use optimization techniques and analyse the best optimization technique for given code.	
10	Write program to generate assembly code from the abstract syntax tree generated by the parser	

Lecture:30, Practical:30, Total:60

REFERENCES:

1	Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffrey D. Ullman, “Compilers: Principles, Techniques and Tools”, 2nd Edition, Pearson Education, 2013.
2	Steven S. Muchnick, “Advanced Compiler Design Implementation”, 1st Edition, Morgan Kaufman Publishers, Elsevier Science, India, 2008.
3	Richard Y. Kain, “Advanced Computer Architecture: A Systems Design Approach”, 1st Edition, Prentice Hall, 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	describe different phases of compiler and design a simple scanner and parser by using its pattern	Applying (K3)
CO2	survey various code optimization techniques to improve the performance of a program in terms of speed and space	Analyzing (K4)
CO3	demonstrate the architectural design of the system for compilation	Applying (K3)
CO4	apply optimization techniques to optimize programs in real time	Applying (K3)
CO5	optimize functions and demonstrate how to store data and access from registers	Analyzing (K4)
CO6	apply the knowledge of LEX tool and YACC tool to design a simple lexical analyser and parser	Applying (K3), Precision (S3)
CO7	examine the optimization technique available for the given code and provide the optimized code.	Analyzing (K4), Precision (S3)
CO8	analyze modern programming languages and write programs for generating target language	Analyzing (K4), Precision (S3)

Mapping of COs with POs s						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	1			
CO2	3	3	1			
CO3	3	1				
CO4	3	2	1			
CO5	3	1				
CO6	3		2	2		
CO7	3	2	1	1		
CO8	3	2	1	1		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy						

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	40	50				100
CAT2		35	40	25			100
CAT3		30	40	30			100
ESE	10	25	40	25			100

*** +3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MSE05 – BLOCKCHAIN TECHNOLOGIES

Programme & Branch	M.E. & Computer Science and Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Basics of Cryptography and Distributed systems	**2**	**PE**	**3**	**0**	**0**	**3**

Preamble	The widespread popularity of digital cryptocurrencies has led the foundation of Blockchain. This course covers both the conceptual as well as application aspects of Blockchain. This includes the fundamental design and architectural primitives of Blockchain, the system and the security aspects, along with various use cases from different application domains.	
Unit - I	**Introduction to Blockchain:**	**9**
Financial transaction – Ledger – trustless system – Elements of blockchain – types – Byzantine General Problems – benefits – challenges – Components and structure of blockchain: blocks – chain – hashing – digital signatures – example – miners – validators – smart contracts - speed – decentralization Vs distributed systems.		
Unit - II	**Cryptography behind Blockchain:**	**9**
Principles – historical perspectives – classical cryptography- types – symmetric – asymmetric – signatures – hashing. **Bitcoin:** History – Why bitcoin – keys and addresses – transactions – blocks – bitcoin network – wallets.		
Unit - III	**Consensus:**	**9**
Practical Byzantine fault tolerance algorithm – Proof of Work - Proof of Stake - Proof of Authority - Proof of Elapsed time Cryptocurrency Wallets: Introduction to cryptocurrency wallets - Transactions - Types of cryptocurrency wallets – Tenancy - Alternate Blockchains.		
Unit - IV	**Hyperledger and Enterprise Blockchains:**	**9**
History - Hyperledger projects - Hyperledger Burrow - Hyperledger Sawtooth - Hyperledger Fabric - Hyperledger Iroha - Hyperledger Indy - Tools in Hyperledger – Deploy a simple application on IBM cloud.		
Unit - V	**Ethereum:**	**9**
Introducing Ethereum - Components of Ethereum - Ethereum accounts - Ethereum network - Ethereum clients - Ethereum gas - Ethereum virtual machine - Ethereum block – Ether - Basics of Solidity - Ethereum Development.		

Lecture: 45, Total: 45

REFERENCES:

1. Brenn Hill, Samanyu Chopra, Paul Valencourt, “Blockchain Quick Reference: A guide to exploring decentralized blockchain application development”, 1st Edition, Packt Publishing, 2018.
2. Andreas Antonopoulos, “Mastering Bitcoin: Programming the open blockchain”, 2nd Edition, O’Reilly Media, 2017.
3. Melanie Swan, “Blockchain: Blueprint for a New Economy”, 1st Edition, O’Reilly Media, 2015.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	Illustrate the workings of blockchain	Applying (K3)
CO2	Apply various cryptographic algorithms in blockchain	Applying (K3)
CO3	Demonstrate different cryptocurrency used in blockchain	Applying (K3)
CO4	deploy a simple application using Hyperledger on IBM cloud	Applying (K3)
CO5	develop and analyze a distributed application using Ethereum and Solidity	Applying (K3)

Mapping of COs with POs s						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1		1		
CO2	3	2		2		
CO3	3	2		2		
CO4	3	2	1	3		
CO5	3	3	2	3		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy						

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	40	50				100
CAT2	10	40	50				100
CAT3	10	40	50				100
ESE	10	40	50				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MSE06 – INTERNET OF THINGS

Programme & Branch	M.E.- Computer Science and Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Microprocessors/Microcontrollers/Computer Organization/Networks	2	PE	2	0	2	3

Preamble	This course provides a thorough understanding of IoT and its applications. It enables to design, develop and analyze the various tools for building IoT applications and also to develop IoT infrastructure for various real time applications.	
Unit - I	**Introduction to Internet of Things and Design Methodology:**	**6**
Definition and Characteristics of IoT - Physical Design of IoT - IoT Protocols - IoT Communication Models - IoT Communication APIs - IoT enabled Technologies - IoT Levels and Templates - M2M - Difference between M2M and IoT - Software defined networks - Network function virtualization - IoT Platform design Methodologies.		
Unit - II	**IoT Architecture and Protocols:**	**6**
Four Pillars of IoT - DNA of IoT - Middleware for IoT: Overview - Communication middleware for IoT - LBS and Surveillance Middleware - Protocol Standardization for IoT - Efforts - M2M and WSN Protocols - SCADA and RFID Protocols - Unified Data Standards.		
Unit - III	**Introduction to Python and IoT Physical Devices:**	**6**
Language features of Python - Data types - Data structures - Control of flow – Functions – Modules – Package - File handling – Date/time operations – Classes - Exception handling Python packages - JSON, XML, HTTPLib, URLLib, SMTPLib - Introduction to Raspberry PI - Interfaces (serial, SPI, I2C)Programming - Python program with Raspberry PI with focus of interfacing external gadgets - Controlling output - Reading input from pins.		
Unit - IV	**Cloud Storage and Analysis:**	**6**
Various Real time applications of IoT - Connecting IoT to cloud - Cloud Storage for IoT - Data Analytics for IoT - Software and Management Tools for IoT.		
Unit - V	**IoT Privacy, Security and Vulnerabilities Solutions :**	**6**
Introduction-Vulnerabilities Of IoT - Security Requirements -Threat Analysis-Use Cases And Misuse Cases-IoT Security Tomography -Layered Attacker Model-Identity Management And Establishment-Access Control - Secure Message Communication-Security Models -Protocols For IoT.		
List of Exercises / Experiments :		
1	Creating an IoT scenario in Cooja Simulator	
2	Sending data between an IoT client and server in Cooja Simulator	
3	Launching an attack in RPL protocol in Cooja Simulator	
4	Controlling things using Raspberry Pi via webpage	
5	Controlling things using Raspberry Pi via mobile app	
6	Data communication using MQTT Protocol via Mosquitto simulator	
7	Configure MQTT Mosquitto Server to secure MQTT	
8	Sensing and Sending the sensor value via JSON/SMTP	
9	Gather, Visualize and analyze the data in BLUEMIX	
10	Carry out decision making with IOT data in Xively Cloud (Google Cloud)	

Lecture:30, Practical:30, Total:60

REFERENCES:

