KONGU ENGINEERING COLLEGE

(Autonomous Institution Affiliated to Anna University, Chennai)

PERUNDURAI ERODE – 638 060

TAMILNADU INDIA

Estd : 1984

REGULATIONS, CURRICULUM & SYLLABI - 2020

(CHOICE BASED CREDIT SYSTEM &
OUTCOME BASED EDUCATION)

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

BACHELOR OF TECHNOLOGY DEGREE
IN
ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

DEPARTMENT OF INFORMATION TECHNOLOGY

KONGU
Assuring the Best

KONGU ENGINEERING COLLEGE, PERUNDURAI, ERODE – 638060

(Autonomous)

REGULATIONS 2020

CHOICE BASED CREDIT SYSTEM AND OUTCOME BASED EDUCATION

BACHELOR OF ENGINEERING (BE) / BACHELOR OF TECHNOLOGY (BTech) DEGREE PROGRAMMES

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

1. DEFINITIONS AND NOMENCLATURE

In these Regulations, unless otherwise specified:

i. "University" means ANNA UNIVERSITY, Chennai.

ii. "College" means KONGU ENGINEERING COLLEGE.

iii. "Programme" means Bachelor of Engineering (BE) / Bachelor of Technology (BTech) Degree programme

iv. "Branch" means specialization or discipline of BE/BTech Degree programme, like Civil Engineering, Information Technology, etc.

v. "Course" means a Theory / Theory cum Practical / Practical course that is normally studied in a semester like Mathematics, Physics 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
BE	Civil Engineering
	Mechanical Engineering
	Electronics and Communication Engineering
	Computer Science and Engineering
	Electrical and Electronics Engineering
	Electronics and Instrumentation Engineering
	Mechatronics Engineering
	Automobile Engineering
	Computer Science and Design
BTech	Chemical Engineering
	Information Technology
	Food Technology
	Artificial Intelligence and Data Science
	Artificial Intelligence and Machine Learning

3. ADMISSION REQUIREMENTS

3.1 First Semester Admission

The candidates seeking admission to the first semester of the eight semester BE / BTech Degree Programme:

Should have passed the Higher Secondary Examination (10 + 2) in the academic stream with Mathematics, Physics and Chemistry as three of the four subjects of study under Part-III subjects of the study conducted by the Government of Tamil Nadu or any examination of any other University or authority accepted by the Anna University, Chennai as equivalent thereto.

(OR)

Should have passed the Higher Secondary Examination of Vocational stream (Vocational groups in Engineering / Technology) as prescribed by the Government of Tamil Nadu.

They should also satisfy other eligibility conditions as prescribed by the Anna University, Chennai and Directorate of Technical Education, Chennai from time to time.

3.2 Lateral Entry Admission

The candidates who hold a Diploma in Engineering / Technology awarded by the State

Board of Technical Education, Tamilnadu or its equivalent are eligible to apply for Lateral entry admission to the third semester of BE / BTech in relevant branches of study.

(OR)

The candidates who hold a BSc degree (10+2+3 stream) with mathematics as one of the subjects at the BSc level from a recognised University are eligible to apply for Lateral entry admission to the third semester of BE / BTech. Such candidates shall undergo two additional Engineering course(s) in the third and fourth semesters as prescribed by the College.

They should satisfy other eligibility conditions 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 BE / BTech programme shall have a curriculum with syllabi comprising of theory, theory cum practical, practical courses in each semester, professional skills training, 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), Programme Specific Outcomes (PSO) 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. Humanities and Social Sciences (HS) including Management Courses

ii. Basic Science (BS) Courses

iii. Engineering Science (ES) Courses

iv. Professional Core (PC) Courses

v. Professional Elective (PE) Courses

vi. Open Elective (OE) Courses

vii. Employability Enhancement Courses (EC) like Project work, Professional Skills, Comprehensive Test & Viva, Entrepreneurships/Start ups and Internship in Industry or elsewhere

viii. Audit Courses (AC)

ix. Mandatory Courses (MC) like Student Induction Program and Environmental Science.

x. Honours Degree Courses (HC)

4.2 Credit Assignment and Honours Degree

4.2.1. 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 BE/BTech programme is 169.

4.2.2. Honours Degree

If a candidate earns 18 to 20 additional credits in an emerging area, then he/she can be awarded with Honours degree mentioning that emerging area as his/her specialization. The respective board of studies shall recommend the specializations for honours degree and appropriate additional courses to be studied by the candidate which shall get approval from Academic Council of the institution. A candidate shall have not less than 8.0 CGPA and no history of arrears during the entire programme to opt for the honours degree.

Various specializations for various branches recommended by the respective boards of studies are given below:

S. No.	Specializations for Honours degree in emerging areas	To be offered as Honours, Only for the following branches mentioned against the specialization
1.	Construction Technology	Civil Engineering
2.	Robotics	Mechanical Engineering
3.	Electric Vehicles	Mechanical Engineering
4.	Artificial Intelligence and Machine Learning	Mechatronics Engineering
5.	Electric Vehicles	Automobile Engineering
6.	Artificial Intelligence and Machine Learning	Electronics and Communication Engineering
7.	Electric Vehicles	Electrical and Electronics Engineering
8.	Control Systems and Sensors Technology	Electronics and Instrumentation Engineering
9.	Cyber Security	Computer Science and Engineering
10.	Data Science	Computer Science and Engineering
11.	Cyber Security	Information Technology
12.	Data Science	Information Technology
13.	Waste Technology	Chemical Engineering
14.	Food Processing and Management	Food Technology

The courses specified under Honours degree in the emerging area may include theory, theory cum practical, practical, project work, etc. under the particular specialization. A candidate can choose and study these specified courses from fourth semester onwards and he/she shall successfully complete the courses within the stipulated time vide clause 5. Total number of credits earned in each semester may vary from candidate to candidate based on the courses chosen. The registration, assessment & evaluation pattern and classification of grades of these courses shall be the same as that of the courses in the regular curriculum of the programme of the candidate vide clause 6, clause 7 and

clause 15 respectively. A candidate can earn Honours degree in only one specialization during the entire duration of the programme.

4.3 Employability Enhancement Courses

A candidate shall be offered with the employability enhancement courses like project work, internship, professional skills training, comprehensive test & viva, internship and entrepreneurships/start ups during the programme to gain/exhibit the knowledge/skills.

4.3.1 Professional Skills Training/ Entrepreneurships/Start Ups

A candidate may be offered with appropriate training courses imparting programming skills, communication skills, problem solving skills, aptitude skills etc. It is offered in two phases as phase I in fifth semester and phase II in sixth semester including vacation periods and each phase can carry two credits.

(or)

A candidate may be allowed to go for training at research organizations or industries for a required number of hours in sixth semester vacation period. Such candidate can earn two credits for this training course in place of Professional Skills Training course II in sixth semester. He/She shall attend Professional Skills Training Phase I in fifth semester and can earn two credits.

(or)

A candidate may be allowed to set up a start up and working part-time for the start ups by applying his/her innovations and can become a student entrepreneur during BE/BTech programme. Candidates can set up their start up from fifth semester onwards either inside or outside of the college. Such student entrepreneurs may earn a maximum of 2 credits per semester for two semesters each in place of either Professional Skills Training I or Professional Skills Training II. The area in which the candidate wants to initiate a start up may be interdisciplinary or multidisciplinary. The progress of the startup shall be evaluated by a panel of members constituted by the Principal through periodic reviews.

4.3.2 Comprehensive Test & Viva

The overall knowledge of the candidate in various courses he/she studied shall be evaluated by (i) conducting comprehensive tests with multiple choice questions generally with pattern similar to GATE and/or (ii) viva-voce examination conducted by a panel of experts assigned by the Head of the department. The members can examine the knowledge of the candidate by asking questions from various domains and the marks will be assigned based on their answers. This course shall carry two credits.

