KONGU ENGINEERING COLLEGE

(Autonomous Institution Affiliated to Anna University, Chennai)

PERUNDURAI ERODE – 638 060

TAMILNADU INDIA

Estd : 1984

REGULATIONS, CURRICULUM & SYLLABI – 2022

(CHOICE BASED CREDIT SYSTEM AND OUTCOME BASED EDUCATION)

(For the students admitted during 2022 - 2023 and onwards)

MASTER OF ENGINEERING DEGREE
IN
COMPUTER SCIENCE AND ENGINEERING

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

KONGU
Assuring the Best

KONGU ENGINEERING COLLEGE, PERUNDURAI, ERODE – 638060

(An Autonomous Institution Affiliated to Anna University)

REGULATIONS 2022

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 2022 – 2023 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
	Structural Engineering
	VLSI Design
	Embedded Systems
	Computer Science and Engineering
MTech	Information Technology
	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 projects through 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 One / Two Credit Courses / Online Courses / Self Study Courses

The candidates may optionally undergo One / Two Credit Courses / Online Courses / Self Study Courses as elective courses.

4.4.1 One / Two Credit Courses: One / Two Credit Courses shall be offered by the college with the prior approval from respective Board of Studies. A candidate can earn a maximum of six credits through one / two credit 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 one /two credit 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 courses or dropping of already registered additional elective 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 eight.

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 Marks
1.	Theory	40	60
2.	Theory cum Practical (The distribution of marks shall be	50	50
3.	Practical	60	40
4.	Project Work / Internship cum Project Work	50	50
5.	One / Two credit Course	The distribution of	---

6.	All other Courses	marks shall be decided based on the credit weightage assigned	

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 40 marks and the end semester examination shall be for 60 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	12.5	---
	Test - II	12.5	
2.	Tutorial / Others (Tutorial/Problem Solving (or) Simulation (or) Simulation & Mini Project (or) Mini Project (or) Case Studies (or) Any other relevant to the course)	10	Type of assessment is to be chosen based on the nature of the course and to 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	40	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 and shall be conducted between November and January during odd semesters and between April and June during even semesters of every year.

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.

7.5.2 The end semester examination shall be conducted for a maximum of 100 marks for duration of 3 hours and reduced to 40 marks. The appointment of examiners and the schedule shall be decided by chairman of Board of Study of the relevant board.

7.6 Project Work

7.6.1 Project work shall becarried out individually. Candidates can opt for full time internship (vide clause 7.7) 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 two 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 Supervisor 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 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.

7.8 One / Two Credit Course

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

7.9 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.

7.10 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.

7.11 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 SC (Successfully Completed). 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 45 % 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

For all the passed candidates, the relative grading principle is applied to assign the letter grades.

Marks / Examination Status	Letter Grade	Grade Point
Based on the relative grading	O (Outstanding)	10
	A+ (Excellent)	9
	A (Very Good)	8
	B+ (Good)	7
	B (Average)	6
	C (Satisfactory)	5
Less than 50	U (Reappearance)	0
Successfully Completed	SC	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 6.50

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.

M.E. COMPUTER SCIENCE AND ENGINEERING CURRICULUM – R2022
(For the students admitted from the academic year 2022-23 onwards)

SEMESTER – I									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
22AMT13	Advanced Mathematics for Computing	3	1	0	4	40	60	100	FC
22GET11	Introduction to Research	2	1	0	3	40	60	100	FC
22MIT11	Data Structures and Analysis of Algorithms	3	0	0	3	40	60	100	PC
22MST11	Machine Learning Techniques	3	0	0	3	40	60	100	PC
22MST12	Communication Networks	3	1	0	4	40	60	100	PC
22MST13	Multicore Architectures	3	0	0	3	40	60	100	PC
Practical / Employability Enhancement									
22MIL11	Data Structures and Analysis of Algorithms Laboratory	0	0	2	1	60	40	100	PC
22MSL11	Machine Learning Laboratory	0	0	2	1	60	40	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									
22MST21	Deep Learning Techniques	3	0	0	3	40	60	100	PC
22MST22	Data Analytics	3	0	0	3	40	60	100	PC
22MST23	Security in Computing	3	1	0	4	40	60	100	PC
	Professional Elective - I	3	0	0	3	40	60	100	PE
	Professional Elective – II	3	0	0	3	40	60	100	PE
	Professional Elective - III	3	0	0	3	40	60	100	PE
Practical / Employability Enhancement									
22MSL21	Deep Learning Laboratory	0	0	2	1	60	40	100	PC
22MSL22	Data Analytics Laboratory	0	0	2	1	60	40	100	PC
Total Credits to be earned					21				

M.E. COMPUTER SCIENCE AND ENGINEERING CURRICULUM – R2022
(For the students admitted from the academic year 2022-23 onwards)

SEMESTER – III									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Cate gory
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
	Professional Elective – IV	3	0	0	3	40	60	100	PE
	Professional Elective - V	3	0	0	3	40	60	100	PE
	Professional Elective - VI	3	0	0	3	40	60	100	PE
Practical / Employability Enhancement									
22MSP31	Project Work - I	---	---	16	8	50	50	100	EC
Total Credits to be earned					**17**				

SEMESTER – IV									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Cate gory
		L	T	P		CA	ESE	Total	
Practical / Employability Enhancement									
22MSP41	Project Work - II	0	0	24	12	50	50	100	EC
Total Credits to be earned					**12**				

Total Credits: 72

LIST OF PROFESSIONAL ELECTIVES (PEs)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Domain/ Stream**
Semester – II							
Elective – I							
1.	22MSE01	Data Mining Techniques	3	0	0	3	
2.	22MSE02	Business Intelligence	3	0	0	3	
3.	22MSE03	Cloud Computing	3	0	0	3	
4.	22MSE04	Compiler Design Techniques	3	0	0	3	
Elective – II							
5.	22MSE05	Advanced Parallel Architecture and Programming	3	0	0	3	
6.	22MSE06	Internet of Things	3	0	0	3	
7.	22MSE07	Vehicular Adhoc Networks	3	0	0	3	
8.	22MSE08	Modern Information Retrieval Techniques	3	0	0	3	
Elective – III							
9.	22MSE09	Randomized Algorithms	3	0	0	3	
10.	22MSE10	Social Network Analysis	3	0	0	3	
11.	22MSE11	Advanced Database Technology	3	0	0	3	
12.	22MSE12	Software Defined Networking	3	0	0	3	
Semester – III							
Elective – IV							
13.	22MSE13	Speech and Natural language processing	3	0	0	3	
14.	22MSE14	Intelligent System Design	3	0	0	3	
15.	22MSE15	Mobile and Pervasive Computing	3	0	0	3	
16.	22MSE16	Nature Inspired Optimization Techniques	3	0	0	3	
17.	22MSE17	Security Practices	3	0	0	3	
Elective –V							
18.	22MSE18	Digital Image Processing and Computer Vision	3	0	0	3	
19.	22MSE19	Data Science	3	0	0	3	
20.	22MSE20	Information Storage Management	3	0	0	3	
21.	22MSE21	Reinforcement Learning	3	0	0	3	
22.	22MSE22	Virtualization Techniques	3	0	0	3	
Elective - VI							
23.	22MSE23	User Interface Design	3	0	0	3	
24.	22MSE24	Blockchain Technologies	3	0	0	3	
25.	22MSE25	Sentiment Analysis	3	0	0	3	
26.	22GET13	Innovation Entrepreneurship and venture Development	3	0	0	3	

22AMT13 - ADVANCED MATHEMATICS FOR COMPUTING							
(Common to ME-CSE & MTech IT)							
Programme & Branch	**M.E. Computer Science and Engineering & MTech – Information Technology**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1**	**FC**	**3**	**1**	**0**	**4**

Preamble	This course is designed to provide the solid foundation on mathematical and statistical knowledge fordesigning various concepts in computing, managing databases, artificial intelligence, compiler and design.	
Unit – I	**Estimation Theory:**	**9+3**
Estimators-Characteristics of estimators - Unbiased estimators - Methods of Estimation: Method of Maximum Likelihood Estimation - 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**
Vector space – Subspaces – Linear dependence and independence – Basis and dimension – Row space, Column space andNull 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.		
		Lecture:45, 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", 6th Edition, PearsonEducation, Asia, 2014.
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 estimators.	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 and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1					
CO2	1		3			
CO3	2					
CO4	2	3	1			
CO5	3	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	10	30	60	-	-	-	100
CAT2	10	30	60	-	-	-	100
ESE	10	20	70	-	-	-	100
* ±3% may be varied (CAT 1 & 2 – 60 marks & ESE – 100 marks)							

22GET11 - INTRODUCTION TO RESEARCH

(Common to all ME / MTech Branches & MCA)

Programme& Branch	All ME/MTech branches & MCA	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	1 / 2	FC	2	1	0	3