1	ArshdeepBahga and Vijay Madisetti, “Internet of Things - A Hands-on Approach”, Universities Press, 2015.
2	Honbo Zhou, “The Internet of Things in the Cloud: A Middleware Perspective”, 1st Edition, CRC Press, 2012.
3	Raj Kamal, “Internet of Things: Architecture and Design Principles”, McGraw Hill , 2017 (unit 5)

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	describe the physical and logical design of IoT and point out an appropriate IoT level and develop design methodologies for a given application	Analyzing (K4)
CO2	analyze the suitable protocol and middleware for the given application	Analyzing (K4)
CO3	carry out the given IoT experiment by recalling the basic concepts and packages of Python for interfacing with devices	Applying (K3)
CO4	develop simple real time applications, upload the data onto the cloud and perform data analytics	Applying (K3)
CO5	identify the security threats against a given IoT system and develop countermeasures for the identified threats	Applying (K3)
CO6	develop IoT applications using Cooja Simulator and Raspberry Pi	Applying (K3), Precision (S3)
CO7	design an IoT application that communicate to server via application layer protocols	Applying (K3), Precision (S3)
CO8	analyse IoT data stored in cloud	Applying (K3), Precision (S3)

Mapping of COs with POs s						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	1	1		
CO2	3	3	1			
CO3	3	2	2	2		
CO4	3	2	2	2		
CO5	3	1	1			
CO6	3	1	2	2		
CO7	3	1	2	2		
CO8	3	2	2	2		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy						

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	10	60	20			100
CAT2	10	10	70	10			100
CAT3	10	20	70				100
ESE	10	20	50	20			100

*** +3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MSE07 – BIG DATA ANALYTICS

Programme & Branch	M.E. & Computer Science and Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Database Management Systems	2	PE	3	0	0	3

Preamble	This course provides basic knowledge about Big data, its framework, storage in databases and stream processing.	
Unit - I	**Big data :**	**9**
Introduction - Types of Digital Data – characteristics – evolution – definition – challenges – Big Data – Big Data Analytics – importance – data science – terminologies used in Big Data environments – Analytics Tools.		
Unit - II	**MapReduce Framework:**	**9**
Introducing Hadoop – Starting Hadoop – Components of Hadoop: Working with files in HDFS - Anatomy of a MapReduce program – Reading and writing - Writing basic MapReduce programs: Getting the patent data set-Constructing the basic template of a MapReduce program-Counting things-Adapting for Hadoop's API changes- Improving performance with combiners – Hadoop Ecosystem.		
Unit - III	**Advanced MapReduce:**	**9**
Chaining MapReduce Jobs - Joining data from different sources -Creating a Bloom filter. Programming Practices: Developing MapReduce programs- Monitoring and debugging on a production cluster- Tuning for performance.		
Unit - IV	**NoSQL Database Systems:**	**9**
Introduction to NoSQL – CAP theorem - MongoDB : Data types – MongoDB Query Language – Cassandra: Features of Cassandra- Data types – CRUD- Collections Alter Commands – Import and Export- Querying system tables.		
Unit - V	**Mining Data Streams:**	**9**
Stream Data Model - Sampling Data in a Stream–Filtering Streams–Counting Distinct Elements in a Stream–Estimating Moments–Counting Ones in a Window–Decaying Window - Stream processing with SPARK and Kafka.		

Lecture: 45, Total: 45

REFERENCES:

1.	Seema Acharya and Subhashini Chellappan, "Big Data and Analytics", 2nd Edition, Wiley, 2019.
2.	Chuck Lam, "Hadoop in Action", 2nd Edition, Manning Publications, 2011.
3.	Anand Rajaraman and Jeffrey David Ullman, "Mining of Massive Datasets", 3rd Edition, Cambridge University Press, 2020.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	identify the various types of data and challenges in the Big data.	Applying (K3)
CO2	develop simple programs using Hadoop framework	Applying (K3)
CO3	explore advanced MapReduce data processing	Applying (K4)
CO4	implement NoSQL database system for real world problems	Analyzing (K4)
CO5	adapt the stream processing techniques such as Spark and Kafka for the given problem.	Applying (K3)

Mapping of COs with POs s						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2				
CO2	3	2	2	2		
CO3	3	2	2	2		
CO4	3	1				
CO5	3	2	2	2		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy						

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	50				100
CAT2	20	20	60				100
CAT3	20	20	40	20			100
ESE	20	20	40	20			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MSE08– MODERN INFORMATION RETRIEVAL TECHNIQUES

Programme & Branch	M.E. & Computer Science and Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	2	PE	3	0	0	3

Preamble	This course discusses about the basic concepts of IR, and various modeling techniques with different ways of indexing and searching mechanisms to build a text or multimedia based IR system.	
Unit - I	**Introduction and Classic IR Models:**	**9**
Information Retrieval - The IR Problem - The IR System - Search Interfaces Today - Visualization in Search Interfaces - Modeling – Boolean Model – Term Weighting – TF-IDF Weighting – Vector Model – Set Theoretic Models – Algeraic Models – Latent Semantic Indexing Model – Neural Network Model - Probabilistic Models - Retrieval Evaluation – Retrieval Metrics.		
Unit - II	**Relevance Feedback, Languages and Query Properties:**	**9**
A Framework for feedback methods - Explicit Relevance feedback - Implicit feedback through local analysis - Global analysis - Documents: Metadata - Documents formats - Queries - Query Language – Query Properties.		
Unit - III	**Text Operations, Indexing and Searching:**	**9**
Text Properties - Document Preprocessing - Text Compression – Text Classification – Characterization of Text Classification – Unsupervised Algorithms – Supervised Algorithms – Decision Tree – K-NN Classifier – SVM Classifier – Feature Selection or Dimensionality Reduction – Evaluation Metrics – Accuracy and Error – Indexing and Searching – Inverted Indexes – Sequential Searching – Multidimensional Indexing.		
Unit - IV	**Web Retrieval and Web Crawling:**	**9**
The Web – Search Engine Architectures – Cluster Based Architecture – Distributed Architectures – Search Engine Ranking – User Interaction –Browsing – Web Crawling – Applications of a Web Crawler – Taxonomy – Architecture and Implementation – Scheduling Algorithms – Evaluation.		
Unit - V	**Applications:**	**9**
Enterprise Search - Tasks - Architecture – Library Systems – Online Public Access Catalogues – IR System and Document Databases – Digital Libraries – Architecture and Fundamentals.		

Lecture: 45, Total: 45

REFERENCES:

1. Ricardo Baeza-Yate, Berthier Ribeiro-Neto, “Modern Information Retrieval the concepts and technology behind search”, 2nd Edition, Pearson Education, Asia, 2011.
2. Chowdhury G.G., “Introduction to Modern Information Retrieval”, 2nd Edition, Neal-Schuman Publishers, 2003.
3. Daniel Jurafsky and James H. Martin, “Speech and Language Processing”, 1st Edition, Pearson Education, 2000.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	describe the basic concepts of information retrieval and apply term weighting strategy in various models	Applying (K3)
CO2	Carry out relevance feedback and describe query properties	Applying (K3)
CO3	Apply statistical methods to perform text operations, indexing and searching	Applying (K3)
CO4	Describe web retrieval process and make use of web crawler for information retrieval	Applying (K3)
CO5	apply IR techniques in digital library	Applying (K3)

Mapping of COs with POs s						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2				
CO2	3	2		2		
CO3	3	2	1	2		
CO4	3	2	1			
CO5	3	2		2		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy						

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	40	40				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MSE09 – INFORMATION STORAGE MANAGEMENT

Programme & Branch	M.E. & Computer Science and Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Computer Networks and Database Management Systems	2	PE	3	0	0	3