4.3.3 Internships

The curriculum enables a candidate to go for full time projects through internship during a part of seventh semester and/or entire final semester and can earn credits vide clause 7.6 and clause 7.11.

A candidate is permitted to go for full time projects through internship in seventh semester with the following condition: The candidate shall complete a part of the seventh semester courses with a total credit of about 50% of the total credits of seventh semester including Project Work I Phase II in the first two months from the commencement of the seventh semester under fast track mode. The balance credits required to complete the seventh semester shall be earned by the candidate through either approved Value Added Courses /Online courses / Self Study Courses or Add/Drop courses as per clause 4.4 and clause 4.5 respectively.

A candidate is permitted to go for full time projects through internship during

eighth semester. Such candidate shall earn the minimum number of credits required to complete eighth semester other than project through either approved Value Added Courses /Online courses / Self Study Courses or Add/Drop courses as per clause 4.4 and clause 4.5 respectively.

Assessment procedure is to be followed as specified in the guidelines approved by the Academic Council.

4.4 Value Added Courses / Online Courses / Self Study Courses

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

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

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

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

4.4.5 A candidate can earn a maximum of 30 credits through all value added courses, online courses and self study courses.

4.5 Flexibility to Add or Drop Courses

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

4.5.2 From the first to eighth semesters the candidates have the option of registering for additional elective/Honours courses or dropping of already registered additional elective/Honours 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 BE / BTech Degree programme in 8 consecutive semesters/4 Years (6 semesters/3 Years for lateral entry candidate), but in any case not more than 14 semesters/7 Years (12 semesters/6 Years for lateral entry candidate).

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.

6.4 A candidate shall register for the chosen courses as well as arrear courses (if any vide clause 6.2 and 6.3) from the list of courses specified under Honours degree.

7. ASSESSMENT AND EXAMINATION PROCEDURE FOR AWARDING MARKS

7.1 The BE/BTech programmes consist of Theory Courses, Theory cum Practical courses, Practical courses, Project Work, Professional Skills Training / Industrial Training, Internship and Entrepreneurships/ Start ups. 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:

<table>
<tr><th>Sl. No.</th><th>Category of Course</th><th>Continuous Assessment Marks</th><th>End Semester Examination Marks</th></tr>
<tr><td>1.</td><td>Theory / Practical</td><td>50</td><td>50</td></tr>
<tr><td>2.</td><td>Theory cum Practical</td><td colspan="2">The distribution of marks shall be decided based on the credit weightage assigned to theory and practical components.</td></tr>
<tr><td>3.</td><td>Professional Skills Training / / Comprehensive Test & Viva / Entrepreneurships / Start ups / Project Work 1 / Industrial Training / Mandatory Course</td><td>100</td><td>---</td></tr>
<tr><td>4.</td><td>Project Work 2 Phase I / Project Work 2 Phase II / Internships</td><td>50</td><td>50</td></tr>
<tr><td>5.</td><td>Value Added Course</td><td rowspan="2">The distribution of marks shall be decided based on the credit weightage</td><td rowspan="2">---</td></tr>
<tr><td>6.</td><td>All other Courses</td></tr>
</table>

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, internships and entrepreneurships/start ups shall be appointed by the Controller of Examinations after obtaining approval from the Principal.

7.3 Theory Courses

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

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

Sl. No.	Type	Max. Marks	Remarks
1.	Test - I	30	Average of best two
	Test - II	30	
	Test - III	30	
2.	Tutorial	15	Should be of Open Book/Objective Type. Average of best 4 (or more, depending on the nature of the course, as may be approved by Principal)
3.	Assignment / Paper Presentation in Conference / Seminar / Comprehension / Activity based learning / Class notes	05	To be assessed by the Course Teacher based on any one type.
	Total	50	Rounded off to the one decimal place

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

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

7.3.3 The end semester examination for theory courses shall be for a duration of three hours and shall be conducted between November and January during odd semesters and between April and June during even semesters 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.

7.6 Project Work II Phase I / Project Work II Phase II

7.6.1 Project work shall be assigned to a single candidate or to a group of candidates not exceeding 4 candidates in a group. 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 II (both Phase I and Phase II) and the Viva-Voce Examination shall be distributed as below:

Continuous Assessment (Max. 50 Marks)						End Semester Examination (Max. 50 Marks)			
Zeroth Review		Review I (Max.. 20 Marks)		Review II (Max. 30 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
0	0	10	10	15	15	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. The candidate(s) 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.

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 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.

7.6.7 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 7.6.6.

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

7.7 Project Work I Phase I / Industrial Training

The evaluation method shall be same as that of the Project Work II as per clause 7.6 excluding 7.6.3, 7.6.5, 7.6.6 and 7.6.7. The marks distribution is given below:

Continuous Assessment (Max. 100 Marks)								
Zeroth Review		Review I (Max.. 20 Marks)		Review II (Max.. 30 Marks)		Review III (Max. 50 Marks)		
						Report Evaluation (Max. 20 Marks)	Viva - Voce (Max. 30 Marks)	
Review Committee	Guide	Review Committee (excluding guide)	Guide	Review Committee (excluding guide)	Guide	Review Committee	Guide	Review Committee
0	0	10	10	15	15	20	10	20

If a candidate fails to secure 50 % of the continuous assessment marks in this course, 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.

7.8 Professional Skills Training

Phase I training shall be conducted for minimum of 80 hours in 4th semester vacation and during 5th semester. Phase II training shall be conducted for minimum of 80 hours in 5th semester vacation and during 6th semester. The evaluation procedure shall be approved by the Principal.

7.9 Comprehensive Test/Viva

A candidate can earn 2 credits by successfully completing this course. The evaluation procedures shall be approved by the Principal.

7.10 Entrepreneurships/ Start ups

A start up/business model may be started by a candidate individually or by a group of maximum of three candidates during the programme vide clause 4.3.1. The head of the department concerned shall assign a faculty member as a mentor for each start up.

A review committee shall be formed by the Principal for reviewing the progress of the Start ups / Business models, innovativeness, etc. The review committee can recommend the appropriate grades for academic performance for the candidate(s) involved in the start ups. This course shall carry a maximum of two credits in fifth semester and two credits in sixth semester respectively and shall be evaluated through continuous assessments for a maximum of 100 marks vide clause 7.1. A report about the start ups is to be submitted to the review committee for evaluation for each start up and the marks will be given to Controller of Examinations after getting approval from Principal.

7.11 Projects through Internships

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 II as per clause 7.6.

7.12 Value Added Course

Minimum of two assessments shall be conducted during the value added course duration by the offering department concerned.

7.13 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.

7.14 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.

7.15 Audit Course

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

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

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

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

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

7.16 Mandatory Course

A candidate shall attend and complete the induction training program of duration three weeks at the beginning of the first semester. It is mandatory for all candidates who have joined in various branches of all BE/BTech programmes. The induction training program includes the courses recommended by AICTE. Apart from this induction program, a candidate shall undergo the courses listed by AICTE as mandatory courses during their programme. No credits shall be given for such courses and shall be evaluated through continuous assessment tests only vide clause 7.1 for a maximum of 100 marks each. Since these courses have no grade points assigned, these courses will not be counted for the purpose of GPA and CGPA calculations.

7.17 Yoga and Values for Holistic Development (YVHD) and Universal Human Values (UHV)

Courses such as YVHD and UHV shall be offered to all candidates of all BE/BTech programmes. These courses shall carry a maximum of 100 marks each and shall be evaluated through continuous assessment tests only vide clause 7.1. The candidate(s) can earn 2 credits for UHV and 1 credit for YVHD by successfully completing these courses. Two continuous assessment tests will be conducted and the average marks will be taken for the calculation of grades.

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.