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+3**
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+3**
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+3**
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+3**
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+3**
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 and PSOs

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 (CAT 1,2,3 – 50 marks & ESE – 100 marks)

22MIT11 - DATA STRUCTURES AND ANALYSIS OF ALGORITHMS							
(Common to MTech-Information Technology & ME-Computer Science and Engineering branches)							
Programme & Branch	**M.Tech – Information Technology & M.E - Computer Science and Engineering branches**	**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	**Introduction:**						**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) – Graph:- String Matching: Naive 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.							
							Total:45

REFERENCES:

1.	Thomas H.Cormen, Charles E.Leiserson, Ronald L. Rivest and Clifford Stein, "Introduction to Algorithms", Third Edition, PHI Learning Private Limited, 2012.
2.	AnanyLevitin, "Introduction to the Design and Analysis of Algorithms", Third Edition, Pearson Education, 2012
3.	Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman, "Data Structures and Algorithms", Pearson Education, Reprint 2006.
4.	Weiss Mark Allen, "Data Structures and Algorithm Analysis in C++", 3rd Edition, Pearson Education, New Delhi, 2007.
5.	Donald E. Knuth, "The Art of Computer Programming", Volumes 1& 3 Pearson Education, 2009. Steven S. Skiena, "The Algorithm Design Manual", Second Edition, Springer, 2008.

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	determine 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

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**2**	**2**	**2**		
CO2	**3**	**2**	**2**	**2**		
CO3	**3**	**2**	**2**	**2**		
CO4	**3**	**2**	**2**	**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	15	70	5			100
CAT2	10	15	75				100
CAT3	10	15	75				100
ESE	10	15	70	5			100

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

22MST11 - MACHINE LEARNING TECHNIQUES							
(Common to ME-Computer Science and Engineering & MTech-Information Technology branches)							
Programme& Branch	**M.E. – Computer Science and Engineering & MTech-Information Technology branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**1**	**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 - 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 and analysis of Machine Learning Experiments: Introduction - Factors, Response, and Strategy of Experimentation - Response Surface Design - Randomization, Replication, and Blocking - Guidelines for Machine Learning Experiments – Comparing two / more algorithms – Comparison over multiple datasets.		
		Total:45

REFERENCES:

1.	Ethem Alpaydin, “Introduction to Machine Learning”, 3rd Edition, Prentice Hall of India, 2014.
2.	Tom M. Mitchell, "Machine Learning", 1st Edition, McGraw-Hill Education, India, 2013.
3.	Willi Richert, Luis Pedro Coelho, “Building Machine Learning Systems with Python”, 2nd Edition, Packt Publishing Ltd., 2015.
4.	Christopher Bishop, “Pattern Recognition and Machine Learning”, Springer-Verlag New York, 2013.

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 analyze machine learning algorithms	Analyzing (K4)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	2		1
CO2	3	2	2	2		1
CO3	3	2	2	2		1
CO4	3	2	2	2		1
CO5	3	2	2	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	30	60				100
CAT3	10	30	50	10			100
ESE	10	30	50	10			100

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

22MST12 - COMMUNICATION NETWORKS							
Programme& Branch	**M.E. – Computer Science and Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1**	**PC**	**3**	**1**	**0**	**4**

Preamble	Learn and understand the various types of communication networks	
Unit – I	**Networking concepts:**	**9+3**
Network models, Application Layer : Web and HTTP– SMTP–DNS- Transport Layer: services – multiplexing and demultiplexing – Reliable data transfer and TCP Congestion control–Network layer: Forwarding and Addressing – Routing algorithms– Data link Layer: introduction, Error detection and correction techniques		
Unit – II	**Wireless LANs and PANs:**	**9+3**
Introduction: Fundamentals of wireless transmission, Electromagnetic spectrum, characteristics of wireless channel– multiple access techniques– Wireless LANs: Fundamentals– IEEE 802.11: Physical Layer–MAC layer –CSMA/CA mechanism– Bluetooth :Specifications– Transport Protocol Group:radio layer, Baseband layer,piconet,operational states		
Unit – III	**Ad hoc Networks :**	**9+3**
Introduction: Cellular and Ad Hoc Networks, Applications– Issues in Ad Hoc Networks–MAC protocols: Issues and design goals of MAC protocols–MACAW–Routing protocols: Issues, classifications– DSDV-DSR- Transport layer : Issues and design goals of Transport layer protocol- TCP over ad hoc wireless network : Feedback TCP, Split-TCP		
Unit – IV	**Software Defined Networks:**	**9+3**
SDN: Background and motivation– Data plane: Functions and protocols– OpenFlow logical network device–OpenFlow protocol–Control Plane: Architecture–ITU-T model– OpenDayLight – REST–cooperation and coordination among controllers– Application Plane: architecture-network services abstraction layer-traffic engineering –measurement and monitoring-security-data center networking.		
Unit – V	**Network Virtualization:**	**9+3**
Network Functions Virtualization: Background and motivation for NFV – virtual machines–NFV Concepts–Benefits–requirements–reference architecture- NFV functionality : Infrastructure, Virtualized Network Functions–management and orchestration– Network Virtualization: Virtual LANs–OpenFlow VLAN support		
		Lecture:45, Tutorial:15, Total:60

REFERENCES:

1.	Kurose James F. and Ross Keith W., “Computer Networking: A Top-Down Approach”, 8thEdition, Pearson Education, New Delhi, 2020.
2.	C. Siva Ram Murthy and B.S. Manoj, "Ad Hoc Wireless Networks: Architectures and Protocols", Pearson Education, New Delhi, 2008.
3.	William Stallings, “Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud”, Pearson Education, New Delhi, 2016
4.	Behrouz A. Forouzan, “Data Communications and Networking”, McGraw-Hill, 5th Edition, New Delhi,2015
5.	Tanenbaum, Andrew S. and David Wetherall, “Computer Networks”, 5th Edition, Prentice Hall of India, New Delhi, 2012.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		BT Mapped (Highest Level)
CO1	identify the different components required for designing a network	Applying (K3)
CO2	choose the different techniques for building WLAN standards	Applying (K3)
CO3	experiment the different routing protocols for the given wireless networks scenario	Applying (K3)
CO4	design a simple software defined network	Applying (K3)
CO5	experiment the network virtualization in Virtual LAN environment	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	2		
CO2	3	2	1	2		
CO3	3	2	1	2		
CO4	3	2	1	2		
CO5	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	60	30				100
CAT2	10	60	30				100
CAT3	20	60	20				100
ESE	10	55	35				100

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

22MST13 - MULTICORE ARCHITECTURES							
Programme & Branch	**M.E & Computer Science and Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites		**1**	**PC**	**3**	**0**	**0**	**3**

Preamble	This course will introduce the concepts 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**
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**
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**
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 with OpenMP**	**9**
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- Parallel Programming with OpenMP.		
Unit – V	**RLP and DLP in Warehouse Scale Computers:**	**9**
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.		
		Total:45

REFERENCES:

1.	John L. Hennessey and David A. Patterson, "Computer Architecture – A Quantitative Approach", 6th Edition, Morgan Kaufmann, Elsevier, 2019.
2.	Rohit Chandra (Author), Ramesh Menon, "Parallel Programming in OpenMP", Elsevier , 2000.
3.	Kai Hwang, "Advanced Computer Architecture", Tata McGraw-Hill Education, 2003.
4.	Kai Hwang , NareshJotwani, "Advance Computer Architecture: Parallelism, Scalability, Programmability", 3rd Edition, McGraw Hill Education,2017

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	examine 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

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	1			
CO2	3	1	1			
CO3	3	1	1			
CO4	3	1	1			
CO5	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	30	30	20	20			100
CAT2	20	20	30	30			100
CAT3	20	40	30	10			100
ESE	10	30	40	20			100

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

22MIL11 - DATA STRUCTURES AND ANALYSIS OF ALGORITHMS LABORATORY							
(Common to MTech-Information Technology and ME-Computer Science and Engineering branches)							
Programme& Branch	**MTech-Information Technology & ME - Computer Science and Engineering branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**1**	**PC**	**0**	**0**	**2**	**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 EXPERIMENTS / EXERCISES:

1.	Implement any two sorting algorithms
2.	Implement Binary Search Trees
3.	Implement Red-Black trees – Insertion and Display
4.	Implement 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
	Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Laboratory Manual

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	demonstrate the use of data structure for solving the given problem	Applying (K3) Precision(S3)
CO2	choose and employ appropriate design technique to solve real world problems	Applying (K3) Precision(S3)
CO3	apply operations like searching, insertion, deletion and traversing on various data structures	Applying (K3) Precision(S3)

Mapping of COs with POs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	2	2		
CO2	3	1	2	2		
CO3	3	1	2	2		