Preamble	This course offers essential details about various storage systems, storage networking technologies and business continuity solutions along with management techniques in order to store, manage, and protect digital information in classic, virtualized, and cloud environments	
Unit - I	**Storage Systems:**	**9**
Introduction - evolution of storage architecture, key characteristics of data center - virtualization, and cloud computing. Data center environment: Host (or computer), connectivity, storage, and access to data, direct attached storage, storage design based on application requirements and disk performance - VMware ESXi. Data Protection: RAID implementations, techniques, levels, impact of RAID on disk performance. Intelligent Storage System: Components, storage provisioning, types and intelligent storage implementations.		
Unit - II	**Storage Networking Technologies:**	**9**
Fibre channel SAN components – FC SAN connectivity – FC protocol stack – FC addressing – zoning – FC SAN topologies – virtualization in SAN. iSCSI – FCIP – FCoE – Network Attached Storage (NAS): components, I/O operation, file sharing protocols, file level virtualization. Object based storage platform – unified storage platform.		
Unit - III	**Backup, Archive and Replication:**	**9**
Business continuity terminologies – BC planning life cycle – failure analysis – BC technology solutions – Backup and archive: purpose, methods, architecture, operations, topologies, targets, data deduplication, backup in virtualized environment and data archive. Local replication in classic and virtual environments – Remote replication in classic and virtual environment.		
Unit - IV	**Cloud Computing:**	**9**
Cloud enabling technologies – characteristics of cloud computing – benefits of cloud computing – cloud service models – cloud deployment models: public cloud, private cloud, community cloud, hybrid cloud. cloud computing infrastructure: physical infrastructure, virtual infrastructure, applications and platform software, cloud management and service creation tools. cloud challenges – cloud adoption considerations.		
Unit - V	**Securing and Managing Storage Infrastructure:**	**9**
Information security framework – risk triad – storage security domains – security implementations in storage networking: FC SAN, NAS, IP SAN – Securing storage infrastructure in virtualized and cloud environments – monitoring the storage infrastructure – storage infrastructure management activities – storage infrastructure management challenges – developing an ideal solution – Information lifecycle management (ILM) – storage tiering.		

Lecture: 45, Total: 45

REFERENCES:

1. EMC Corporation, “Information Storage and Management”, 2nd Edition, Wiley, 2012.
2. Robert Spalding, “Storage Networks: The Complete Reference”, Tata McGraw Hill, Osborne, 2003.
3. Marc Farley, “Building Storage Networks”, 2nd Edition, Tata McGraw Hill, Osborne, 2001.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	demonstrate the various storage systems and RAID implementations	Applying (K3)
CO2	identify various storage networking technologies and its components	Applying (K3)
CO3	apply business continuity solutions – backup and replication, and archive for managing fixed content	Applying (K3)
CO4	make use of cloud computing concepts for information storage	Applying (K3)
CO5	use the storage security framework and practice storage monitoring and management activities	Applying (K3)

Mapping of COs with POs s						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1				
CO2	3	3	1			
CO3	2	3				
CO4	3	2		1		
CO5	2	1				
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy						

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	60	20				100
CAT2	20	60	20				100
CAT3	20	60	20				100
ESE	20	60	20				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MSE10– RANDOMIZED ALGORITHMS

Programme & Branch	M.E. & Computer Science and Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Design and Analysis of Algorithms, Data Structures and Algorithms	2	PE	3	0	0	3

Preamble	In this course, the probability tools required to design and analyze a randomized algorithm are studied. The emphasis will be on strengthening the analytical skills of the student so that he can independently design or analyze a randomized algorithm.	
Unit - I		**9**
Min-Cut Algorithm, Binary Planar Partitions, **Game-theoretic techniques:** Game Tree Evaluation, The Minimax principle, Randomness and Non-uniformity. **Moments and deviations:** Occupancy Problems, Markov and Chebyshev Inequalities, Randomized Selection, Two-point Sampling, Stable Marriage Problem and Coupon Collector's Problem.		
Unit - II		**9**
Tail Inequalities: Chernoff Bound, Routing in a parallel Computer, A wiring Problem, Martingales. **The probabilistic method:** Overview, Maximum Satisfiability, Expanding Graphs, Lovasz Local Lemma and Method of Conditional Probabilities.		
Unit - III		**9**
Markov Chains and Random Walks: A 2-SAT Example, Markov Chains, Random Walks on Graphs, Electrical Networks, Cover Times, Graph Connectivity, Expanders and Rapidly Mixing Random Walks. **Algebraic techniques:** Fingerprinting and Freivalds Technique, verifying polynomial identities, perfect matchings in graphs, verifying equality of strings, pattern matching, Interactive proof systems.		
Unit - IV		**9**
Data Structures: Fundamental Data-structuring problem, Random Treaps, Skip Lists, Hash Tables and Hashing. **Graph algorithms:** All-pairs Shortest Paths, Min-cut Problem, Minimum Spanning Trees.		
Unit - V		**9**
Approximate Counting: Randomized Approximation Schemes, DNF Counting Problem, Volume Estimation. **Parallel and distributed algorithms:** PRAM model and its sorting, Maximal Independent Sets, Perfect Matching, Choice Coordination Problem, Byzantine Agreement.		

Lecture: 45, Total: 45

REFERENCES:

1.	Rajeev Motwani and Prabhakar Raghavan, "Randomized Algorithms", 1st Edition, Cambridge University Press, Reprint 2010.
2.	Michael Mitzenmacher and Eli Upfal, "Probability and Computing: Randomized Algorithms and Probabilistic Analysis", Cambridge University Press, 2005.
3.	Grimmett and Stirzaker, "Probability and Random Processes", Oxford, 2001.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply the basic concepts in the design and analysis of randomized algorithms	Applying (K3)
CO2	develop tail inequalities and different probability that are frequently used in algorithmic application	Applying (K3)
CO3	determine the use of Markov chains and Random walks in the different practical applications	Applying (K3)
CO4	discover the applications of data structures and graph algorithms	Analyzing (K4)
CO5	examine the different appropriate counting schemes and parallel and distributed algorithms for various applications	Analyzing (K4)

Mapping of COs with POs s						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1				
CO2	3	2	1			
CO3	3	2	1			
CO4	3	3	2			
CO5	3	3	2			
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy						

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	20	70				100
CAT2		20	60	20			100
CAT3		10	40	50			100
ESE		20	50	30			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MSE11 – SOCIAL NETWORK ANALYSIS

Programme & Branch	M.E. & Computer Science and Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	2	PE	3	0	0	3