A candidate who could not satisfy the attendance requirements as per clause 8.1.1 due to his/her entrepreneurships/ start ups activities, but has secured not less than 60 % in the current semester can be permitted to appear for the current semester examinations with the recommendation of review committee and approval from the Principal.

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.

The candidates who have failed in the courses Professional Skill Training I/II and Comprehensive Test/Viva shall be permitted to take up supplementary examinations.

15. AWARD OF LETTER GRADES

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

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

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

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

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

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

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

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

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

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

16. ELIGIBILITY FOR THE AWARD OF DEGREE

A candidate shall be declared to be eligible for the award of the BE / BTech 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 eight semesters (six semesters for lateral entry candidates) in the **First Appearance** within eight consecutive semesters (six consecutive semesters for lateral entry candidates) 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 and who gets readmitted and has to move from one regulations to another regulations 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 eight semesters (six semesters for lateral entry candidates) in the **First Appearance** within eight consecutive semesters (six consecutive semesters for lateral entry candidates) 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 eight semesters (six semesters for lateral entry candidates) within ten consecutive semesters (eight consecutive semesters for lateral entry candidates) excluding authorized break of study (vide clause 11) after the commencement of his / her study.
- Withdrawal from the examination (vide clause 10) shall not be considered as an appearance.
- Should have secured a CGPA of not less than 7.00

17.3 Second Class:

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

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

17.5 Honours Degree:

A candidate who qualifies for the award of the degree (vide clause 16) and who satisfies the following conditions shall be declared to have earned the BE/BTech degree with Honours (vide clause 16 and clause 4.2.2):

- Should have passed the examination in all the courses of all the eight semesters (six semesters for lateral entry candidates) in the **First Appearance** within eight consecutive semesters (six consecutive semesters for lateral entry candidates) 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 8.00

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 BE / BTech programme.

******

B.TECH. & ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING Regulation 2020

SEMESTER – I									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
20EGT11	English Language Skills	3	0	0	3	50	50	100	HS
20MAC11	Matrices and Differential Equations	3	1*	2*	4	50	50	100	BS
20PHT11	Applied Physics	3	0	0	3	50	50	100	BS
20CYT11	Applied Chemistry	3	0	0	3	50	50	100	BS
20ALT11	Problem Solving and Programming	3	0	0	3	50	50	100	PC
20ALC11	Basics of Electrical and Electronics Engineering	3	0	2	4	50	50	100	ES
Practical / Employability Enhancement									
20ALL11	Problem Solving and Programming Laboratory	0	0	2	1	50	50	100	PC
20PHL11	Physical Sciences Laboratory I	0	0	2	1	50	50	100	BS
20MNT11	Student Induction Program #	---	---	---	0	100	0	100	MC
Total Credits to be earned					**22**				

*****Alternate Weeks

SEMESTER – II									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
20EGT21	Advanced Communication Skills	3	0	0	3	50	50	100	HS
20MAT21	Discrete Mathematics and Linear Algebra	3	1	0	4	50	50	100	BS
20ALC21	Digital Principles and Design	3	0	2	4	50	50	100	ES
20ALT21	Data Structures	3	0	0	3	50	50	100	PC
20ALC22	Python Programming	3	0	2	4	50	50	100	ES
Practical / Employability Enhancement									
20ALL21	Data Structures Laboratory	0	0	2	1	50	50	100	PC
20ALL22	Open Source Laboratory	0	0	2	1	50	50	100	BS
20MEL11	Engineering Practices Laboratory	0	0	2	1	50	50	100	ES
20VEC11	Yoga and Values for Holistic Development	1	0	1	1	100	0	100	HS
Total Credits to be earned					**22**				

*****Alternate Weeks

SEMESTER – III									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
20MAT35	Probability Theory And Inferential Statistics	3	0	0	3	50	50	100	BS
20ALC31	Foundations of Artificial Intelligence and Machine Learning	3	0	2	4	50	50	100	ES
20ALC32	Design and Analysis of Algorithms	3	0	2	4	50	50	100	PC
20ALT31	Computer Organization	3	0	0	3	50	50	100	PC
20ALT32	Database Management Systems	3	0	0	3	50	50	100	PC
20ALC33	Data Visualization	2	0	2	3	50	50	100	PC
Practical / Employability Enhancement									
20ALL31	Database Management Systems Laboratory	0	0	2	1	50	50	100	PC
20ALL32	English for Workplace Communication Laboratory	0	0	2	1	50	50	100	HS
20GET31	Universal Human Values	2	0	0	2	100	0	100	HS
Total Credits to be earned					**24**				

SEMESTER – IV									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
20ALT41	Optimization Techniques	3	1	0	4	50	50	100	PC
20ALT42	Web Technology	3	0	0	3	50	50	100	ES
20ALC41	Object Oriented Programming	2	0	2	3	50	50	100	PC
20ALT43	Operating Systems	3	0	0	3	50	50	100	PC
20ALT44	Applied Machine Learning	3	0	0	3	50	50	100	PC
	Open Elective - I	3	1/0	0/2	4	50	50	100	OE
Practical / Employability Enhancement									
20ALL41	Web Technology Laboratory	0	0	2	1	50	50	100	ES
20ALL42	Applied Machine Learning Laboratory	0	0	2	1	50	50	100	PC
20MNT31	Environmental Science	2	0	0	0	100	0	100	MC
Total Credits to be earned					**22**				

***Alternate Weeks**

SEMESTER – V									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
20ALT51	Artificial Intelligence	3	0	0	3	50	50	100	PC
20ALT52	Deep Learning	3	0	0	3	50	50	100	PC
20ALC51	Design Patterns and Principles	3	0	2	4	50	50	100	PC
20ALC52	Big Data Analytics	3	0	2	4	50	50	100	PC
	Professional Elective -1	3	0	0	3	50	50	100	PE
	Open Elective – 2	3	1/0	0/2	4	50	50	100	OE
Practical / Employability Enhancement									
20ALL51	Deep Learning Laboratory	0	0	2	1	50	50	100	PC
20GEL51	Professional Skills Training 1 / Industrial Training 1 *$	--	--	--	2	100	0	100	EC
Total Credits to be earned					**24**				

$ Professional Skills Training / Industrial Training for a total period of about 80 hr during the period of 4thsem end summer holidays and 5th sem.

*A candidate can earn 2 credits through start ups in place of Professional Skills Training I / Industrial training I in 5th sem.

SEMESTER – VI									
Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
20ALT61	Artificial Intelligence and Robotics	3	0	0	3	50	50	100	PC
20ALT62	Nature Inspired Optimization Techniques	3	0	0	3	50	50	100	PC
20ALT63	Information Retrieval Techniques	3	1	0	4	50	50	100	PC
	Open Elective - 3	2/3	0	0/2	3	50	50	100	OE
Practical / Employability Enhancement									
20ALL61	Artificial Intelligence and Robotics Laboratory	0	0	2	1	50	50	100	PC
20GEP61	Comprehensive Test / Viva	---	---	---	2	100	0	100	EC
20GEL51	Professional Skills Training 2 / Industrial Training 2 @	---	---	---	2	100	0	100	EC
20ALP61	Project Work 1 #	0	0	4	2	100	0	100	EC
Total Credits to be earned					**20**				

#Project Work 1 Phase I (6thsem) shall be continued further as Project Work 1 Phase II (7thsem).

@ Professional Skills Training / Industrial Training for a total period of about 80 hr during 5thsem end summer holidays and 6thsem.