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

22MSL11 - MACHINE LEARNING LABORATORY							
(Common to ME-Computer Science and Engineering & MTech-Information Technology branches)							
Programme& Branch	**M.E. – Computer Science and Engineering & MTech-Information Technology branches**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**1**	**PC**	**0**	**0**	**2**	**1**

Preamble	Exposed to apply the various supervised and unsupervised learning algorithms to solve real time problems

LIST OF EXPERIMENTS / EXERCISES:

1.	Implementation of preprocessing techniques
2.	Implementation of linear regression
3.	Implementation of PCA for dimensionality reduction
4.	Implementation of Decision tree
5.	Implementation of k-means clustering
6.	Implementation of k-NN
7.	Implementation of Multilayer perceptron for classification
8.	Implementation of Backpropagation algorithm
9.	Implementation of Gaussian Mixture Model Using the Expectation Maximization
10.	Comparison of linear regression and decision tree algorithm for the given dataset
11.	Comparison of kernel functions of Support Vector Machine for the given dataset
12.	Evaluating machine learning algorithm with balanced and unbalanced datasets
	Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Operating System : Windows/Linux
2.	Software : MATLAB, Python, R
3.	Laboratory Manual

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	Applying (K3), Precision (S3)
CO2	implement the unsupervised algorithms and evaluate the performance	Applying (K3), Precision (S3)
CO3	implement and compare the performance of different algorithms	Applying (K3), Precision (S3)

Mapping of COs with POs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	2	2		1
CO2	3	1	2	2		1
CO3	3	1	2	2		1

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

22MST21- 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	PC	3	0	0	3

Preamble	This course willhelp the students to understand the fundamental concepts in the design of deep neural networks and to implement its various architectures. It also explores different dimensions of deep learning applications.	
Unit – I	**Foundations of Deep Learning:**	**9**
Linear Regression: Linear Regression – LR Implementation from Scratch – Implementation of LR – Softmax Regression – The image Classification dataset – Implementation of Softmax Regression from Scratch - Concise Implementation of Softmax Regression. **Multilayer Perceptrons:** MLP- Implementation of MLP from Scratch - Concise Implementation of MLP - Model Selection, Underfitting, and Overfitting - Weight Decay – Dropout - Forward & Backward Propagation, and Computational Graphs - Numerical Stability and Initialization.		
Unit – II	**Convolutional Neural Networks:**	**9**
Convolutional Neural Networks: Fully-Connected Layers to Convolutions - Convolutions for Images - Padding and Stride - Multiple Input and Multiple Output Channels – Pooling. **Modern Convolutional Neural Networks:**LeNet – AlexNet – VGG – NiN – GoogleLeNet - Batch Normalization – ResNet – DenseNet		
Unit – III	**Recurrent Neural Networks:**	**9**
Recurrent Neural Networks: Sequence Models - Text Preprocessing - Language Models and the Dataset – RNN – Implementation of RNN from Scratch - Concise Implementation of RNN - Backpropagation Through Time**. Modern Recurrent Neural Networks:** GRU – LSTM – Deep RNN – Bi-RNN - Machine Translation and the Dataset - Encoder-Decoder Architecture - Sequence to Sequence Learning - Beam Search		
Unit – IV	**Attention Mechanisms and Transformers:**	**9**
Attention Cues - Attention Pooling - Attention Scoring Functions - Bahdanau Attention - Multi-Head Attention - Self-Attention and Positional Encoding - The Transformer Architecture - Transformers for Vision - Large-Scale Pretraining with Transformers.		
Unit – V	**Recommender Systems and Generative Adversarial Networks:**	**9**
Recommender Systems : Overview of Recommender Systems - The MovieLens Dataset - Matrix Factorization - AutoRec: Rating Prediction with Autoencoders - Personalized Ranking for Recommender Systems - Neural Collaborative Filtering for Personalized Ranking - Sequence-Aware Recommender Systems - Feature-Rich Recommender Systems - Factorization Machines - Deep Factorization Machines. **Generative Adversarial Networks:** GAN - Deep Convolutional Generative Adversarial Networks		
		Total:45

REFERENCES:

1. Aston Zhang, “Dive into Deep Learning”, Link: https://classic.d2l.ai/chapter_preface/index.html
2. Andrew Glassner, “Deep Learning: A Visual Approach”, https://archive.org/details/deep-learning-a-visual-approach/mode/2up
3. IndradenBakker,“PythonDeepLearningCookbook”,1st Edition,PacktPublishing,October2017.
4. Josh Patterson and AdamGibson,“DeepLearning–APractitioner"sApproach”, 1st Edition,O"ReillySeries,August2017
5. IanGoodfellow, YoshuaBengio and Aaron Courville,“DeepLearning”,1st Edition, MITPress,2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	apply the concepts of regression and multilayer perceptron to solve simple problems	Applying (K3)
CO2	exemplify the concepts of CNN models and apply it for solving computer vision related problems	Applying (K3)
CO3	apply the concepts of RNN models for solving natural language processing and time series prediction problems	Applying (K3)
CO4	makeuseofTensorflow/kerasframeworksto build attention based models in deep learning.	Applying (K3)
CO5	Utilize deep learning methods for developing recommender systems and Generative Adversarial Networks for solving real world problems	Applying (K3)

Mapping of COs with POs and PSOs

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		

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	30	60				100
ESE	10	30	60				100

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

22MST22 - DATA ANALYTICS

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

Preamble	This course helps students to understand the concepts of data analytics and its lifecycle. The course also focuses on application of statistical techniques, time series analysis, text mining and Hadoop for analysing big data and building solutions.	
Unit – I	**Introduction:**	**9**
Data Analytics lifecycle - Exploratory Data Analysis - Data Cleaning and Preparation : Handling missing data-Data transformation-Data wrangling: join, Combine, and Reshape- Hierarchical Indexing - Combining and Merging Datasets - Reshaping and Pivoting. Plotting and Visualization - Data Aggregation and Group Operations-Dimensionality Reduction-Principal Component Analysis(PCA).		
Unit – II	**Statistical Analysis:**	**9**
Hypothesis Testing-difference of means - Chi-Square test-Students t-test - Welch's t-test-Wilcoxon Rank-Sum Test - Type I and Type II Errors-Power and Sample Size-ANOVA -Analysis of variance - Correlation analysis-Regression analysis.		
Unit – III	**Time Series Analysis:**	**9**
Overview of Time Series Analysis-Box-Jenkins Methodology-Autoregressive Models-Moving Average Models-ARMA and ARIMA Models-Additional Methods.		
Unit – IV	**Text Analysis:**	**9**
Text Analysis Steps-Part-of-Speech (POS) Tagging, Lemmatization, and Stemming-A Text Analysis Example-Collecting raw text-Representing text-Term Frequency—Inverse Document Frequency (TFIDF)-Categorizing Documents by Topics- Sentiment Analysis- Gaining Insights.		
Unit – V	**Bigdata Analytics:**	**9**
Use Cases - Mapreduce - Apache Hadoop-Yet Another Resource Negotiator (YARN)-The Hadoop Ecosystem-Pig-Hive-HBase-Mahout-NoSQL.		
		Total:45

REFERENCES:

1.	Wes McKinney, "Python for Data Analysis", 2nd Edition, O'Reilly Media Publication, 2017. Unit 1
2.	EMC Education Services (Editor), "Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data", 1st Edition, John Wiley & Sons,2015. Unit 2-5
3.	Douglas C. Montgomery George C. Runger, "Applied Statistics and Probability for Engineers", 6th Edition, John Wiley & Sons, 2016.
4.	Albright S Christian, Winston Wayne L and Zappe Christopher, "Data analysis and Decision Making", South Western College Publication, 2010.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	identify the data types and make use of exploratory data analysis with the real time data.	Applying (K3)
CO2	interpret and communicate the outcomes of estimation and hypothesis tests in the context of a problem.	Applying (K3)
CO3	make use of time series models and testing forecasting accuracy tests with the real time data.	Applying (K3)
CO4	employ text analytics techniques for building solutions for text mining problem.	Applying (K3)
CO5	Apply hadoop and map reduce for data analytics applications.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**								
CO1	3	2	1	1	1									
CO2	3	2	1	1	1									
CO3	3	2	1	1	1									
CO4	3	2	1	1	1									
CO5	3	2	1	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	30	50				100
CAT2	20	30	50				100
CAT 3	20	30	50				100
ESE	20	30	50				100

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

22MST23 - 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–SSHRemote 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. (II to first half of IV)
2.	BehrouzA.Forozan, - Cryptography and Network Security, Tata McGraw-Hill, Special Indian Edition,2008(I and second half of IV)
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	apply the legal and ethical issues of security and management	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2		1		
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	30	60				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)

22MSL21 - DEEP LEARNING LABORATORY								
Programme& Branch	**M.E. & Computer Science and Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Fundamental concepts of Algorithms and computer programming	**2**	**PC**	**0**	**0**	**2**	**1**

Preamble	This course deals with various algorithms to enable computers to learn data without being explicitly programmed. An insight into various types of deep learning algorithms, strategies for model generation and evaluation.