Preamble	This course studies the properties of graph with its application in social network analysis. It also explores some of the surprising and beautiful discoveries achieved with Social Network Analysis and its applications.	
Unit - I	**Graph Theory and Social Networks:**	**9**
Graphs: Basic Definitions- Paths and Connectivity- Distance and Breadth First Search-Network Dataset: An overview. Strong and Weak Ties: Triadic Closure- The Strength of Weak Ties- Tie Strength and Network Structure in Large Scale Data- Tie Strength, Social Media, and Passive Engagement- Closure, Structural Holes, and Social Capital. Networks in their Surrounding Contexts: Homophily – Mechanism Underlying Homophily - Selection and Social Influence- Affiliation. Positive and Negative Relationships: Structural Balance- Characterizing the Structure of Balanced Networks – Application of Structural Balance – A Weaker Form of Structural Balance		
Unit - II	**Game Theory and Interaction in Networks:**	**9**
Games: What is Game?- Reasoning about Behavior in Game- Best Responses and Dominant Strategies- Nash Equilibrium- Multiple Equilibria- Coordination Games, The Hawk-Dove Game-Mixed Strategies-Examples and Empirical Analysis- Pareto Optimality and Social Optimality. Evolutionary Game Theory: Fitness as a Result of interaction- Evolutionarily Stable Strategies- A General Description of Evolutionarily Stable Strategies- Relationship between Evolutionarily and Nash Equilibria- Evolutionarily Stable Mixed Strategies. Modeling Network Traffic using Game Theory: Traffic at Equilibrium- Braess's Paradox. Matching Markets: Bipartite Graphs and Perfect Matchings -Valuations and Optimal Assignments.		
Unit - III	**Information Networks and the World Wide Web:**	**9**
The Structure of the Web: The World Wide Web- Information Networks, Hypertext, and Associative Memory- The Web as a Directed Graph- The Bow-Tie Structure of the Web. Link Analysis and Web Search: Searching the Web: The problem of Ranking-Link Analysis using Hubs and Authorities- Page Rank- Applying Link Analysis in Modern Web Search.		
Unit - IV	**Network Dynamics - Population Models:**	**9**
Information Cascades: Following the Crowd- A Simple Herding Experiment- Bayes Rule: A model of Decision Making-Making under Uncertainty- Baye's Rule in the Herding Experiment- A Simple, General Cascade Model- Sequential Decision Making and Cascades. Network Effects: The Economy Without Network Effects- The Economy with Network Effects- Stability, Instability and Tipping Points- A Dynamic View of the Market- Industries with Network Goods- Mixing Individual Effects with Population-Level Effects. Power Laws and Rich-Get-Richer Phenomena: Popularity as Network Phenomenon-Power Laws- Rich-Get-Richer Models-The Unpredictability of Rich-Get-Richer Model-The Long Tail-The Effect of Search Tools and Recommendation Systems.		
Unit - V	**Network Dynamics – Structural Models:**	**9**
Cascading Behavior in Networks: Diffusion in Network-Modeling diffusion through a Network- Cascades and Clusters- Diffusion, Thresholds, and the Role of Weak Ties- Extensions of the Basic Cascade Model- Knowledge, Thresholds and Collective Action. The Small-World Phenomenon: Six Degrees of Separation- Structure and Randomness- Decentralized Search- Modeling the process of Decentralized Search- Empirical Analysis and Generalized Models- Core Periphery Structures and Difficulties in Decentralized Search. Epidemics: Diseases and the Networks that transmit them-Branching Processes- The SIR Epidemic Model-The SIS Epidemic Model- Synchronization- Transient Contacts and the Danger of Concurrency.		

Lecture: 45, Total: 45

REFERENCES:

1. David Easley, Jon Klienberg, "Networks, Crowds, and Markets: Reasoning about a Highly Connected World", Cambridge University Press, 2010.
2. Stanley Wasserman, Katherine Faust, "Social Networks Analysis: Methods and Applications", Cambridge University Press, 2010.
3. Charles Kadushin, "Understanding Social Networks: Theories, Concepts, and Findings", Oxford University Press, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply the concepts of graph theory for analysis of social networks distribution	Applying (K3)
CO2	utilize game theory for decision making in the context of social networking	Applying (K3)
CO3	employ different link analysis and web search techniques for solving the given problem	Applying (K3)
CO4	analyze network behavior based on population model	Analyzing (K4)
CO5	demonstrate the aggregate behavior of the social networks based on structural model	Applying (K3)

Mapping of COs with POs s						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	1			
CO2	3	2	1			
CO3	3	1	2			
CO4	3	3	2			
CO5	3	2	1			
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy						

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	30	60				100
CAT2	10	15	50	25			100
CAT3	10	20	50	20			100
ESE	10	15	65	10			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MSE12 – DEEP LEARNING TECHNIQUES

Programme & Branch	M.E. & Computer Science and Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Fundamental concepts of Algorithms and computer programming	2	PE	2	0	2	3

Preamble	This course explores the fundamentals concepts in the design of deep neural networks and its various architectures. It also explores different dimensions of deep learning applications.	
Unit - I	**Foundations of Deep Learning:**	**9**
Introduction – Math behind machine learning – Linear Algebra – Statistics –Machine Learning works – Logistic regression – Evaluating Models – Neural Networks – Training Neural Networks – Activation functions – Loss functions – Hyperparameters.		
Unit - II	**Architectural Design:**	**9**
Defining Deep Learning – Common Architectural Principles of Deep Networks: Parameters – Layers - Activation functions - Loss functions - Optimization Algorithms – Hyperparameters. Building blocks of Deep Networks: RBMS - Autoencoders - Variational Autoencoders.		
Unit - III	**Types of Deep Networks**:	**9**
Unsupervised pretrained Networks – Convolutional Neural Networks (CNNs) – Recurrent Neural Networks – Recursive Neural Networks – Applications.		
Unit - IV	**CNN and RNN:**	**9**
Convolutional Neural Networks: Applying Pooling layers – Optimizing with Batch Normalization – Understanding padding and strides – Experimenting with Different types of initialization – Implementing a convolutional autoencoder – Applying a 1D CNN to text. **Recurrent Neural Networks**: Implementing a simple RNN – Adding LSTM – Using GRUs – Implementing Bidirectional RNNs – Character-level text generation.		
Unit - V	**Case Studies:**	**9**
Large scale deep learning – Computer vision – Speech recognition – Natural language processing – implementation.		
List of Exercises / Experiments :		
1	Implementation of linear regression technique.	
2	Program to create a multi-layer neural network.	
3	Program to test the performance of multi-layer neural network with various activation and loss functions	
4	Tuning the neural network performance with hyper parameters	
5	Implementation of convolutional neural networks	
6	Implementation of Recurrent neural networks	
7	Implementation of Recursive neural networks	
8	Developing a simple image recognition application	
9	Developing a simple speech recognition application	
10	Developing a Chatbot	

Lecture: 45, Practical: 30, Total:75

REFERENCES:

1	Josh Patterson and Adam Gibson, “Deep Learning – A Practitioner’s Approach”, 1st Edition, O’Reilly Series, August 2017
2	Indra den Bakker, “Python Deep Learning Cookbook”, 1st Edition, Packt Publishing, October 2017.
3	Ian Goodfellow, Yoshua Bengio and Aaron Courville, “Deep Learning”, 1st Edition, MIT Press, 2016. (UNIT 5)

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	experiment with the various parameters of deep learning model	Applying (K3)
CO2	model deep neural network with its functional components	Applying (K3)
CO3	adapt the appropriate deep network architecture for solving the real time problem	Applying (K3)
CO4	make use of Tensorflow/keras frameworks for building deep neural model for the given problem.	Applying (K3)
CO5	examine the deep networks in different practical applications	Analyzing (K4)
CO6	design the regression technique and variants of deep neural networks	Applying (K3), Precision (S3)
CO7	analyze the performance of artificial neural network	Analyzing (K4), Precision (S3)
CO8	develop the simple deep learning applications	Applying (K3), Precision (S3)

Mapping of COs with POs s						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1				
CO2	3	1				
CO3	3	2	1			
CO4	3	2	1			
CO5	3	2	2	1		
CO6	3	3	1	1		
CO7	3	3	2	1		
CO8	3	3	1	1		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy						

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	22	58	10			100
CAT2	10	18	62	10			100
CAT3	15	10	65	10			100
ESE	10	22	58	10			100

*** +3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MSE13 – SPEECH AND NATURAL LANGUAGE PROCESSING

Programme & Branch	M.E. & Computer Science and Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	3	PE	3	0	0	3

Preamble	The course provides the foundation knowledge on speech production and perception along with processing of speech signal and also deals with the basics of text processing and then it also covers some of the most interesting applications of text mining.	
Unit - I	**Words and Morphology:**	**9**
Introduction - Models and Algorithms – Words – Morphology - Morphological Parsing using Finite State Transducers - FST Lexicon and Rules - Porter Stemmer - Spelling Errors - Error Pattern - Non-Word Error - Probabilistic Models - Applying Bayesian Methods to Spelling – Weighted Automata and Segmentation - N-grams - Smoothing – Backoff.		
Unit - II	**Tagging and Grammar:**	**9**
Part of Speech Tagging - Tagsets for English - Rule Based Tagging - Stochastic Part of Speech Tagging – Transformation-Based Tagging - CFG for English - Context Free Rule - Sentence-Level Constructions - Noun Phrase - Coordination-Agreement - Verb Phrase and Sub categorization -Auxiliaries – Parsing - Top Down Parsing - Bottom Up Parsing - Earley Algorithm.		
Unit - III	**Features and Unificataion:**	**9**
Features and Unification – Structures - Unification of Structure - Features and Structures in Grammar – Implementing Unification - Parsing with Unification Constraints - Probabilistic CFG - Probabilistic Lexicalize CFG – Dependency Grammar.		
Unit - IV	**Semantics:**	**9**
Semantic Analysis - Syntax Driven Semantic Analysis - Attachments for a Fragment of English - Integrating Semantic analysis into Earley Parser - Word Sense Disambiguation and Information Retrieval.		
Unit - V	**Advanced Topics:**	**9**
Computational Phonology - HMM and Speech Recognition – Discourse - Dialogue and Conversation - Deep Learning and Natural Language Processing.		