SEMESTER – VII

Course Code	Course Title	Hours / Week			Credit	Maximum Marks			Category
		L	T	P		CA	ESE	Total	
Theory/Theory with Practical									
20GET71	Engineering Economics & Management	3	0	0	3	50	50	100	HS
20ALC71	Internet of Things and Edge Analytics	3	0	2	4	50	50	100	PC
	Professional Elective – 2	3	0	0	3	50	50	100	PE
	Professional Elective – 3	3	0	0	3	50	50	100	PE
	Professional Elective – 4	3	0	0	3	50	50	100	PE
	Professional Elective – 5	3	0	0	3	50	50	100	PE
Practical / Employability Enhancement									
20ALP71	Project Work 2 Phase I	0	0	6	3	50	50	100	EC
Total Credits to be earned					**22**				

$ Project Work 1 Phase II (7thsem) shall be continuation of Project Work 1 Phase I (6thsem).
Courses in Sl. Nos. 7.1, 7.2 and 7.3 shall be completed in the first half of the semester.
Courses in Sl. Nos. 7.4 and 7.5shall be handled in the second half of the semester. One or both of these two courses can also be completed in 5th semester (fast track). Intern students can study these two courses through NPTEL/MOOC portals also

SEMESTER – VIII									
Course Code	**Course Title**	**Hours / Week**			**Credit**	**Maximum Marks**			**Category**
		L	**T**	**P**		**CA**	**ESE**	**Total**	
Theory/Theory with Practical									
	Professional Elective -6	3	0	0	3	50	50	100	PE
	Open Elective – 4	2/3	0	0/2	3	50	50	100	OE
Practical / Employability Enhancement									
20ALP81	Internship / Project work 2 Phase 2	---	---	14	7	50	50	100	EC
Total Credits to be earned					**13**				

Internship / Project work for a total period of about 240 hrs.
One or both of the courses in Sl. Nos. 8.1 and 8.2 can also be completed in 6th semester (fast track). Intern students can study these two courses through NPTEL/MOOC portals also.

LIST OF PROFESSIONAL ELECTIVE COURSES (PE)							
S. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Sem**
		Elective I					
1.	20ALE01	Theory of Computation	3	0	0	3	5
2.	20ALE02	Multi-core Architecture	3	0	0	3	5
3.	20ALE03	Data Warehousing and Data Mining	3	0	0	3	5
4.	20ALE04	Computer Networks	3	0	0	3	5
5.	20ALE05	Soft Computing Techniques	3	0	0	3	5
		Elective II					
6.	20ALE06	Wireless and Sensor Networks	3	0	0	3	7
7.	20ALE07	Cloud Computing	2	0	2	3	7
8.	20ALE08	Web Mining	3	0	0	3	7
9.	20ALE09	Modeling and Simulation	3	0	0	3	7
		Elective III					
10.	20ALE10	Information Security	3	0	0	3	7
11.	20ALE11	Regression Analysis	2	0	2	3	7
12.	20ALE12	Reinforcement learning	3	0	0	3	7
13.	20ALE13	Embedded System and Programming	3	0	0	3	7
14.	20ALE14	Time Series Analysis and Forecasting	2	0	2	3	7
		Elective IV					
16.	20ALE15	Parallel Computing Architecture and Programming	3	0	0	3	7
17.	20ALE16	Social Media Data Analytics	3	0	0	3	7
18.	20ALE17	Real Time Analytics	3	0	0	3	7
19.	20ALE18	Graph Theory and it's Applications	3	0	0	3	7
		Elective V					
20.	20ALE19	Operations and Supply Chain Management	3	0	0	3	7
21.	20ALE20	Multivariate Data Analysis	3	0	0	3	7
22.	20ALE21	Cognitive Science and Analytics	3	0	0	3	7
23.	20ALE22	Text and Speech Analytics	3	0	0	3	7

		Elective VI					
24.	20ALE23	Software Defined Networks	3	0	0	3	8
25.	20ALE24	Software Quality and Testing	3	0	0	3	8
26.	20ALE25	Software Project Management	3	0	0	3	8
27.	20ALE26	Cyber Forensics	3	0	0	3	8
28.	20ALE27	Agile Methodologies for Software Development	3	0	0	3	8
Total Credits to be earned						18	

OPEN ELECTIVE COURSES OFFERED TO OTHER DEPARTMENTS (OE)

(Common to all departments except offering department)

S. No.	Course Code	Course Name	L	T	P	C	Sem
1	20ALO01	Business Intelligence	3	1	0	4	IV
2	20ALO02	Data Exploration and Visualization Techniques	3	0	2	4	V
3	20ALO03	Industrial Machine Learning	3	0	0	3	VI
4	20ALO04	Machine Learning for Smart Cities	3	0	0	3	VIII

SEMESTER I

20EGT11 ENGLISH LANGUAGE SKILLS

(Common to all Engineering and Technology Branches)

Programme & Branch	All BE/BTech branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	HS	3	0	0	3

Preamble	This course is designed to impart required levels of fluency in using the English Language at A2/B1 Level in the Common European Framework (CEFR).	
Unit - I	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – I**	**9**
Listening - Talking about past experiences - listening to descriptions - Speaking - Exchanging personal information - Talking about cities and transportation - Reading - Life and achievements of a famous personality - Global transport systems - Writing - Childhood experiences - Process Description – Grammar & Vocabulary – Past tense – Expressions of quantity – Indirect questions.		
Unit - II	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – II**	**9**
Listening - Information about hotels and accommodation - Recipes and food items - Speaking - Life style changes and making comparisons - Talking about food - Reading - Habit formation and changing habits - International cuisine - Writing - Personal email - emails about food and recipes – Grammar & Vocabulary – Evaluations and Comparisons with adjectives – Simple past and present perfect tenses.		
Unit - III	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – III**	**9**
Listening - Information about travel - descriptions / conversations about family life - Speaking - Vacations and Holidays - Requests, complaints and offering explanations - Reading - Tourist places and travel experiences - Group behaviour and politeness - Writing - Personal letter about travelling - Writing guidelines and checklists – Grammar & Vocabulary – Future tense – Modals – Two-part verbs.		
Unit - IV	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – IV**	**9**
Listening - Descriptions about festivals - Presentations on technology - Speaking - About technology - festivals, special events and traditions - Reading - Sports, hobbies and past time - About different cultures - Writing - Product Description - Writing web content – Grammar & Vocabulary – Infinitives and Gerunds for uses and purposes – Imperatives for giving suggestions – Relative clauses of time.		
Unit - V	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – V**	**9**
Listening - Talking about changes - Job preferences - Speaking - Comparing different periods or phases in life – Changes that happen - Skills and abilities, Personality Development - Employability Skills – Reading - Reading about life experiences - Emotions and feelings – Job preferences – Jobs and Personality – Writing - Writing about one's past, present and future – Researching job options – Choosing the right job – Grammar & Vocabulary – Time contrasts – Conditional sentences with "if clauses" – Gerunds – short responses.		

Lecture: 45, Total: 45

TEXT BOOK:

1. Jack C. Richards, Jonathan Hull, and Susan Proctor, "Interchange - Student's Book 2", 4th Edition, Cambridge University Press, New York, 2017. for Unit I, II, III, IV and V.