LIST OF EXPERIMENTS / EXERCISES:

1.	Explore the various deep learning libraries like PyTorch, TensorFlow, MXNet, etc.,
2.	Predict house prices using multi-layer neural network
3.	Test the performance of multi-layer neural network with various activation and loss functions
4.	Develop a simple application for Object detection in Images
5.	Demonstrate a simple application for Image classification using CNN
6.	Create RNN-based Character-Level Language Model
7.	Design a bidirectional RNN with multiple hidden layers
8.	Implement the attention mechanism in the neural network
9.	Implement collaborative filtering based Recommendation system
10.	Develop a simple application using GAN
11.	Implement a simple application for Human Face Detection using CNN
12.	Build a simple application for Named Entity Recognition using LSTM
	Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Operating System : Windows/Linux
2.	Software : Anaconda/Python
3.	Laboratory Manual

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	build skills in DL tools/libraries in the field of designing, training and deploying simple neural networks for solving different practical/engineering problems.	Applying (K3), Precision (S3)
CO2	identify and develop various CNN/RNN based models to solve real world problems.	Applying (K3), Precision (S3)
CO3	implement attention mechanism, recommendation system and Generative Adversarial Networks to develop diverse applications.	Applying (K3), Precision (S3)

Mapping of Cos with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	1	1		
CO2	3	3	2	1		
CO3	3	3	1	1		

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

22MSL22 - DATA ANALYTICS LABORATORY							
Programme & Branch	**ME & Computer Science and Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**2**	**PC**	**0**	**0**	**2**	**1**

Preamble	This course focuses on providing hands on experience in designing and implementing data analytics techniques for providing solutions to the real world problems.

LIST OF EXPERIMENTS / EXERCISES:

1.	Demonstrate the missing data handling approaches for the given data set.
2.	Perform exploratory data analysis with simple visualizations using real time data.
3.	Demonstrate data wrangling concepts using sample dataset.
4.	Perform dimensionality reduction for the given data.
5.	Computing summary statistics using real time data.
6.	Demonstrate testing of hypothesis for Small and Large sample tests for real-time problems.
7.	Apply simple linear and multiple linear regression models to real dataset.
8.	Apply Time series model AR , ARMA and ARIMA and testing Forecasting accuracy tests.
9.	Apply Text Analysis concepts with the sample dataset.
10.	Perform Topic modeling using real time data.
11.	Demonstrate the sentiment analysis process with the sample dataset.
12.	Demonstrate the Hadoop and map reduce concept using sample dataset.

Total:30

REFERENCES/ MANUAL /SOFTWARE:

1.	Operating System : Windows/Linux
2.	Software : Python / R
3.	Laboratory Manual

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	demonstrate the data preprocessing concepts and show the visualization results using real time data.	Applying (K3), Precision (S3)
CO2	apply different statistical analysis, time series analysis and text analysis to real data set.	Applying (K3), Precision (S3)
CO3	experiment Hadoop and map reduce concepts using sample dataset.	Applying (K3), Precision (S3)

Mapping of COs with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	1	1	1	
CO2	3	2	1	1	1	
CO3	3	2	1	1	1	

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

22MSP31 - PROJECT WORK I							
Programme & Branch	**ME - Computer Science and Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Programming Languages**	**3**	**EC**	**0**	**0**	**16**	**8**

Preamble	It provides practical exposure to the students and an opportunity to apply the computational mathematics concepts to solve the real world problems. It also gives opportunity to the students to work in a team.

Total:240

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	formulate specific problem statements for ill-defined real life problems with reasonable assumptions and constraints.	Creating (K6), Precision (S3)
CO2	perform literature search in the area of interest.	Evaluating (K5), Precision (S3)
CO3	conduct experiments, design and analysis, solution iterations and document the results.	Evaluating (K5), Precision (S3)
CO4	perform error analysis and synthesize the results and arrive at scientific conclusions.	Evaluating (K5), Precision (S3)
CO5	document the results in the form of technical report and give oral presentation	Creating (K6), Precision (S3)

Mapping of Cos with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	2	2	3	3	3	3	3	3	3	3	3
CO3	3	3	3	2	2	3	3	3	3	3	3	3	3	3
CO4	3	3	3	2	2	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

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

22MSP41 - PROJECT WORK II							
Programme & Branch	**ME - Computer Science and Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Programming Languages**	**4**	**EC**	**0**	**0**	**24**	**12**

Preamble	It provides practical exposure to the students and an opportunity to apply the computational mathematics concepts to solve the real world problems. It also gives opportunity to the students to work in a team.
	Total:360

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	formulate specific problem statements for ill-defined real life problems with reasonable assumptions and constraints.	Creating (K6), Precision (S3)
CO2	perform literature search in the area of interest.	Evaluating (K5), Precision (S3)
CO3	conduct experiments, design and analysis, solution iterations and document the results.	Evaluating (K5), Precision (S3)
CO4	perform error analysis and synthesize the results and arrive at scientific conclusions.	Evaluating (K5), Precision (S3)
CO5	document the results in the form of technical report and give oral presentation	Creating (K6), Precision (S3)

Mapping of Cos with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	2	2	3	3	3	3	3	3	3	3	3
CO3	3	3	3	2	2	3	3	3	3	3	3	3	3	3
CO4	3	3	3	2	2	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

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

22MSE01 - DATA MINING TECHNIQUES							
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 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	**Classifier:**	**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	**Cluster Analysis:**	**9**
Partitioning Methods–Hierarchical Methods–Density based Methods - Gridbased Methods - Evaluation of Clustering – Outliers and Outlier analysis - Outlier detection Methods - Statistical Approaches.		
Unit – V	**Application:**	**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.		
		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 and PSOs

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	15	25	60				100
CAT2	15	35	50				100
CAT3	15	35	50				100
ESE	10	30	60				100

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

22MSE02 - BUSINESS INTELLIGENCE							
Programme & Branch	**M.E Computer Science and Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Database , SQL Queries	**2**	**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.		
		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	apply multidimensional model for integration and reporting services	Applying (K3)
CO4	summarize the functionalities of key performance indicators	Applying (K3)
CO5	apply BI to mobile, cloud, ERP and social CRM systems	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	1			
CO2	2	3	1	2		
CO3	2	2	2	2		
CO4	3	2	2	2		
CO5			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	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)

22MSE03 - CLOUD COMPUTING							
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 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.

Total:45

REFERENCES:

1. Barrie Sosinsky, “Cloud Computing Bible”, 1st Edition, Wiley Publishing, 2015., for Units 1,2,3,4,5
2. Kai Hwang, Geoffrey C Fox & Jack G Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Reprint Edition, Morgan Kauffmann , 2017.
3. www.openstack.org
4. Rajkumar Buyya, James Broberg & Andrzej M. Goscinski, "Cloud Computing: Principles and Paradigms", Wiley, 2013.

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 and PSOs

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	20	60	20				100
CAT2	20	60	20				100
CAT3	20	40	20	20			100
ESE	20	45	20	15			100

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

22MSE04 - COMPILER DESIGN TECHNIQUES							
Programme & Branch	**M.E.- Computer Science and Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Programming Language**	**2**	**PE**	**3**	**0**	**0**	**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.

Introduction:	**Introduction**	**9**
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.		
Optimization:	**Optimization**	**9**
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**	**9**
Processor Architectures **-** Code-Scheduling Constraints- Basic-Block Scheduling -Global Code Scheduling -Software Pipelining.		
Unit – IV	**Optimizing for Parallelism and Locality**	**9**
Basic Concepts**-** Matrix-Multiply-An Example -Iteration Spaces - Affine Array Indexes - Data Reuse -Array data dependence Analysis**-** Finding Synchronization - Free Parallelism- Pipelining.		
Unit – V	**Inter procedural Analysis and Register Allocation**	**9**
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.		
		Total:45

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	Applying (K3)
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	Applying (K3)

Mapping of COs with POs and PSOs

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											

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	15	45	40				100
CAT3	15	45	40				100
ESE	15	35	50				100

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

22MSE05 – 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**	**2**	**PE**	**3**	**0**	**0**	**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:**	**9**
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:**	**9**
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:**	**9**
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:**	**9**
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:**	**9**
Introduction to OpenCL – OpenCL example – Platforms, Contexts and Devices – OpenCL programming in C – Simple Programs.		
		Total:45

REFERENCES:

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

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	Applying (K3)
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)

Mapping of COs with POs and PSOs

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		

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	20	40	40				100
ESE	20	40	40				100

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

22MSE06 - 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	3	0	0	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:**	**9**
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:**	**9**
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:**	**9**
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:**	**9**
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:**	**9**
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.		
		Total:45