Lecture: 45, Total: 45

REFERENCES:

1.	Daniel Jurafsky and James H. Martin, “Speech and Language Processing”, Pearson Education, 2009.
2.	Christopher Manning and Hinrich Schuetze,” Foundations of Statistical Natural Language Processing”, MIT Press, 2000.
3.	Li Deng and Yang Liu, ” Deep Learning in Natural Language Processing“, Springer,2018

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	analyze word structure using morphological analysis and Finite State Transducers	Analyzing (K4)
CO2	apply Probabilistic approaches for Spelling and use N-grams for Language Modelling	Applying (K3)
CO3	analyze Sentences using Parsing with CFG and Probabilistic Parsing	Analyzing (K4)
CO4	apply Semantic in word sense disambiguation and Information Retrieval	Applying (K3)
CO5	make use of Computation Phonology and HMM for Speech recognition and Text to Speech conversion	Applying (K3)

Mapping of COs with POs s						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	2	3		
CO2	3	3	2	3		
CO3	3	3	2	3		
CO4	3	3	3	3		
CO5	3	3	3	3		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy						

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1		60	40				100
CAT2		20	40	40			100
CAT3		10	55	35			100
ESE		20	50	30			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MSE14 – INTELLIGENT SYSTEM DESIGN

Programme & Branch	M.E. & Computer Science and Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Artificial Intelligence	**3**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course deals with designing intelligent systems using various techniques like search and heuristics, making use of logic in knowledge representation and reasoning, and employing machine learning techniques with data sets. The role of fuzzy and neural systems in building intelligent systems will also be discussed.	
Unit - I	**Fuzzy Set Theory:**	**9**
Introduction to Neuro-Fuzzy and Soft Computing – Fuzzy Sets – Fuzzy Rules and Fuzzy Reasoning – Fuzzy Inference Systems – Least-Squares Methods for System Identification		
Unit - II	**Optimization and Neural Networks:**	**9**
Derivative-based Optimization – Derivative-free Optimization – Adaptive Networks – Supervised Learning Neural Networks – Unsupervised Learning and Other Neural Networks		
Unit - III	**Learning from Reinforcement:**	**9**
Introduction – Failure is the Surest Path to Success – Temporal Difference Learning – The art of Dynamic Programming – Adaptive Heuristic Critic – Q-Learning – A Cost Path Problem – World Modeling – Other Network Configurations – Reinforcement Learning by Evolutionary Computation.		
Unit - IV	**Neuro-Fuzzy Modeling:**	**9**
Adaptive Neuro-Fuzzy Inference System (ANFIS) – Coactive Neuro-Fuzzy Modeling – Advanced Neuro-Fuzzy Modeling: Classification and Regression Tress – Data Clustering Algorithms – Rulebase Structure Identification.		
Unit - V	**Neuro-Fuzzy Control:**	**9**
Feedback Control Systems and Neuro-Fuzzy Control – Expert Control: Mimicking an Expert – Inverse Learning – Specialized Learning – Backpropagation Through Time and Real-Time Recurrent Learning – Reinforcement Learning Control – Gradient-Free Optimization – Gain Scheduling – Feedback Linearization and Sliding Control		

Lecture: 45, Total: 45

REFERENCES:

1.	J.S.R.Jang, C.T. Sun, Eiji Mizutani “Neuro-Fuzzy and Soft Computing”, Pearson Education , 2004
2.	Crina Grosan and Ajith Abraham, “Intelligent Systems – A Modern Approach”, Springer – Verlag Berlin Heidelberg, 2011.
3.	Robert J. Schalkoff, “Intelligent Systems Principles, Paradigms and Pragmatics”, Jones and Bartlett Publishers, 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	Make use of fuzzy sets and fuzzy inference system to carry out regression.	Applying (K3)
CO2	Apply derivative based optimization and derivative free optimization and summarize different types of learning.	Applying (K3)
CO3	Utilize reinforcement learning for real world problems.	Applying (K3)
CO4	Model neuro-fuzzy systems for classification and clustering	Applying (K3)
CO5	Develop neuro-fuzzy based control systems	Applying (K3)

Mapping of COs with POs s						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	1			
CO2	3	2	1			
CO3	3	2	1			
CO4	3	2	1			
CO5	3	2	1			
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy						

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	46	24				100
CAT2	10	47	43				100
CAT3	27	43	30				100
ESE	20	40	40				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MSE15 – MOBILE AND PERVASIVE COMPUTING

Programme & Branch	M.E. & Computer Science and Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Network design and Technologies	**3**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides an understanding of wireless and mobile communication concepts through various layers of mobile networking. It also helps to realize the pervasive and context aware computing architectures, systems and applications.	
Unit - I	**Introduction to Wireless Environment:**	**9**
Introduction to wireless communication-Wireless Transmission- Medium Access Control- Wireless MAC protocols –Comparison of 2G, 3G,4G looking ahead 5G systems.		
Unit - II	**Mobile Communication:**	**9**
GSM - Bluetooth - Mobile network layer-Mobile transport layer - File system support for mobility support - Mobile execution environments and applications.		
Unit - III	**Pervasive Communication:**	**9**
Past , Present , Future – Application Examples – Device Technology – WAP and Beyond – Pervasive Web Application Architecture : Example Application.		
Unit - IV	**Context Aware Computing:**	**9**
Structure and Elements of Context-aware Pervasive Systems: Abstract architecture – Infrastructures - Middleware and toolkits, Context-aware mobile services: Context for mobile device users – Location-based services- Ambient service- Enhancing Context-aware mobile services and Context aware artifacts.		
Unit - V	**Context-Aware Pervasive System:**	**9**
Context-aware sensor networks – A framework for Context aware sensors – Context-aware security systems – Constructing Context-aware pervasive system- Future of Content aware systems.		

Lecture: 45, Total: 45

REFERENCES:

1.	Schiller Jochen, “Mobile Communication”, 2nd Edition, PHI/Pearson Education, 2009.
2.	Burkhardt Jochen, Henn Horst and Hepper Stefan, Schaec Thomas and Rindtorff Klaus, “Pervasive Computing Technology and Architecture of Mobile Internet Applications”, Addison Wesley Reading, 2007.
3.	Seng Loke, “Context-Aware Pervasive Systems: Architectures for a New Breed of Applications”, 1st Edition, Auerbach Publications, 2006.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	Analyze the operation and performance of wireless protocols	Analyze(K4)
CO2	Apply the concepts and principles of various mobile communication technologies	Applying (K3)
CO3	Analyze the working of protocols that support mobility	Analyze(K4)
CO4	Identify the architecture of pervasive computing and apply them in pervasive computing	Applying (K3)
CO5	Apply context aware computing and design pervasive systems for real time examples	Applying (K3)

Mapping of COs with POs s						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	3	3		
CO2	3	3	3	3		
CO3	3	3	3	3		
CO4	3	3	3	3		
CO5	3	3	3	3		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy						

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	20	40	30			100
CAT2	10	30	40	30			100
CAT3	10	20	60				100
ESE	20	30	30	20			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MSE16 - NATURE INSPIRED OPTIMIZATION TECHNIQUES

Programme & Branch	M.E. & Computer Science and Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	-	3	PE	3	0	0	3