REFERENCES:

1. Sanjay Kumar and Pushp Lata, "Communication Skills", 2nd Edition, Oxford University Press, New Delhi, 2015.
2. Pamela Hartmann and Brenda Wegmann, "New Interactions English Language Learning and Assessment Platform (Level Intro - Level IV)", McGraw Hill India, 2020.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	use language effectively and accurately acquiring vocabulary from real-life context	Applying (K3)
CO2	listen/view and comprehend different spoken discourses / excerpts in different accents	Applying (K3)
CO3	read different genres of texts adopting various reading strategies	Analyzing (K4)
CO4	write cohesively, coherently and flawlessly avoiding grammatical errors, using a wide range of vocabulary, organizing their ideas logically on a topic	Creating (K6)
CO5	speak clearly, confidently, comprehensibly and communicate with others using appropriate communicative strategies	Creating (K6)

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			2	3	2	2		
CO2									2	3		1		
CO3						1				3	1	1		
CO4										3		1		
CO5									2	3		2		

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1		16	30	37		17	100
CAT2		17	30	37		16	100
CAT3		13	33	37		17	100
ESE		7	21	37		35	100

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

20MAC11 - MATRICES AND DIFFERENTIAL EQUATIONS

(Common to All Engineering and Technology Branches)

Programme & Branch	All BE/BTech branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	BS	3	1*	2*	4

Preamble	To provide the skills to the students for solving different real time problems by applying matrices and differential equations.	
Unit - I	**Matrices:**	**9**
Introduction – Characteristic equation – Eigen values and Eigen vectors of a real matrix – Properties of Eigen values and Eigen vectors (without proof) – Cayley - Hamilton theorem (Statement and applications only) – Orthogonal matrices – Orthogonal transformation of a symmetric matrix to diagonal form – Quadratic form – Nature of Quadratic forms - Reduction of quadratic form to canonical form by orthogonal transformation.		
Unit - II	**Ordinary Differential Equations:**	**9**
Introduction – Solutions of First order differential equations: Exact differential equations – Leibnitz's Linear Equation – Bernoulli's equation – Clairaut's equation.		
Unit - III	**Ordinary Differential Equations of Higher Order:**	**9**
Linear differential equations of second and higher order with constant coefficients - Particular Integrals for the types: e^{ax} – cosax / sinax – x^n – $e^{ax}x^n$, e^{ax}sinbx and e^{ax}cosbx – x^nsinax and x^ncosax – Differential Equations with variable coefficients: Euler-Cauchy's equation – Legendre's equation.		
Unit - IV	**Applications of Ordinary Differential Equations:**	**9**
Method of variation of parameters – Simultaneous first order linear equations with constant coefficients – Applications of differential equations: Simple harmonic motion – Electric circuits (Differential equations and associated conditions need to be given).		
Unit - V	**Laplace Transform** & **Inverse Laplace Transform:**	**9**
Laplace Transform: Conditions for existence – Transform of elementary functions – Basic properties – Derivatives and integrals of transforms – Transforms of derivatives and integrals – Transform of unit step function – Transform of periodic functions. Inverse Laplace transform: Inverse Laplace transform of elementary functions – Partial fraction method – Convolution theorem (Statement only) – Solution of linear ODE of second order with constant coefficients.		

List of Exercises / Experiments:

1.	Introduction to MATLAB
2.	Computation of eigen values and eigen vectors
3.	Plotting and visualizing single variable functions
4.	Solving first and second order ordinary differential equations
5.	Solution of Simultaneous first order ODEs
6.	Solving second order ODE by variation of parameters
7.	Determining Laplace and inverse Laplace transform of basic functions
8.	Solution of Second order ODE by employing Laplace transforms

***Alternate week**

Lecture: 45, Tutorial and Practical:15, Total:60

TEXT BOOK:

1. Ravish R. Singh, Mukul Bhatt "Engineering Mathematics", 1st Edition, McGraw Hill Education, New Delhi, 2016. for Unit I, II, III, IV and V.

REFERENCES:

1. Kreyszig E., "Advanced Engineering Mathematics", 10th Edition, John Wiley Sons, 2011.
2. Kandasamy P., Thilagavathy K. and Gunavathy K., "Engineering Mathematics For First Year B.E/B.Tech", Reprint Edition 2014, S.Chand and Co., New Delhi.
3. Duraisamy C., Vengataasalam S., Arun Prakash K. and Suresh M., "Engineering Mathematics – I", 2nd Edition, Pearson India Education, New Delhi, 2020.
4. MATLAB Manual.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	solve engineering problems which needs matrix computations.	Applying (K3)
CO2	identify the appropriate method for solving first order ordinary differential equations.	Applying (K3)
CO3	solve higher order linear differential equations with constant and variable coefficients.	Applying (K3)
CO4	apply the concept of ordinary differential equations for modeling and finding solutions to engineering problems.	Applying (K3)
CO5	apply Laplace Transform to find solutions of Linear Ordinary Differential Equations	Applying (K3)
CO6	know the basics of MATLAB and computing eigen values and eigen vectors of real matrix by MATLAB.	Understanding (K2), Manipulation (S2)
CO7	solve ordinary differential equations with constant and variable coefficients and simultaneous first order ordinary differential equations using MATLAB.	Applying (K3), Manipulation (S2)
CO8	compute Laplace and inverse Laplace Transform of basic functions and solve Second Order ODE by using Laplace Transform with MATLAB.	Applying (K3), Manipulation (S2)

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	2	1										
CO2	3	3	2	1										
CO3	3	3	2	1										
CO4	3	3	2											
CO5	3	3	2	1										
CO6					3									
CO7					3									
CO8					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	70				100
CAT2	10	20	70				100
CAT3	10	20	70				100
ESE	10	20	70				100

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

20PHT11 - APPLIED PHYSICS

(Common to All Engineering and Technology Branches)

Programme & Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	BS	3	0	0	3

Preamble	This course aims to impart the essential concepts of propagation of elastic waves, acoustics, ultrasonics, laser and fiber optics, quantum physics, crystal structure and crystal defects. It also describes the physical phenomena related to the aforementioned concepts and their applications in engineering and provides motivation towards innovations	
Unit - I	**Propagation of Elastic Waves:**	**9**
Oscillatory Motion: Introduction to simple harmonic motion - Damping velocity - Damping coefficient - Differential equation of simple harmonic motion - Velocity and acceleration - Restoring force - Vibration of a spring and mass system - Frequency response - Phase response - Resonance - Wave motion: Definition of a plane progressive wave - Attenuation of waves - Differential equation of a plane progressive wave - Phase velocity - Phase and phase difference - Solution of the differential equation of a plane progressive wave.		
Unit - II	**Acoustics and Ultrasonics:**	**9**
Acoustics: Introduction - Reverberation and reverberation time - Growth and decay of sound - Sabine's formula for reverberation time – Determination of sound absorption coefficient – Design of an auditorium: Factors affecting acoustics of buildings and the remedies. Ultrasonics: Introduction – Properties of ultrasonic waves – Generation of ultrasonic waves: Magnetostrictive generator and Piezoelectric generator - Determination of velocity of ultrasonics in a liquid: Acoustic grating – Industrial application: Non-destructive testing - Other applications of ultrasonic waves (qualitative).		
Unit - III	**Laser and Fiber Optics:**	**9**
Laser and Applications: Introduction – Interaction of light with matter - Three quantum process: Stimulated absorption, spontaneous emission and stimulated emission - Population inversion - Einstein's coefficients and their relations - Pumping methods - Nd:YAG laser - CO_2 laser - Holography. Fiber Optics and Applications: Introduction - Numerical aperture and acceptance angle - Classification of optical fibers based on refractive index, modes and materials - Fiber optics communication system (qualitative) - Fiber optic sensors: Temperature and displacement sensors.		
Unit - IV	**Quantum Physics:**	**9**
Introduction - Blackbody radiation - Planck's quantum hypothesis - Compton scattering (qualitative) - de Broglie's hypothesis - Properties of matter waves - Application of Heisenberg uncertainty principle - Schrodinger's time independent and time dependent wave equations - Physical significance of wave function - The free particle - Potential energy step - Infinite potential well (one - dimensional).		
Unit - V	**Crystal Physics:**	**9**
Introduction - Classification of solids - Space lattice - Crystal structure - Unit cell - Bravais lattice - Single and polycrystalline materials - Lattice planes - Miller indices - Indices of crystal direction - Interplanar spacing in cubic system - Hexagonal close packed crystal structure and c/a ratio - Symmetry -Symmetry elements in cubic crystal - Crystal imperfections: line, surface and volume imperfections - Features of crystal imperfections (qualitative).		

Total: 45

TEXT BOOK:

1. Avadhanulu M.N., Kshirsagar P.G. and Arun Murthy T.V.S., "A Textbook of Engineering Physics",11th Edition, S. Chand & Company Pvt. Ltd., New Delhi, 2019. for Unit I, II, III, IV and V.