REFERENCES:

1.	Arshdeep Bahga and Vijay Madisetti, “Internet of Things - A Hands-on Approach”, Universities Press, 2015 for units- 1,3,4
2.	Honbo Zhou, “The Internet of Things in the Cloud: A Middleware Perspective”, 1st Edition, CRC Press, 2012 for unit 2
3.	Raj Kamal, “Internet of Things: Architecture and Design Principles”, McGraw Hill , 2017 for unit 5
4.	Simon Monk, “Raspberry Pi Cookbook”, First Edition, O’Reily, 2014
5.	http://www.steves-internet-guide.com/mqtt/
6.	https://cloud.ibm.com/docs/solution-tutorials?topic=solution-tutorials-gather-visualize-analyze-iot-data

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	Applying (K3)
CO2	examine the suitable protocol and middleware for the given application	Applying (K3)
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 and IoT applications using Cooja Simulator and Raspberry Pi	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	1		
CO2	3	2	1	1		
CO3	3	2	1	1		
CO4	3	2	1	1		
CO5	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	30	30	40				100
CAT2	15	40	45				100
CAT3	15	40	45				100
ESE	15	40	45				100

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

22MSE07– VEHICULAR ADHOC NETWORKS							
Programme & Branch	**M.E. – Computer Science and Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Communication Networks**	**2**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course provides an overview about vehicular adhoc networks, its challenges and applications. This course also provides theories such as vehicular mobility modeling, physical and MAC layer considerations, application level coding, composition and security aspects.

Unit – I	**Introduction to VANET:**	**9**
Introduction: Basic principles and challenges, past and ongoing VANET activities – Cooperative vehicular safety applications: Enabling technologies, cooperative system architecture, safety applications – Information dissemination in VANETs – VANET convenience and efficiency applications.		
Unit – II	**Vehicular Mobility Modeling:**	**9**
Introduction – random models – flow and traffic models – behavioral models – trace and survey-based models – integration with network simulators – design framework for realistic vehicular mobility models.		
Unit – III	**Physical Layer:**	**9**
Standards overview – Wireless propagation theory – Channel metrics – Measurement theory – Empirical channel characterization at 5.9 GHz – Future directions.		
Unit – IV	**MAC layer and Scalability aspects:**	**9**
Challenges and requirements – MAC approaches for VANETs – Communication based on IEEE 802.11p – Performance evaluation and modeling – Aspects of congestion control – Open issues.		
Unit – V	**Application level coding and Security:**	**9**
Application level message coding: Introduction to the application environment – message dispatcher – example applications – datasets – predictive coding – architecture analysis – Data security in Vehicular networks: challenges – models – infrastructure – cryptographic protocols – privacy protection mechanisms – implementation aspects.		
		Total:45

REFERENCES:

1.	H. Hartenstein and K. P. Laberteaux, VANET: Vehicular Applications and InterNetworking Technologies, First Edition, Wiley, 2010
2.	P. H.-J. Chong, I. W.-H. Ho, Vehicular Networks: Applications, Performance Analysis and Challenges, Nova Science Publishers, 2019.
3.	C. Sommer, F. Dressler, Vehicular Networking, Cambridge University Press, 2015.
4.	M. Emmelmann, B. Bochow and C. C. Kellum, Vehicular Networking: Automotive Applications and Beyond, Wiley, 2010.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	Identify the suitable architecture for the challenges in VANET applications	Applying (K3)
CO2	Design a suitable mobility model for the vehicular networks	Applying (K3)
CO3	Predict the suitable configurations for the physical layer of vehicular networks	Applying (K3)
CO4	Propose the suitable configurations for the MAC layer of vehicular networks	Applying (K3)
CO5	Model the application level and security aspects of vehicular networks	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	3		
CO2	3	2	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	65	20				100
CAT2	15	65	20				100
CAT3	15	65	20				100
ESE	15	65	20				100

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

22MSE08– 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.							
							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 and PSOs

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)

22MSE09- 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 power of randomization in the design and analysis of algorithms is introduced. The most widely used techniques for the analysis of randomized algorithms and the behaviour of random structures from a theoretical perspective are covered

Unit – I	**Introduction:**	**9**
Min-Cut Algorithm -Binary Planar Partitions - A Probabilistic Recurrence- Computation Model and Complexity Classes-Game-theoretic techniques: Game Tree Evaluation-The Minimax principle-Randomness and Non-uniformity -Moments and deviations: Occupancy Problems, Markov and Chebyshev Inequalities		
Unit – II	**Tail Inequalities:**	**9**
Chernoff Bound - Routing in a parallel Computer - A wiring Problem – Martingales - The probabilistic method Overview - Maximum Satisfiability - Expanding Graphs - Lovasz Local Lemma - Method of Conditional Probabilities.		
Unit – III	**Markov Chains:**	**9**
A 2-SAT Example- Markov Chains- Random Walks on Graphs-Electrical Networks- Cover Times- Graph Connectivity-Expanders and Rapidly Mixing Random Walks - Probability Amplification by Random Walks on Expanders		
Unit – IV	**Data Structures:**	**9**
Fundamental Data-structuring problem - Random Treaps - Skip Lists -Hash Tables Universal Family of Hash Functions -Perfect Hashing - Graph algorithms- All-pairs Shortest Paths - Min-cut Problem - Minimum Spanning Trees.		
Unit – V	**Randomized Computational Geometry:**	**9**
Randomized Incremental Construction - Convex Hulls in the Plane - Delaunay Triangulations - Trapezoidal Decompositions - Random Sampling - Linear Programming Randomized Approximation Schemes-PRAM model and its sorting-Byzantine Agreement		
		Total:45

REFERENCES:

1.	Rajeev Motwani and Prabhakar Raghavan, “Randomized Algorithms”, 1st Edition, Cambridge University Press, Reprint 2010 for Units (I to V)
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	Applying (K3)
CO5	examine the different geometrical, parallel and distributed algorithms for various randomness applications.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	1		
CO2	3	2	1	1		
CO3	3	2	1	1		
CO4	3	2	1	1		
CO5	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	20	40	40				100
CAT2	20	40	40				100
CAT3	20	40	40				100
ESE	10	40	50				100

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

22MSE10- 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.		
		Total:45

REFERENCES:

1.	David Easley, Jon Klienberg, "Networks, Crowds, and Markets: Reasoning about a Highly Connected World", 1st Edition, Cambridge University Press, 2010, for Units I, II, III, IV,V.
2.	Stanley Wasserman, Katherine Faust, "Social Networks Analysis: Methods and Applications", 1st Edition, Cambridge University Press, 2010.
3.	Charles Kadushin, "Understanding Social Networks: Theories, Concepts, and Findings", 1st Edition, 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 and PSOs

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	40	50				100
CAT2	10	40	50				100
CAT3	10	40	35	15			100
ESE	10	40	40	10			100

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

22MSE11- ADVANCED DATABASE TECHNOLOGY							
Programme & Branch	**M.E. – Computer Science and Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**NIL**	**2**	**PE**	**3**	**0**	**0**	**3**

Preamble	To provide an in-depth and up-to-date presentation of the most important aspects of database systems and applications, and related technologies for real time applications.	
Unit - I	**Relational Model:**	**9**
Relational Model – Database Schema – ER Model – complex attributes – mapping cardinalities – removing redundant attributes – reducing ER to relational schema – relational database design – normal forms		
Unit - II	**Parallel and Distributed Databases:**	**9**
Database System Architectures: Centralized database systems - Server System Architectures - Parallel Systems - Distributed Systems - Parallel and distributed data storage: Data partitioning – replication – parallel indexing Parallel and distributed query processing: parallel sort – parallel join - Parallel and Distributed Transaction Processing: distributed transactions – commit protocols – concurrency control in distributed databases – replication.		
Unit - III	**Object and Object-Relational Databases and XML:**	**9**
Object Database Concepts - The ODMG Object Model and the Object Definition Language - Object Database Conceptual Design - Structured, Semi structured, and Unstructured Data - XML Hierarchical (Tree) Data Model - XML Documents, DTD, and XML Schema - Storing and Extracting XML Documents from Databases - XML Languages		
Unit - IV	**Advanced Database Models and Systems:**	**9**
Active Database Concepts and Triggers - Temporal Database Concepts - Spatial Database Concepts - Multimedia Database Concepts - Introduction to Deductive Databases - Information Retrieval and Web Search -Information Retrieval (IR) Concepts - Retrieval Models - Types of Queries in IR Systems - Text Preprocessing - Inverted Indexing -Evaluation Measures of Search Relevance - Web Search and Analysis - Trends in Information Retrieval.		
Unit - V	**NOSQL Databases and Big Data Storage Systems:**	**9**
NOSQL Systems - The CAP Theorem - Document-Based NOSQL Systems and MongoDB - NOSQL Key-Value Stores - Column-Based or Wide Column NOSQL Systems - NOSQL Graph Databases and Neo4j - Big Data - Introduction to MapReduce and Hadoop - Hadoop Distributed File System (HDFS) - MapReduce: Additional Details - Hadoop v2 alias YARN		
		Total:45