Preamble	This course helps the learners to understand the algorithms that are inspired by naturally occurring phenomena. The focus is on abstracting nature inspired techniques which influence computing.	
Unit - I		**9**
Introduction to Algorithms: Newton's Method – Optimization - Search for Optimality - No-Free-Lunch Theorems - Nature-Inspired Metaheuristics - Brief History of Metaheuristics. **Analysis of Algorithms:** Introduction - Analysis of Optimization Algorithms - Nature-Inspired Algorithms - Parameter Tuning and Parameter Control.		
Unit - II		**9**
Simulated Annealing: Annealing and Boltzmann Distribution - Parameters - SA Algorithm - Unconstrained Optimization - Basic Convergence Properties - SA Behavior in Practice - Stochastic Tunneling. **Genetic Algorithms** : Introduction - Genetic Algorithms - Role of Genetic Operators - Choice of Parameters - GA Variants - Schema Theorem - Convergence Analysis.		
Unit - III		**9**
Particle Swarm Optimization: Swarm Intelligence - PSO Algorithm - Accelerated PSO – Implementation - Convergence Analysis - Binary PSO. **Cat Swarm Optimization:** Natural Process of the Cat Swarm - Optimization Algorithm – Flowchart - Performance of the CSO Algorithm.		
Unit - IV		**9**
TLBO Algorithm: Introduction **-** Mapping a Classroom into the Teaching-Learning-Based optimization – Flowchart. **Cuckoo Search:** Cuckoo Life Style - Details of COA – flowchart - Cuckoos' Initial Residence Locations - Cuckoos' Egg Laying Approach - Cuckoos Immigration - Capabilities of COA. **Bat Algorithms:** Echolocation of Bats - Bat Algorithms – Implementation - Binary Bat Algorithms - Variants of the Bat Algorithm - Convergence Analysis.		
Unit - V		**9**
Other Algorithms: Ant Algorithms - Bee-Inspired Algorithms - Harmony Search - Hybrid Algorithms.		

Lecture: 45, Total: 45

REFERENCES:

1. Xin-She Yang, "Nature-Inspired Optimization Algorithms", 1st Edition, Elsevier, 2014.
2. Omid Bozorg-Haddad, "Advanced Optimization by Nature-Inspired Algorithms" Springer Volume 720, 2018.
3. Srikanta Patnaik, Xin-She Yang, Kazumi Nakamatsu, "Nature-Inspired Computing and Optimization Theory and Applications", Springer Series, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply the basic concepts of optimization techniques	Applying (K3)
CO2	identify the parameter which is to be optimized for an application	Analyzing (K4)
CO3	analyze and develop mathematical model of different swarm optimization algorithms	Analyzing (K4)
CO4	select suitable optimization algorithm for a real time application	Analyzing (K4)
CO5	examine and recommend solutions for optimization based applications	Analyzing (K4)

Mapping of COs with POs s						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1				
CO2	3	2	1			
CO3	3	3	2			
CO4	3	3	2			
CO5	3	3	2			
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy						

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	16	50	17	17			100
CAT2	10	33	24	33			100
CAT3	10	33	32	25			100
ESE	5	21	38	36			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MSE17 – DIGITAL IMAGE PROCESSING AND COMPUTER VISION

Programme & Branch	M.E. & Computer Science and Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	4	PE	3	0	0	3

Preamble	Provides basic knowledge about image, its representation and preprocessing and prepares the students to perform analysis of processed data.	
Unit - I		**9**
Introduction – Image representation and properties: Image representation- digital image properties- color images- **Mathematical and physical background:** Overview - Linear integral transforms - Images as stochastic processes - Image formation physics**.**		
Unit - II		**9**
Data structures for image analysis: Levels of image data representation - Traditional image data structures - Hierarchical data structures**. Image pre-processing**: Pixel brightness transformations - Geometric transformations- Local pre-processing - Image restoration		
Unit - III		**9**
Segmentation: Thresholding – Edge-based segmentation- Region-based segmentation-Matching - Evaluation issues		
Unit - IV		**9**
3D geometry, correspondence, 3D from intensities: 3D vision tasks - Basics of projective geometry- A single perspective camera- Scene reconstruction from multiple views - Two cameras, stereopsis - 3D information from radiometric measurements.		
Unit - V		**9**
Texture Analysis: Statistical texture description - Syntactic texture description methods - Hybrid texture description methods. **Motion Analysis:** Differential motion analysis methods - Optical flow - Analysis based on correspondence of interest points- Detection of specific motion patterns - Video tracking		

Lecture: 45, Total: 45

REFERENCES:

1. Milan Sonka , Vaclav Hlavac , Roger Boyle, “Image Processing, Analysis, and Machine Vision”, 4th edition, Cengage Learning, 2015
2. Distante **,** Arcangelo, Distante**,** Cosimo, “Handbook of Image Processing and Computer Vision”, Springer International Publishing, 2020

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	Apply image fundamentals and mathematical transforms necessary for image processing.	Applying (K3)
CO2	identify the significances of **Data structures for image** and different image preprocessing methods.	Applying (K3)
CO3	explore different segmentation methods for different images	Applying (K3)
CO4	recognize the need for 3D vision and develop an application using it	Applying (K3)
CO5	Apply Texture and motion analysis for real time images	Applying (K3)

Mapping of COs with POs s						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1				
CO2	3	2	1			
CO3	3	3	2			
CO4	3	3	2			
CO5	3	3	2			
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy						

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	15	50	35				100
CAT2	15	50	35				100
CAT3	15	50	35				100
ESE	20	50	30				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MSE18 – SOFTWARE DEFINED NETWORKING

Programme & Branch	M.E. & Computer Science and Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Network Design Technologies	**4**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides insight on basics of software defined networking and how it is changing the way communications networks are managed, maintained, and secured.	
Unit - I	**Data plane and Control Plane** :	**9**
Introduction, What do they do?, Distributed Control planes, Centalized control planes. OpenFlow : Introduction, Hybrid approach. SDN Controllers: VMware, Nicira, OpenFlow-Related, Mininet, NOX /POX, Trema, Ryu, Big switch networks / FloodLight.		
Unit - II	**Network Programmability :**	**9**
Introduction, The Management Interface, The Application – Network divide, Modern programmatic interfaces, I2RS, Modern orchestration. YANG, OpenConfig and gNMI.		
Unit - III	**SDN in Data Center:**	**9**
Data Center concepts and constructs: Introduction, The Multitenant Data Center, The Virtualized Multitenant Data Center, SDN solutions for the Data Center Network, VLANs, EVPN, VxLAN, NVGRE.		
Unit - IV	**SDN and NFV:**	**9**
Network Function Virtualization :Virtualization and Data plane I/O, Service Engineered path - Service Locations and Chaining. Network Topology and Topological Information Abstraction: Network Topology, Traditional methods, LLDP, BGP-TE / LS, ALTO, I2RS Topology. Building an SDN Framework: The Juniper SDN Framework, Open Daylight Controller/Framework		
Unit - V	**SDN Usecases:**	**9**
Usecases for Bandwidth Scheduling, Manipulation and calendaring, Data Center Overlays, Big Data and Network Function Virtualization, Input Traffic Monitoring, Classification, and Triggered Actions.		