REFERENCES:

1. Purnima Khare and Swarup A.,"Engineering Physics: Fundamentals and Modern Applications", 1st Edition, Jones and Bartlett Publishers, Sudbury, Massachusetts, 2009.
2. Gaur R.K. and Gupta S.L., "Engineering Physics", 8th Edition, Dhanpat Rai and Sons, New Delhi, 2009.
3. Tamilarasan K. and Prabu K., "Engineering Physics – I", 3rd Edition, McGraw Hill Education Pvt. Ltd., New Delhi, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	make use of the concepts of oscillatory and wave motion to comprehend the phenomena related to the propagation of elastic waves.	Applying (K3)
CO2	apply the concepts of growth and decay of sound energy in a hall to compute Sabine's formula to recognize the requirements of acoustically good buildings, and to describe the production of ultrasonic wave, working of acoustic grating & non-destructive testing using ultrasonic waves.	Applying (K3)
CO3	apply the concepts of stimulated emission to explain the working and the applications of laser in engineering and technology, and to apply the principle of propagation of light through optical fiber to compute acceptance angle and numerical aperture to comprehend the loss in optical fiber, fiber optic communication system and working of fiber optic sensors.	Applying (K3)
CO4	use the concepts of quantum mechanics to describe the behavior of electrons in a metal by solving Schrodinger's wave equation for particle motion in infinite potential well.	Applying (K3)
CO5	utilize the concepts of the seven crystal systems to obtain interplanar spacing in cubic lattice and c/a ratio of HCP crystal structure, and to comprehend symmetry elements, reciprocal lattice and the types of crystal imperfections and their impacts.	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	3	2	1											
CO2	3	2	1											
CO3	3	2	1											
CO4	3	2	1											
CO5	3	2	1											

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	20	35	45				100
CAT3	25	35	40				100
ESE	20	40	40				100

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

20CYT11 - APPLIED CHEMISTRY

(Common to All Engineering and Technology Branches)

Programme & Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	BS	3	0	0	3

Preamble	Applied Chemistry course explores the basic principles and advancements of chemistry in the field of engineering and technology. It aims to impart the fundamentals of chemistry towards innovations in science and technology and also for societal applications.	
Unit - I	**Water Technology:**	**9**
Introduction - sources of water - impurities in water - types of water - hardness of water- expression of hardness (simple problems) - units of hardness –estimation of hardness of water by EDTA method – determination of alkalinity - disadvantages of using hard water in Industries - boiler troubles - scale and sludge, boiler corrosion, caustic embrittlement, priming and foaming - softening of water: i) Internal treatment process - carbonate and calgon conditioning ii) External treatment method - demineralization process iii) Treatment of water for municipal water supply (Removal of suspended particles and disinfection methods, Break-point of chlorination).		
Unit - II	**Electrochemistry:**	**9**
Introduction – electrochemical cells - applications of electrochemical series - reference electrode - standard calomel electrode - ion selective electrode - glass electrode - concentration cells - electrode and electrolyte concentration cells (simple problems) -applications- potentiometric titrations - acid-base, redox, precipitation titrations - advantages- conductometric titrations - strong acid vs strong base, weak acid vs strong base, mixture of weak and strong acid vs strong base- advantages of conductometric titrations.		
Unit - III	**Corrosion and its Control:**	**9**
Introduction – causes and effects of corrosion - types of corrosion - chemical corrosion – Pilling Bed-worth rule - electrochemical corrosion –types **-** galvanic corrosion, concentration cell corrosion – other types of corrosion -stress, intergranular and microbiological corrosion- galvanic series - factors influencing rate of corrosion – corrosion control methods - design and material selection, anodic protection, corrosion inhibitors, protective coatings - i) metallic coatings : hot dipping (tinning and galvanizing) ii) non-metallic coating : anodizing iii) organic coating : paints – constituents and their functions.		
Unit - IV	**Fuels and Combustion:**	**9**
Introduction – classification of fuels - characteristics of a good fuel - combustion - calorific values – gross and net calorific values - Dulong's formula (simple problems) - Flue gas analysis by Orsat's method - ignition temperature - spontaneous ignition temperature - explosive range - solid fuels - coal and its varieties – proximate and ultimate analysis – significance – metallurgical coke - Otto-Hoffman byproduct method - liquid fuel - refining of petroleum – manufacture of synthetic petrol - hydrogenation of coal - Bergius process - knocking - octane number – cetane number - gaseous fuel - water gas.		
Unit - V	**Polymers:**	**9**
Introduction – terminology - classification - polymerization - types of polymerization (definition only)- polymerisation techniques- bulk, solution, suspension and emulsion polymerisation - plastics- difference between thermoplastics and thermosetting plastics - compounding of plastics- plastic moulding methods - compression, injection, extrusion and blow moulding methods - industrial polymers: preparation, properties and applications of PVC, PAN, polyurethane, polyesters – biodegradable polymers-classification and applications.		

Lecture: 45, Total: 45

TEXT BOOK:

1. Wiley Editorial Board, "Wiley Engineering Chemistry", 2nd Edition, Wiley India Pvt. Ltd, New Delhi, Reprint 2019. for Unit I, II, III, IV and V.

REFERENCES:

1. Palanisamy P.N., Manikandan P., Geetha A.& Manjula Rani K., "Applied Chemistry", 6th Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2019.
2. Payal B. Joshi, Shashank Deep, "Engineering Chemistry", Oxford University Press, New Delhi, 2019.
3. Palanna O., "Engineering Chemistry", McGraw Hill Education, New Delhi, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply the suitable water softening methods to avoid boiler troubles.	Applying (K3)
CO2	apply the principle of electrochemistry for various applications.	Applying (K3)
CO3	make use of corrosion control methods to solve corrosion related problems.	Applying (K3)
CO4	illustrate the quality of fuels from its characteristics.	Understanding (K2)
CO5	explain the types of polymers, plastics and fabrication methods.	Understanding (K2)

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	2	1	1										
CO2	3	2	1	1										
CO3	3	2	1	1										
CO4	3	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	25	35	40				100
CAT2	25	35	40				100
CAT3	25	35	40				100
ESE	25	35	40				100

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

20ADT11 - PROBLEM SOLVING AND PROGRAMMING

Programme & Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	PC	3	0	0	3

Preamble	Problem solving skill is the most important skill to be possessed by any student. Most of the time, the emphasis is on learning a programming language rather than on inculcating the problem solving skills. This course is designed for use by freshmen students taking their first course in programming. It deals with the techniques needed to practice computational thinking, the art of using computers to solve problems and the ways the computers can be used to solve problems. This course also focuses on developing programming skills using C language.	
Unit - I	**Introduction to Computer and Problem Solving:**	**9**
Overview of computers : Types, Generations, Characteristics, Basic computer Organization – Programming methodologies – Structured programming Problem solving techniques: Algorithms - Flowcharts – Pseudo codes – Structuring the logic: Sequential, selection and repetitive structure.		
Unit - II	**Introduction to C and Control Statements:**	**9**
Introduction to C and Control Statements: The life cycle of a C program – features of C - Data - Variables – Declaring, assigning and printing variables – Data Classification : integer, float and character types – constants – operators and expressions – Control Structures : decision making and looping statements – Input and output functions.		
Unit - III	**Arrays and Functions:**	**9**
Arrays : Declaring and initializing 1D array - Two dimensional arrays – Multidimensional arrays. Functions: Basics, The anatomy of a function – Types of functions based on arguments and return types – Passing 1D and 2D arrays as arguments to functions – Calling function from another function – recursive functions -Variable scope and lifetime - Storage classes.		
Unit - IV	**Pointers and Strings:**	**9**
Pointers: Memory access and pointers, pointer basics, declaring, initializing and dereferencing a pointer, parameter passing mechanisms , operations on pointers. Strings : Basics, declaring and initializing strings – pointers for string manipulation – string handling functions : standard and user defined functions – character oriented functions, Two dimensional array of strings		
Unit - V	**User-defined data types:**	**9**
Structure basics –declaring and defining a structure - attributes of structures – nested structures – arrays as structure members – arrays of structure – Passing structures as arguments to functions - Unions – Bit Fields -Enumerated type.		