REFERENCES:

1.	Henry F Korth, Abraham Silberschatz, S. Sudharshan, "Database System Concepts", Seventh Edition, McGraw Hill, 2019
2.	R. Elmasri, S.B. Navathe, "Fundamentals of Database Systems", Seventh Edition, Pearson Education, 2017.
3.	Thomas Cannolly and Carolyn Begg, "Database Systems, A Practical Approach to Design, Implementation and Management", Sixth Edition, Pearson Education, 2015.
4.	C. J. Date, A.Kannan and S. Swamynathan, "An Introduction to Database Systems", Eighth Edition, Pearson Education, 2006.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	design and implement relational databases.	Applying (K3)
CO2	design a semantic based database to meaningful data access	Applying (K3)
CO3	represent the data using XML database for better interoperability	Applying (K3)
CO4	embed the rule set in the database to implement intelligent databases	Applying (K3)
CO5	design and implement NoSQL database.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3		
CO2	3	2	3	3		
CO3	3	2	3	3		
CO4	3	2	3	3		
CO5	3	1	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	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)

22MSE12 – SOFTWARE DEFINED NETWORKING

Programme & Branch	**M.E. – Computer Science and Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Communication Networks**	**2**	**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	**Introduction**	**9**
Traditional switch Architecture, Autonomous and Dynamic Forwarding Table- need for SDN- The Genesis of SDN, How SDN works, The OpenFlow Specification , OpenFlow 1.0 and OpenFlow Basics, OpenFlow 1.1 and OpenFlow 1.3		
Unit – II	**SDN in Data Center**	**9**
SDN in the Data Center, SDN Use Cases in the Data Center, Open SDN versus Overlays in the Data Center, SDN in other Environments, SDN Applications, SDN Open Source, Switch Implementation, Controller Implementation, SDN Futures		
Unit – III	**SDN Control Plane**	**9**
Distributed Control plane, Centralized Control plane, OpenFlow, SDN Controllers, Network Programmability, Data Center concepts and constructs, The Virtualized Multitenant Data Center, SDN solution for Data Center Network		
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 Use cases:**	**9**
Usecases for Bandwidth Scheduling, Manipulation and calendaring, Data Center Overlays, Big Data and Network Function Virtualization, Input Traffic Monitoring, Classification, and Triggered Actions.		
		Total:45

REFERENCES:

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

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	experiment the data plane and control plane of software defined networks	Applying (K3)
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 and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	1		
CO2	3	2	1	1		
CO3	3	2	1	1		
CO4	3	2	1	1		
CO5	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	30	50	20				100
CAT2	35	35	30				100
CAT3	30	30	40				100
ESE	30	30	40				100

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

22MSE13 - 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.		
		Total:45

REFERENCES:

1.	Daniel Jurafsky and James H. Martin, “Speech and Language Processing”, Pearson Education, 2017.
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	use morphological analysis and Finite State Transducers to analyze word structure	Applying (K3)
CO2	apply Probabilistic approaches for Spelling and use N-grams for Language Modelling	Applying (K3)
CO3	make use of CFG and Probabilistic Parsing to analyze sentences	Applying (K3)
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 and PSOs

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	15	50	35				100
CAT2	15	50	35				100
CAT3	15	50	35				100
ESE	15	55	30				100

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

22MSE14 – 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	**Problem Solving and Searching:**	**9**
Evolution of Modern Computational Intelligence - Problem Solving by Search - Informed (Heuristic) Search - Iterative Search - Adversarial Search.		
Unit – II	**Logic and Knowledge Base Systems:**	**9**
Knowledge Representation and Reasoning - Rule-Based Expert Systems - Managing Uncertainty in Rule Based Expert Systems.		
Unit – III	**Fuzzy and Neural Systems:**	**9**
Fuzzy Expert Systems – Artificial Neural Networks - Advanced Artificial Neural Networks.		
Unit – IV	**Learning from Data:**	**9**
Machine Learning – Decision Trees Evolutionary Algorithms - Evolutionary Meta heuristics.		
Unit – V	**Bio-Inspired Intelligence:**	**9**
Swarm Intelligence - Hybrid Intelligent Systems.		
		Total:45

REFERENCES:

1.	Crina Grosanand, Ajith Abraham, "Intelligent Systems – A modern approach", Springer – Verlag Berlin Heidelberg, 1st Edition,2011.
2.	Robert J. Schalkoff, “Intelligent Systems Principles, Paradigms and Pragmatics”, Jones and Bartlett Publishers, LLC, 2011.First Edition
3.	N.P.Padhy, “Artificial Intelligence and Intelligent Systems”, Oxford University Press, 2005. Illustrated Edition

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	apply search techniques and heuristics for solving problems	Applying (K3)
CO2	make use of logic in knowledge representation and reasoning	Applying (K3)
CO3	identify the role of fuzzy and neural systems in building intelligent systems	Applying (K3)
CO4	build the machine learning techniques using datasets	Applying (K3)
CO5	employ bio-inspired algorithms and build hybrid intelligence systems	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	2			
CO2	3	1	2			
CO3	3	2	3			
CO4	3	2	3	2		
CO5	2	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	30	45	25				100
CAT2	20	45	35				100
CAT3	20	45	35				100
ESE	20	45	35				100

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

22MSE15 - MOBILE AND PERVASIVE COMPUTING							
Programme & Branch	**ME & 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.		
		Total:45

REFERENCES:

1.	Schiller Jochen, “Mobile Communication”, 2nd Edition, PHI/Pearson Education, 2009, for Units – I and II
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, for Unit-III
3.	Seng Loke, “Context-Aware Pervasive Systems: Architectures for a New Breed of Applications”, 1st Edition, Auerbach Publications, 2006, for Unit – IV and V
4.	Natalia Silvis, “Pervasive Computing Engineering Smart Systems”, Springer, 2017

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 and PSOs

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	50	20			100
CAT2	10	45	35	10			100
CAT3	10	50	40				100
ESE	10	40	40	10			100

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

22MSE16 - NATURE INSPIRED OPTIMIZATION TECHNIQUES

Programme & Branch	**M.E. – Computer Science and Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Linear algebra and Calculus**	**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	**Introduction to Algorithms and Analysis of Algorithms:**	**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	**Simulated Annealing and Genetic Algorithms:**	**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	**Particle Swarm and Cat Swarm Optimization:**	**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	**TLBO Algorithm, Cuckoo Search and Bat Algorithms:**	**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	**Other Algorithms:**	**9**

Ant Algorithms - Bee-Inspired Algorithms - Harmony Search - Hybrid Algorithms.

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 and PSOs

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	20	15			100
CAT2	10	35	30	25			100
CAT3	10	35	30	25			100
ESE	5	35	40	20			100

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

22MSE17 - SECURITY PRACTICES							
Programme & Branch	**M.E – Computer Science and Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Basics of networks and security**	**3**	**PE**	**3**	**0**	**0**	**3**

Preamble	The course provides core fundamentals of system and web security concepts, detailed study of Privacy and Storage security and related Issues.	
Unit – I	**SYSTEM SECURITY:**	**9**
Building a secure organization- A Cryptography primer- detecting system Intrusion- Preventing system Intrusion- Fault tolerance and Resilience in cloud computing environments- Security web applications, services and servers.		
Unit – II	**NETWORK SECURITY:**	**9**
Internet Security - Botnet Problem- Intranet security- Local Area Network Security - Wireless Network Security - Wireless Sensor Network Security- Cellular Network Security- Optical Network Security- Optical wireless Security.		
Unit – III	**SECURITY MANEGEMENT:**	**9**
Information security essentials for IT Managers- Security Management System - Policy Driven System Management- IT Security - Online Identity and User Management System - Intrusion and Detection and Prevention system.		
Unit – IV	**CYBER SECURITY AND CRYPTOGRAPHY:**	**9**
Cyber Forensics- Cyber Forensics and Incidence Response - Security e-Discovery - Network Forensics - Data Encryption- Satellite Encryption - Password based authenticated Key establishment Protocols.		
Unit – V	**PRIVACY AND STORAGE SECURITY:**	**9**
Privacy on the Internet - Privacy Enhancing Technologies - Personal privacy Policies - Detection of Conflicts in security policies-privacy and security in environment monitoring systems. Storage Area Network Security - Storage Area Network Security Devices - Risk management - Physical Security Essentials.		
		Total:45

REFERENCES:

1.	John R.Vacca, Computer and Information Security Handbook, Second Edition, Elsevier 2013.
2.	Michael E. Whitman, Herbert J. Mattord, Principal of Information Security, Fourth Edition, Cengage Learning, 2012.