Lecture: 45, Total: 45

REFERENCES:

1.	Thomas D. Nadeau, Ken Gray, “SDN: Software Defined Networks, An Authoritative Review of Network Programmability Technologies”, O'Reilly Media, August 2013.
2.	https://www.opennetworking.org/wp-content/uploads/2019/10/NG-SDN-Tutorial-Session-2.pdf
3.	Paul Goransson, Chuck Black, “Software Defined Networks: A Comprehensive Approach”, 1st Edition, Morgan Kaufmann, June 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	examine the data plane and control plane of software defined networks	Analyzing (K4)
CO2	demonstrate the role of software defined network in different networking environment	Applying (K3)
CO3	employ openflow protocol to determine the operations of software defined network	Applying (K3)
CO4	model software defined controller for various networking applications	Applying (K3)
CO5	use software defined network to solve the given network problems	Applying (K3)

Mapping of COs with POs s						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	2			
CO2	3	2	1			
CO3	3	2	1			
CO4	3	2	1			
CO5	3	2	1			
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy						

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1		20	40	40			100
CAT2	10	40	50				100
CAT3	10	40	50				100
ESE	10	30	40	20			100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MSE19 – REINFORCEMENT LEARNING

Programme & Branch	M.E. & Computer Science and Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Deep Learning	4	PE	3	0	0	3

Preamble	This course will provide a solid introduction to the field of reinforcement learning and explore the core challenges and approaches, including generalization and exploration with reinforcement learning algorithms.	
Unit - I	**Title:**	**9**
Introduction : Reinforcement Learning – Examples-Elements of Reinforcement Learning – Limitations and Scope – **Multi –armed Bandits :** A k-armed Bandit Problem - Action-value Methods - The 10-armed Testbed - Incremental Implementation - Tracking a Non-stationary Problem - Optimistic Initial Values - Gradient Bandit Algorithms		
Unit - II		**9**
Finite Markov Decision processes : The Agent – Environment Interface - Goals and Rewards - Returns and Episodes - Unified Notation for Episodic and Continuing Tasks - Policies and Value Functions - **Dynamic programming**: Policy Evaluation (Prediction) - Policy Improvement - Policy Iteration - Value Iteration -Asynchronous Dynamic Programming - Generalized Policy Iteration		
Unit - III		**9**
Monte carlo methods : Monte Carlo Prediction - Monte Carlo Estimation of Action Values - Monte Carlo Control - Monte Carlo Control without Exploring Starts - Off-policy Prediction via Importance Sampling -Incremental Implementation - Off-policy Monte Carlo Control - **Temporal Difference Learning:** TD Prediction - Advantages of TD Prediction Methods - Optimality of TD(0) - Sarsa: On-policy TD Control - Q-learning: Off-policy TD Control		
Unit - IV		**9**
n-step Bootstrapping : n-step Sarsa - n-step Off-policy Learning - n-step Tree Backup Algorithm - **Planning and Learning with Tabular Methods** : Models and Planning – Dyna - Integrated Planning, Acting, and Learning - Prioritized Sweeping - Expected vs. Sample Updates - Trajectory Sampling - Real-time Dynamic Programming - Planning at Decision Time - Heuristic Search - Rollout Algorithms - Monte Carlo Tree Search		
Unit - V		**9**
On-policy Prediction with Approximation: Value-function Approximation - The Prediction Objective (VE) - Stochastic-gradient and Semi-gradient Methods - Linear Methods - Feature Construction for Linear Methods -Selecting Step - Size Parameters Manually - **On-policy Control with Approximation:** Episodic Semi-gradient Control - Semi-gradient n-step Sarsa - Average Reward: A New Problem Setting for Continuing Tasks - Policy Gradient Methods		

Lecture: 45, Total: 45

REFERENCES:

1.	Sutton and Barto ,"Reinforcement Learning: An Introduction", The MIT Press, 2nd Edition,2018
2.	Marco Wiering and Martijn van Otterlo ,"Reinforcement Learning: State-of-the-Art(Adaptation, Learning, and Optimization)",Volume-12 ,Springer ,2012

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	describe the key features of reinforcement learning that distinguishes it from AI and non-interactive machine learning and apply for an application	Applying(K3)
CO2	devise an appropriate solution for the given RL problem	Applying(K3)
CO3	Implement common RL algorithms	Applying(K3)
CO4	Use performance metrics based on multiple criteria to evaluate RL algorithms	Applying(K3)
CO5	Make use of Stochastic –gradient and Semi –gradient methods for On – policy Prediction and Control	Applying(K3)

Mapping of COs with POs s						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2				
CO2	3	2	1			
CO3	3	2	1			
CO4	3	2				
CO5	3	2				
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy						

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	30	30				100
CAT2	30	30	40				100
CAT3	30	40	30				100
ESE	40	30	30				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MSE20 – VIRTUALIZATION TECHNIQUES

Programme & Branch	M.E. & Computer Science and Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Operating system, Networking concepts	**4**	**PE**	**3**	**0**	**0**	**3**

Preamble	Virtual machine allows the creation of an environment that is not logically tied to the underlying hardware. The cloud is essentially a virtual environment that arises from the combination of multiple virtual machines into one powerful entity. Therefore, the process of virtualization is a key element in the creation of cloud platforms and infrastructure.	
Unit - I	**Overview of Virtualization**	**9**
Understanding Virtualization: Describing Virtualization - Understanding the Importance of Virtualization - Understanding Virtualization Software Operation. Understanding Hypervisors: Describing a Hypervisor- Understanding the Role of a Hypervisor - Comparing today's Hypervisor. Understanding Virtual Machines: Describing a Virtual Machine - Understanding How a Virtual Machine Works - Working with Virtual Machines.		
Unit - II	**Virtual Machines**	**9**
Creating a Virtual Machine: Performing P2V Conversions - Loading Your Environment - Building a New Virtual Machine. Installing Windows on a Virtual Machine: Loading Windows into a Virtual Machine -Understanding Configuration Options - Optimizing a New Linux Virtual Machine. Installing Linux on a Virtual Machine: Loading Linux into a Virtual Machine - Understanding Configuration Options - Optimizing a New Linux Virtual Machine.		
Unit - III	**Managing virtual machines**	**9**
Managing CPUs for a Virtual Machine: Understanding CPU Virtualization - Configuring VM CPU Options -Tuning Practices for VM CPUs. Managing Memory for a Virtual Machine: Understanding Memory Virtualization - Configuring VM Memory Options - Tuning Practices for VM Memory. Managing Storage for a Virtual Machine: Understanding Storage Virtualization - Configuring VM Storage Options - Tuning Practices for VM Storage.		
Unit - IV	**Networking virtual machines**	**9**
Managing Networking for a Virtual Machine: Understanding Network Virtualization - Configuring VM Network Options - Tuning Practices for Virtual Networks. Copying a Virtual Machine: Cloning a Virtual Machine - Working with Templates - Saving a Virtual Machine State.		
Unit - V	**Managing Devices**	**9**
Managing Additional Devices in Virtual Machines: Using Virtual Machine Tools – Understanding Virtual Devices - Configuring Sound Card, USB Devices, Graphic Displays and other Devices. Understanding Availability: Increasing Availability - Protecting a Virtual Machine – Protecting Multiple Virtual Machines -Protecting Datacenters. Understanding Applications in a Virtual Machine: Examining Virtual Infrastructure Performance Capabilities - Deploying Applications in a Virtual Environment - Understanding Virtual Appliances and vApps.		

Lecture: 45, Total: 45

REFERENCES:

1. **Matthew Portnoy, "Virtualization Essentials", 2nd Edition, SYBEX Publications, 2016.**
2. Lee Chao, "Virtualization and Private Cloud with VMware Cloud Suite", 1st Edition, CRC Press,2017.
3. Chris Wolf, Erick M. Halter, "Virtualization: From the Desktop to the Enterprise", Illustrated Edition, APress 2005.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	demonstrate the Virtualization, Hypervisor and Virtual machines	Applying (K3)
CO2	create a virtual machine and installing the operating systems	Applying (K3)
CO3	configure virtual machine's CPU, memory and storage	Applying (K3)
CO4	clone the virtual machine and configure networks	Applying (K3)
CO5	protect virtual machine and deploying application	Applying (K3)

Mapping of COs with POs s						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1		1		3		
CO2	2	2	3		1	
CO3	3	2			1	
CO4	3					
CO5		1	3	3	1	1
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy						

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	40	40				100
CAT2	20	20	60				100
CAT3	20	20	60				100
ESE	20	30	50				100

*** ±3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MSE21 – USER INTERFACE DESIGN

Programme & Branch	M.E. & Computer Science and Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	HTML,CSS and Javascript	**4**	**PE**	**2**	**0**	**2**	**3**