Lecture: 45, Total:45

TEXT BOOK:

1. Sumitabha Das, “Computer Fundamentals and C Programming”, 1st Edition, McGraw Hill, 2020. for Unit I, II, III, IV and V.

REFERENCES:

1. Yashavant Kanetkar, "Let us C", 16th Edition, BPB Publications, 2020.
2. Reema Thareja., “Programming in C ”, 2nd Edition, Oxford University Press, New Delhi, 2020.
3. Balagurusamy E., "Programming in ANSI C", 7th Edition, Mc Graw Hill Education, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	outline the basics of computers and apply problem solving techniques to express the solution for the given problem	Applying (K3)
CO2	identify the appropriate looping and control statements in C and develop applications using these statements	Applying (K3)
CO3	develop simple C programs using the concepts of arrays and modular programming	Applying (K3)
CO4	recall the basic concepts of pointers and develop C programs using strings and pointers	Applying (K3)
CO5	make use of user defined data types to solve given problems	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	3	2			2								3	1
CO2	3	2	2										3	1
CO3	3	2	2										3	1
CO4	3	2	2										3	1
CO5	3	2	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	20	30	50				100
CAT2	10	30	60				100
CAT3	10	30	60				100
ESE	10	30	60				100

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

20ADC11 - BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING

Programme & Branch	BTech- Artificial Intelligence and Data Science	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	ES	3	0	2	4

Preamble	To provide comprehensive idea about power Systems, AC and DC circuit analysis, working principles and applications of basic machines in electrical engineering.	
Unit - I	**Introduction to Power Systems:**	**9**
Fundamentals of electricity:Definition – Symbol and unit of Quantities-Work - Power and Energy -Power Generation – Transmission system – Comparison of Overhead and Underground Systems - Star to Delta and to Star Transformations - House Wiring: Materials and Accessories –Types of wiring – Principles of Earthing.		
Unit - II	**DC Circuits and AC Circuits:**	**9**
DC Circuits and AC Circuits: Resistance: Resistors in Series and Parallel - Network Reduction - Voltage and Current Division Rule - Ohm's Law- Method of solving a circuit by Kichoff's laws. AC Circuits: Alternating (Sinusoidal) Voltage and Current, R.M.S and Average Value, Power Factor, Form Factor and Peak Factor –Analysis of AC Circuit.		
Unit - III	**Electrical Machines:**	**9**
DC Machines: Construction, Principle of Operation of DC Motor-Types and Applications. AC Machines: Construction and Working Principle of AC Generator, Single Phase Transformer, Three Phase Induction Motor and Single Phase Induction Motor (Split Phase and Capacitor Start Induction Motor) - Applications.		
Unit - IV	**Basic Electronics:**	**9**
Theory of PN Junction Diode - Operation of Rectifiers (Half wave, Full wave) and Filters - Zener Diodes - Zener Diode as Voltage Regulator - Transistors: Types - Operation of NPN Transistor - Transistor as an Amplifier - Operation and Characteristics of Thyristor: Silicon Controlled Rectifier – Triac.		
Unit - V	**Fundamentals of Communication Engineering:**	**9**
Introduction – Communication System - Need for Modulation –Basic principles of Modulation: Amplitude Modulation – Frequency Modulation – Comparison of AM & FM - Communication Systems (Block Diagram approach): Radio Broadcast, TV: Standards, Transmitter and Receiver- Satellite and Optical Fibre Communication		

List of Experiments / Exercises:

1.	Verification of Ohm's Law and Kichoff's Law
2.	Measurement of real power, reactive power, power factor and impedance of RC, RL and RLC circuits.
3.	Load test on DC shunt motor
4.	Performance characteristics of single phase Transformer
5.	Load test on single phase induction motor
6.	VI characteristics of PN junction diode.
7.	VI characteristics of Zener diode.
8.	Voltage Regulator using Zener diode.
9.	Voltage regulator using 78XX
10.	Study of Mixie, Ceiling Fan and Vacuum Cleaner

Lecture: 45, Practical: 30, Total: 75

TEXT BOOK:

1.	Muthusubramanian R. and Salivahanan S., "Basics of Electrical and Electronics Engineering", 18th Reprint, Tata McGraw Hill, 2014. for Unit I, II, III, IV and V.

REFERENCES:

1.	Jegathesan V., Vinoth Kumar K. and Saravanakumar R., "Basic Electrical and Electronics Engineering", 1st Edition, Wiley India, 2011.
2.	Sukhija M.S. and Nagsarkar T.K., "Basics of Electrical and Electronics Engineering", 1st Edition, Oxford University Press, 2012.
3.	Laboratory Manual

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret the basic concepts of electrical power systems	Applying (K3)
CO2	analyze the DC and AC circuits	Analyzing (K4)
CO3	interpret the construction and working of different types of electric machines	Applying (K3)
CO4	demonstrate the basic functions of electronic components	Applying (K3)
CO5	apply the basic concepts of Communication Engineering in simple applications.	Applying (K3)
CO6	experiment the electric circuits by applying various theorems	Applying (K3), Manipulation (S2)
CO7	test basic electrical machines like transformer, DC motors and induction motor	Applying (K3), Precision (S3)
CO8	analyze the characteristics of semiconductor devices	Analyzing (K4), 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	2	1										2	1
CO2	3	2	1										2	1
CO3	3	2	1										2	1
CO4	3	2	1										2	1
CO5	3	2	1										2	1
CO6	3	2	1		1								2	1
CO7	3	2	1		1								2	1
CO8	3	2	1		1								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	40	10			100
CAT2	10	40	40	10			100
CAT3	10	60	30				100
ESE	10	40	40	10			100

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

20ADL11 - PROBLEM SOLVING AND PROGRAMMING LABORATORY

Programme & Branch	BTech- Artificial Intelligence and Data Science	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	1	PC	0	0	2	1

Preamble	The purpose of the course is to introduce problem solving aspects and inculcate the logical thinking capability to solve a given problem. The course will also introduce to students to the field of programming using C language. The students will be able to enhance their analyzing and problem solving skills and use the same for writing programs in C.

List of Exercises / Experiments:

	Electric Circuits
1.	Writing algorithms and drawing flowcharts using Raptor Tool for problems involving sequential structures
2.	Writing algorithms and drawing flowcharts using Raptor Tool for problems involving selective structures
3.	Writing algorithms and Drawing flowcharts using Raptor Tool for problems involving repetitive structures
4.	Programs for demonstrating the use of different types of operators like arithmetic, logical, relational and ternary operators (Sequential structures)
5.	Programs to Illustrate the different formatting options for input and output
6.	Programs using decision making statements like ‘if’, ‘else if’, ‘switch’, conditional and unconditional ‘goto’ (Selective structures)
7.	Programs for demonstrating repetitive control statements like ‘for’, ‘while’ and ‘do-while’ (Iterative structures)
8.	Programs for demonstrating one-dimensional and two-dimensional numeric array
9.	Programs to demonstrate modular programming concepts using functions (Using built-in and user-defined functions)
10.	Programs to implement various character and string operations with and without built-in library functions.
11.	Programs to demonstrate the use of pointers
12.	Programs to illustrate the use of user-defined data types

Total: 30

REFERENCES /MANUALS/SOFTWARES:

1.	Raptor and C Compiler

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	demonstrate the execution of flowchart for the given problem using Raptor	Applying (K3), Precision (S3)
CO2	demonstrate the application of sequential, selective and repetitive control structures	Applying (K3), Precision (S3)
CO3	implement solutions to the given problem using derived and user defined data types and functions	Applying (K3), 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	2	1	1	1					1			1	2
CO2	3	2	1	1	1					1			1	2
CO3	3	2	1	1	1					1			1	2

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

20PHL11 – PHYSICAL SCIENCES LABORATORY I

(Common to All Engineering and Technology Branches)

Programme & Branch	All BE/BTech Branches	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	1	BS	0	0	2	1

Preamble	This course aims to impart hands on training in the determination of the physical parameters such as Young's modulus, rigidity modulus, frequency of vibration, velocity of ultrasonic waves, compressibility of water, wavelength of laser, acceptance angle and the numerical aperture of an optical fiber, and to develop the skills in handling different basic instruments and also aims to impart the basic concepts of volumetric, conductometric and pH meter experiments and thereby, to improve the analytical capability.