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	Understand the core fundamentals of system security.	Applying (K3)
CO2	Apply the security concepts related to networks in wired and wireless scenario.	Applying (K3)
CO3	Implement and Manage the security essentials in IT Sector.	Applying (K3)
CO4	Able to explain the concepts of Cyber Security and encryption Concepts.	Applying (K3)
CO5	Able to attain a through knowledge in the area of Privacy and Storage security and related Issues.	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	3	3		
CO2	3	2	2	3		
CO3	3	2	2	3		
CO4	3	3	3	2		
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	20	40	40				100
CAT2	40	30	30				100
CAT3	40	30	30				100
ESE	25	45	35				100

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

22MSE18 - DIGITAL IMAGE PROCESSING AND COMPUTER VISION

Programme & Branch	**M.E. – Computer Science and Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**3**	**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 Digital Image Fundamentals **9**

Introduction - Elements of Visual Perception- Light and the Electromagnetic Spectrum- Image Sensing and Acquisition-Image Sampling and Quantization-Some Basic Relationships between Pixels- Introduction to the Basic Mathematical Tools used in Digital Image Processing

Unit - II Intensity Transformations and Spatial Filtering **9**

Basic Intensity Transformation Functions- Histogram Processing- Fundamentals of Spatial Filtering-Smoothing Spatial Filters-Sharpening Spatial Filters- Highpass, Bandreject, and Bandpass Filters from Lowpass Filters- Combining Spatial Enhancement Methods. Wavelet and Other Image Transforms: Fourier-Related Transforms - Walsh-Hadamard Transforms - Slant Transform - Haar Transform - Wavelet Transforms.

Unit - III Image Restoration and Reconstruction **9**

A Model of the Image Degradation/Restoration process - Noise Models - Restoration in the Presence of Noise only—Spatial Filtering - Periodic Noise Reduction using Frequency Domain Filtering - Linear, Position - Invariant Degradations - Estimating the Degradation Function - Inverse Filtering - Minimum Mean Square Error (Wiener) Filtering - Constrained Least Squares Filtering- Geometric Mean Filter.

Unit - IV Image Compression and Segmentation **9**

Image Compression and Watermarking: Huffman Coding - Golomb Coding - Arithmetic Coding - LZW Coding - Run-length Coding. Segmentation: Fundamentals Point, Line, and Edge Detection -Thresholding - Segmentation by Region Growing and by Region Splitting and Merging - Region Segmentation using Clustering and Super pixels.

Unit – V 3D geometry, correspondence, 3D from intensities **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

Total:45

REFERENCES:

1. Rafael C. Gonzalez, Richard E. Woods, “Digital Image Processing”, 4th edition, Pearson, 2018
2. Distante , Arcangelo, Distante, Cosimo, “Handbook of Image Processing and Computer Vision”, Springer International Publishing, 2020
3. Milan Sonka, Vaclav Hlavac , Roger Boyle, “Image Processing, Analysis, and Machine Vision”, 4th edition, Cengage Learning, 2015

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	apply image fundamentals and mathematical tools necessary for image processing.	Applying (K3)
CO2	identify the significances of image transformations and spatial filtering	Applying (K3)
CO3	examine the fundamentals of image restoration and reconstruction	Applying (K3)
CO4	explore different compression and segmentation methods for different images	Applying (K3)
CO5	recognize the need for 3d vision and develop an application using it	Applying (K3)

Mapping of COs with POs and PSOs

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	15	50	35				100

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

22MSE19 - DATA SCIENCE							
Programme & Branch	**M.E. & Computer Science and Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**3**	**PE**	**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.		
		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 and PSOs

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	30	50				100
CAT2	20	20	60				100
CAT3	15	30	55				100
ESE	20	20	60				100

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

22MSE20 – INFORMATION STORAGE MANAEGMENT							
Programme & Branch	**M.E. – Computer Science and Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Computer Networks and Database Management Systems**	**3**	**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.		
		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 and PSOs

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)

22MSE21 - REINFORCEMENT LEARNING							
Programme & Branch	**M.E. & Computer Science and Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Deep Learning**	**3**	**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							**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							
							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 and PSOs

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	20	30	50				100
CAT2	20	30	50				100
CAT3	15	30	55				100
ESE	15	35	50				100

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

22MSE22 - VIRTUALIZATION TECHNIQUES							
Programme & Branch	**M.E. – Computer Science and Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	Operating system, Networking concepts	**3**	**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**
Basics of Virtualization - Virtualization Types – Desktop Virtualization – Network Virtualization – Server and Machine Virtualization – Storage Virtualization – System-level or Operating Virtualization – Application Virtualization-Virtualization Advantages – Virtual Machine Basics – Taxonomy of Virtual machines - Process Virtual Machines – System Virtual Machines – Hypervisor - Key Concepts.		
Unit - II	**Server Consolidation:**	**9**
Hardware Virtualization – Virtual Hardware Overview - Server Virtualization – Physical and Logical Partitioning - Types of Server Virtualization – Business cases for Sever Virtualization – Uses of Virtual server Consolidation – Planning for Development – Selecting server Virtualization Platform.		
Unit - III	**Network Virtualization:**	**9**
Design of Scalable Enterprise Networks - Virtualizing the Campus WAN Design – WAN Architecture- WAN Virtualization - Virtual Enterprise Transport Virtualization–VLANs and Scalability - Theory Network Device Virtualization Layer 2 - VLANs Layer 3 VRF Instances Layer 2 - VFIs Virtual Firewall Contexts Network Device Virtualization - Data- Path Virtualization Layer 2: 802.1q - Trunking Generic Routing Encapsulation – IPsec-L2TPv3 Label Switched Paths - Control-Plane Virtualization.		
Unit - IV	**Virtualizing Storage:**	**9**
SCSI- Speaking SCSI- Using SCSI buses – Fiber Channel – Fiber Channel Cables – Fiber Channel Hardware Devices – iSCSI Architecture – Securing iSCSI – SAN backup and recovery techniques – RAID – SNIA Shared Storage Model – Classical Storage Model – SNIA Shared Storage Model – Host based Architecture – Storage based architecture – Network based Architecture – Fault tolerance to SAN – Performing Backups – Virtual tape libraries.		
Unit - V	**Virtual Machines Products:**	**9**
Xen Virtual machine monitors- Xen API – VMware – VMware products – VMware Features – Microsoft Virtual Server – Features of Microsoft Virtual Server.		
		Total:45

REFERENCES:

1.	William von Hagen, “Professional Xen Virtualization”, 1st Edition, Wrox Publications, January, 2008.
2.	Chris Wolf, Erick M. Halter, “Virtualization: From the Desktop to the Enterprise”, Illustrated Edition, APress 2005.
3.	Kumar Reddy, Victor Moreno, “Network virtualization”, 1st Edition, Cisco Press, July, 2006.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	compile all types of virtualization techniques	Applying (K3)
CO2	design and planning of server consolidation	Applying (K3)
CO3	create a virtual machine and to extend it to a virtual network	Applying (K3)
CO4	analyse the intricacies of server, storage and network virtualizations	Applying (K3)
CO5	demonstrate the various virtual machine products	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1			
CO2	3	2	1	1		
CO3	3	2	1	1		
CO4	1	3	2	1		
CO5		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	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)

22MSE23 - USER INTERFACE DESIGN							
Programme & Branch	**M.E. & Computer Science and Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	HTML,CSS and Javascript	**3**	**PE**	**3**	**0**	**0**	**3**

Preamble	UID deals with design of responsive web application using Full Stack Web Development –MEAN MongoDB, ExpressJS, AngularJS and NodeJS.	
Unit – I	**Introduction to NoSQL Database - MongoDB:**	**9**
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:**	**9**
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:**	**9**
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:**	**9**
Template Driven Forms - Model Driven Forms or Reactive Forms - Custom Validators - Dependency Injection - Services - RxJS Observables HTTP - Routing.		
		Total:45

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)

Mapping of COs with POs and PSOs

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		

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	20	40	40				100
ESE	20	40	40				100

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

22MSE24 - BLOCKCHAIN TECHNOLOGIES							
Programme & Branch	**M.E. & Computer Science and Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Basics of Cryptography and Distributed systems**	**3**	**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.		
		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 a distributed application using Ethereum and Solidity	Applying (K3)

Mapping of COs with POs and PSOs

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	60	30				100
CAT2	10	60	30				100
CAT3	10	60	30				100
ESE	10	60	30				100