Preamble	UID deals with design of responsive web application using Full Stack Web Development –MEAN ie MongoDB, ExpressJS, AngularJS and NodeJS.	
Unit - I	**Introduction to NoSQL Database - MongoDB:**	**6**
What is NoSQL Database - Why to Use MongoDB - Difference between MongoDB & RDBMS - Download & Installation - Common Terms in MongoDB – Implementation of Basic CRUD Operations using MongoDB.		
Unit - II	**Introduction to Server-side JS Framework – Node.js:**	**9**
Introduction - What is Node JS – Architecture – Feature of Node JS - Installation and setup - Creating web servers with HTTP (Request and Response) – Event Handling - GET and POST implementation - Connect to NoSQL Database using Node JS – Implementation of CRUD operations.		
Unit - III	**Introduction to TypeScript:**	**6**
TypeScript : Introduction to TypeScript – Features of TypeScript – Installation setup – Variables – Datatypes – Enum – Array – Tuples – Functions – OOP concepts – Interfaces – Generics – Modules – Namespaces – Decorators – Compiler options – Project Configuration.		
Unit - IV	**Introduction to Client-side JS Framework – Basics of Angular:**	**6**
Introduction to Angular - Needs and Evolution – Features – Setup and Configuration – Components and Modules – Templates – Change Detection – Directives – Data Binding - Pipes – Nested Components.		
Unit - V	**Client-side JS Framework – Forms and Routing in Angular:**	**6**
Template Driven Forms - Model Driven Forms or Reactive Forms - Custom Validators - Dependency Injection - Services - RxJS Observables HTTP - Routing.		
List of Exercises / Experiments :		
1	Implementation of basic CRUD Operations using MongoDB	
2	Design scientific calculator using 'Modules' in Node.js	
3	Create web server connection with HTTP Request and HTTP Response	
4	Implementation of Event Handling using GET and POST Method	
5	Establish Connection to NoSQL Database using NodeJS and implement CURD operations	
6	Demonstrate Inheritance and Interfaces using Typescript	
7	Design a web application using components, modules and router in Angular	
8	Design a reactive form to maintain customer details using Angular	
9	Implement services and dependency injection using Angular	
10	Develop and deploy eCart application using Angular	

Lecture: 30, Practical:30, Total:60

REFERENCES:

1	Electronic Resources at **https://infytq.infosys.com**
2.	Nathan Rozentals, "Mastering TypeScript", 2nd Edition, Packt Publishing, 2017.
3.	Nathan Murray, Ari Lerner, Felipe Coury, Carlos Taborda, "ng-book, The Complete Book on Angular 6", Createspace Publisher, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	demonstrate NoSQL Database CURD operations using MongoDB	Applying (K3)
CO2	develop server side applications using Node JS	Applying (K3)
CO3	make use of Type Script to build web application	Applying (K3)
CO4	employ Angular features and create component based web pages	Applying (K3)
CO5	design a Full Stack web application	Applying (K3)
CO6	design RWD to perform CURD operations with MongoDB	Applying (K3), Precision (S3)
CO7	create web server connection with HTTP request and HTTP response	Applying (K3), Precision (S3)
CO8	develop full stack application using angular for the given use case	Applying (K3), Precision (S3)

Mapping of COs with POs s						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	3	3		
CO2	3	3	3	3		
CO3	3	2		3		
CO4	2	1		2		
CO5	3	3	3	3		
CO6	3	3	3	3		
CO7	3	2		3		
CO8	3	3	3	3		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy						

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	30	60				100
CAT2	20	40	40				100
CAT3	10	30	60				100
ESE	20	20	60				100

*** +3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**

20MSE22 – ADVANCED PARALLEL ARCHITECTURE AND PROGRAMMING

Programme & Branch	M.E. & Computer Science and Engineering	Sem.	Category	L	T	P	Credit
Prerequisites	Computer Architecture and Multicore Architecture	**4**	**PE**	**2**	**0**	**2**	**3**

Preamble	This course provides an understanding of the fundamental principles and engineering trade-offs involved in designing modern parallel computing systems as well as to teach parallel programming techniques necessary to effectively utilize these machines. It also explores key machine performance characteristics of parallel programming.	
Unit - I	**Parallel Architecture and Foundations of Parallel Programming:**	**6**
Parallel Architecture: Need, Convergence, Design issues – Parallel Application Case Studies – The von Neumann architecture - Processes, multitasking, and threads – Modifications to the von Neumann Model – Parallel Hardware and Software – Input and Output – Performance – Parallel Program Design – Writing and Running Parallel Programs.		
Unit - II	**Message Passing Paradigm:**	**6**
Basic MPI programming – MPI_Init and MPI_Finalize – MPI communicators – SPMD programs – message passing – MPI_Send and MPI_Recv – message matching – MPI I/O – parallel I/O – collective communication – derived types – Performance evaluation of MPI programs – A Parallel Sorting Algorithm.		
Unit - III	**Shared Memory Paradigm Pthreads:**	**6**
Basics of Pthreads – Execution, Error checking of threads – Matrix-Vector Multiplication – Critical sections – Busy waiting – Mutexes – Producer-Consumer Synchronization and Semaphores – Barriers and Condition variables – Read Write locks – Caches, Cache Coherence and False sharing – Thread-Safety – Pthreads case study.		
Unit - IV	**Shared Memory Paradigm OpenMP:**	**6**
Basic OpenMP constructs – The Trapezoidal Rule – Scope of Variables – Reduction Clause – Parallel for Directive – Loops in OpenMP – Scheduling loops – Synchronization in OpenMP – Case Study: Producer Consumer problem– Cache Issues – Threads safety in OpenMP.		
Unit - V	**OpenCL Language:**	**6**
Introduction to OpenCL – OpenCL example – Platforms, Contexts and Devices – OpenCL programming in C – Simple Programs.		
List of Exercises / Experiments :		
1	Implementation of numerical methods using MPI and OpenMP	
2	Use MPI to implement the histogram program	
3	Parallelizing loops in OpenMP	
4	Write a Pthreads program that implements the histogram	
5	Matrix vector multiplication using Pthreads	
6	Producer-consumer synchronization and semaphores using Pthreads	
7	Implementation of read/write locks using Pthreads	
8	Use OpenMP to implement a program that does Gaussian elimination	
9	Vector operations with OpenCL	
10	Implement iterative tree search	

Lecture: 30, Practical:30, Total:60

REFERENCES:

1	David E. Culler, Jaswinder Pal Singh, “Parallel Computing Architecture: A Hardware/ Software Approach”, Morgan Kaufmann, Elsevier, 2013.
2	Peter S. Pacheco, “An introduction to parallel programming”, Morgan Kaufmann, 2011.
3	Munshi Aaftab, Gaster R. Benedict,”OpenCL Programming Guide”, Addision-Wesley, 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	examine the issues in Parallel Architecture and Programming	Analyzing (K4)
CO2	develop message passing parallel programs using MPI framework	Applying (K3)
CO3	build shared memory parallel programs using Pthreads	Applying (K3)
CO4	experiment with OpenMP for shared memory applications	Applying (K3)
CO5	solve the given problem with parallel programs using OpenCL	Applying (K3)
CO6	make use of MPI and OpenMP for solving problems in numerical methods	Applying (K3), Precision (S3)
CO7	utilize Pthreads to model and parallel programs for different system tasks	Applying (K3), Precision (S3)
CO8	experiment different vector operations with OpenCL	Applying (K3), Precision (S3)

Mapping of COs with POs s						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2				
CO2	3	1	1	2		
CO3	3	1	1	2		
CO4	3	1	1	2		
CO5	3	1	1	2		
CO6	3	1	1	2		
CO7	3	1	1	2		
CO8	3	2	1	2		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy						

ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	30	40	20			100
CAT2	10	40	50				100
CAT3	10	40	50				100
ESE	10	30	45	15			100

*** +3% may be varied (CAT 1,2,3 – 50 marks & ESE – 100 marks)**