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

22MSE25 - SENTIMENT ANALYSIS								
Programme & Branch	**M.E. – Computer Science and Engineering**	**Sem.**	**Category**	**L**	**T**	**P**	**Credit**
Prerequisites	**Nil**	**3**	**PE**	**3**	**0**	**0**	**3**
Preamble	To extract the opinions and sentiments from natural language text using computational methods. For analyzing the sentiment analysis problem from a linguistic angle to help readers understand the underlying structure of the problem and the language constructs commonly used to express opinions and sentiments and presenting computational methods to analyze and summarize opinions.						
Unit – I	**Introduction to Sentiment Analysis**						**9**
Introduction: Sentiment Analysis Applications - Sentiment Analysis Research - Sentiment Analysis as Mini NLP. The Problem of Sentiment Analysis: Definition of Opinion - Definition of Opinion Summary - Affect, Emotion, and Mood - Different Types of Opinions - Author and Reader Standpoint. Document Sentiment Classification: Supervised Sentiment Classification - Unsupervised Sentiment Classification - Sentiment Rating Prediction - Cross-Domain Sentiment Classification - Cross-Language Sentiment Classification - Emotion Classification of Documents.							
Unit – II	**Subjectivity Classification and Challenges**						**9**
Sentence Subjectivity and Sentiment Classification: Subjectivity - Sentence Subjectivity Classification - Sentence Sentiment Classification - Dealing with Conditional Sentences - Dealing with Sarcastic Sentences - Cross-Language Subjectivity and Sentiment Classification - Using Discourse Information for Sentiment Classification - Emotion Classification of Sentences							
Unit – III	**Aspect Oriented Classification**						**9**
Aspect Sentiment Classification: - Rules of Sentiment Composition - Negation and Sentiment - Modality and Sentiment - Coordinating Conjunction But - Sentiment Words in Non-opinion Contexts - Rule Representation - Word Sense Disambiguation and Co reference Resolution. Aspect and Entity Extraction: Frequency-Based Aspect Extraction - Exploiting Syntactic Relations - Using Supervised Learning - Mapping Implicit Aspects - Grouping Aspects into Categories - Exploiting Topic Models - Entity Extraction and Resolution - Opinion Holder and Time Extraction							
Unit – IV	**Sentiment Lexicon generation and Summarization**						**9**
Sentiment Lexicon Generation: Dictionary-Based Approach - Corpus-Based Approach - Desirable and Undesirable Facts. Analysis of Comparative Opinions: Problem Definition - Identify Comparative Sentences - Identifying the Preferred Entity Set - Special Types of Comparison - Entity and Aspect Extraction. Opinion Summarization and Search: Aspect-Based Opinion Summarization - Enhancements to Aspect-Based Summary - Contrastive View Summarization - Traditional Summarization - Summarization of Comparative Opinions - Opinion Search - Existing Opinion Retrieval Techniques. Mining Intentions: Problem of Intention Mining - Intention Classification - Fine-Grained Mining of Intentions.							
Unit – V	**Identifying intention, fake and quality of opinion**						**9**
Detecting Fake or Deceptive Opinions: Different Types of Spam - Supervised Fake Review Detection - Supervised Yelp Data Experiment - Automated Discovery of Abnormal Patterns - ModelBased Behavioral Analysis - Group Spam Detection - Identifying Reviewers with Multiple User ids - Exploiting Business in Reviews - Some Future Research Directions. Quality of Reviews: Quality Prediction as a Regression Problem - Other Methods - Some New Frontiers.							
							Total:45

REFERENCES:

1.	Bing Liu “Sentiment Analysis: Mining Opinions, Sentiments and Emotions”, Cambridge University Press, 2015.
2.	Federico Pozzi, Elisabetta Fersini, Enza Messina, Bing Liu,” Sentiment Analysis in Social Networks”, Morgan Kaufmann, 2016.
3.	Erik Cambria, Dipankar Das “A Practical Guide to Sentiment Analysis” Springer International Publishing AG 2017.
4.	Aakansha Sharaff, G. R. Sinha, Surbhi Bhatia,”New Opportunities for Sentiment Analysis and Information Processing”, IGI Global, 2021

COURSE OUTCOMES: **On completion of the course, the students will be able to**		**BT Mapped (Highest Level)**
CO1	understand the underlying structure of the problem and the language constructs commonly used to express opinions, sentiments, and emotions.	Understanding(K2)
CO2	apply classification of sentences for sentiment analysis.	Applying(K3)
CO3	Perform aspect oriented classification various in sentiment analysis.	Applying(K3)
CO4	infer the words and phrases that convey positive or negative sentiments to apply in sentiment analysis	Applying(K3)
CO5	Identifying and apply the techniques of opinion quality, author intention and fake opinions	Applying(K3)

Mapping of COs with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2				1	
CO2	3			3	1	3
CO3	2			3	3	2
CO4		2	3	2		3
CO5		2	2	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	15	55	30				100
CAT2	15	30	55				100
CAT3	15	30	55				100
ESE	10	40	50				100

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

<table>
<tr><td colspan="9">22GET13 - INNOVATION, ENTREPRENEURSHIP AND VENTURE DEVELOPMENT</td></tr>
<tr><td colspan="9">(Common to ME/MTech and MCA Programmes)</td></tr>
<tr><td>Programme & Branch</td><td>All ME/MTech and MCA Programmes</td><td>Sem.</td><td>Category</td><td>L</td><td>T</td><td>P</td><td>Credit</td></tr>
<tr><td>Prerequisites</td><td>Nil</td><td>3</td><td>PE</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="9"></td></tr>
<tr><td>Preamble</td><td colspan="8">This course will direct the students on how to employ their innovations towards a successful entrepreneurial venture development.</td></tr>
<tr><td>Unit – I</td><td colspan="6">Innovation and Entrepreneurship:</td><td>9</td></tr>
<tr><td colspan="9">Creativity and Innovation – Types of innovation – challenges in innovation- steps in innovation management- Meaning and concept of entrepreneurship - Role of Entrepreneurship in Economic Development - Factors affecting Entrepreneurship – Entrepreneurship vs Intrapreneurship.</td></tr>
<tr><td>Unit – II</td><td colspan="6">Design Thinking and Product Design:</td><td>9</td></tr>
<tr><td colspan="9">Design Thinking and Entrepreneurship – Design Thinking Stages: Empathize – Define – Ideate – Prototype – Test. Design thinking tools: Analogies – Brainstorming – Mind mapping. Techniques and tools for concept generation, concept evaluation – Product architecture –Minimum Viable Product (MVP)- Product prototyping – tools and techniques– overview of processes and materials – evaluation tools and techniques for user-product interaction.</td></tr>
<tr><td>Unit – III</td><td colspan="6">Business Model Canvas (BMC) and Business Plan Preparation:</td><td>9</td></tr>
<tr><td colspan="9">Lean Canvas and BMC - difference and building blocks- BMC: Patterns – Design – Strategy – Process–Business model failures: Reasons and remedies. Objectives of a Business Plan - Business Planning Process and Preparation.</td></tr>
<tr><td>Unit – IV</td><td colspan="6">IPR and Commercialization:</td><td>9</td></tr>
<tr><td colspan="9">Need for Intellectual Property- Basic concepts - Different Types of IPs: Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design– Patent Licensing - Technology Commercialization – Innovation Marketing.</td></tr>
<tr><td>Unit – V</td><td colspan="6">Venture Planning and Means of Finance:</td><td>9</td></tr>
<tr><td colspan="9">Startup Stages - Forms of Business Ownership - Sources of Finance – Idea Grant – Seed Fund – Angel & Venture Fund – Institutional Support to Entrepreneurs – Bank and Institutional Finance to Entrepreneurs.</td></tr>
<tr><td colspan="9" align="right">Total:45</td></tr>
<tr><td colspan="9">REFERENCES:</td></tr>
</table>

1.	Gordon E. & Natarajan K., "Entrepreneurship Development", 6th Edition, Himalaya Publishing House, Mumbai, 2017.
2.	Sangeeta Sharma, "Entrepreneurship Development", 1st Edition, PHI Learning Pvt. Ltd., New Delhi, 2017.
3.	Charantimath Poornima M., "Entrepreneurship Development and Small Business Enterprises", 3rd Edition, Pearson Education, Noida, 2018.
4.	Robert D. Hisrich, Michael P. Peters & Dean A. Shepherd, "Entrepreneurship", 10th Edition, McGraw Hill, Noida, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	understand the relationship between innovation and entrepreneurship	Understanding (K2)
CO2	understand and employ design thinking process during product design and development	Analyzing (K4)
CO3	develop suitable business models as per the requirement of the customers	Analyzing (K4)
CO4	practice the procedures for protection of their ideas IPR	Applying (K3)
CO5	understand and plan for suitable type of venture and modes of finances	Applying (K3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1				3	2	1	3	2		1	1	
CO2	1	2			3	2	1						1	
CO3	3	1	3			1							1	
CO4	1	2				3							1	
CO5	1	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	40	40	20				100
CAT2	30	40	30				100
CAT3	30	40	30				100
ESE	30	40	30				100

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