List of Exercises / Experiments:

1.	Determination of the Young's modulus of the material of a given beam using uniform bending method.
2.	Determination of the rigidity modulus of the material of a given wire using torsional pendulum.
3.	Determination of frequency of electrically vibrating rod by forming standing waves using Melde's apparatus.
4.	Determination of the velocity of ultrasonic waves in a liquid and the compressibility of a liquid using ultrasonic interferometer.
5.	Determination of (i) the wavelength of a semiconductor laser and (ii) the acceptance angle and the numerical aperture of a given optical fiber.
6.	Estimation of total, temporary and permanent hardness of water by EDTA method.
7.	Estimation of $Ca^{2+}$and Mg^{2+}hardness separately by EDTA method.
8.	Estimation of alkalinity of the given water sample.
9.	Conductometric titration -Mixture of acids.
10.	Estimation of hydrochloric acid using pH meter.

Total: 30

REFERENCES:

1.	Tamilarasan K. and Prabu K.,"Physics Laboratory Manual', 1st Edition, SCM Publishers, Erode, 2020.
2.	Palanisamy P.N., Manikandan P., Geetha A. and Manjula Rani K., "Chemistry Laboratory Manual", 1st Edition, Rajaganapathy Publishers, Erode, 2020.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	determine the Young's modulus of a material using the concepts of elasticity and bending moment of a beam and to determine the rigidity modulus of a wire using the concepts of twisting couple and to compute the frequency of electrically vibrating rod using the concept of standing waves formed in fixed vibrating string.	Applying (K3), Precision (S3)
CO2	determine the wavelength of a semiconductor laser beam using the concept of diffraction of light, and to compute the acceptance angle and the numerical aperture of an optical fiber using the concepts of total internal reflection and divergence of light in air and estimate the amount of hardness for the given water sample by EDTA method, and the amount of alkalinity for the given water sample.	Applying (K3), Precision (S3)
CO3	demonstrate the conductivity meter and pH meter to estimate the amount of the given solution.	Applying (K3), 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										
CO2				3										
CO3				3										

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

SEMESTER-II

20EGT21 ADVANCED COMMUNICATION SKILLS

(Common to all Engineering and Technology Branches)

Programme & Branch	All BE/BTech branches	Sem.	Category	L	T	P	Credit
Prerequisites	20EGT11 – English Language Skills	2	HS	3	0	0	3

Preamble	This course is designed to impart required levels of fluency in using the English Language at B1Level in the Common European Framework (CEFR).	
Unit - I	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase –VI**	**9**
Listening – Job and career related descriptions and conversations – requests of different kinds and the responses – **Speaking -** Career choices and professional skills – making requests and responding to requests – **Reading** – Using texts about jobs and careers – about different societies and cultural differences – **Writing** – Resumes, CVs and job oriented advertisements – business and career related emails – **Grammar &Vocabulary** – Gerunds and elements of comparison – requests and indirect requests.		
Unit - II	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – VII**	**9**
Listening – Expository and narrative descriptions – information about different cultures, nations and societies. **Speaking** – Narrating and describing – talking about other countries and other cultures – **Reading** – Using texts about media and information technology – living abroad and experiencing different cultures – **Writing** – Blog writing – brochures and tourist pamphlets – **Grammar & Vocabulary** – The past tense forms - noun phrases and relative clauses.		
Unit - III	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – VIII**	**9**
Listening – Consumerism – product description – complaints and redressal – environmental issues – ecology – saving the planet – **Speaking** – Talking about problems, issues, complaints – solutions and redressal – talking about environmental issues – **Reading** – Using texts on segregating wastes – recycling and reusing – texts on environmental issues – **Writing** – Online reviews, articles and writing web content – **Grammar & Vocabulary** – Phrases and sentences used for describing problems – passives – prepositions and infinitives.		
Unit - IV	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – IX**	**9**
Listening – Education, learning and the choice of courses – various services needed in daily life – self-improvement for success in life – **Speaking** - Discussions about educational and career oriented issues – talking about everyday services – giving advice and self improvement – **Reading** – Reading about learning strategies and learning styles – using texts about personality development – **Writing** – Writing about hobbies – pastime and individual skills – writing short articles on everyday life and personality development – **Grammar & Vocabulary** – Using of "would" and certain gerund forms – use of modals, verbs, gerunds, negative questions and infinitives.		
Unit - V	**Listening, Speaking, Reading, Writing and Grammar & Vocabulary. Activity Based Learning – Phase – X**	**9**
Listening – Historical narratives – biographies and learning about the future – important life events, milestones and happenings of the past – **Speaking** – Talking about the past, present and the future – talking about important events in life – **Reading** – Texts about new technologies and future science – using texts about social organization, culture and social practices – **Writing** – Biographical sketches – historical events – famous personalities, stages of life and getting along with people – **Grammar & Vocabulary** – Future tense forms – time clauses and certain "if clauses".		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Jack C. Richards, Jonathan Hull, and Susan Proctor, "Interchange - Student's Book 3", 4th Edition, Cambridge University Press, New York, 2017. for Unit I, II, III, IV and V.

REFERENCES:

1.	Sanjay Kumar and Pushp Lata, "Communication Skills: A Workbook based on AICTE Syllabus", Oxford University Press, 2020.
2.	Board of Editors, "Skills Annexe: Functional English for Success", Orient BlackSwan, Hyderabad, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	use functional grammar for improving communication skills	Applying (K3)
CO2	listen and comprehend different spoken excerpts critically and infer Unspoken and implied meanings.	Applying (K3)
CO3	read different genres of texts, infer implied meanings and critically analyze and evaluate them for ideas as well as for method of presentation.	Analyzing (K4)
CO4	write effectively and persuasively and produce different types of writing such as narration, description, exposition and argument as well as creative, critical, analytical and evaluative writing.	Creating (K6)
CO5	speak effectively, to express opinions clearly, initiate and sustain a discussion and also negotiate using appropriate communicative strategies.	Creating (K6)

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	1	1		
CO2									2	3		1		
CO3						1				3	1	1		
CO4										3		2		
CO5									2	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		13	30	33	-	17	100
CAT2		13	33	37	-	17	100
CAT3		20	30	33	-	17	100
ESE		6	40	36	-	18	100

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

20MAT21 – DISCRETE MATHEMATICS AND LINEAR ALGEBRA
(Common to AI & DS and AI & ML branches)

Programme & Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	2	BS	3	1	0	4

Preamble	To provide in depth knowledge in various concepts of linear algebra,mathematical logic, relations and various category of functions which serves as a foundation for machine learning and data scienceand also develop skills to apply algebraic structures in coding theory.	
Unit - I	**Mathematical Logic**	**9+3**
Propositional Calculus: Propositions – Logical connectives – Compound propositions – Conditional and biconditional propositions – Truth tables – Tautologies and contradictions – Theory of Inference – Rules of inference – Arguments – Validity of arguments. Predicate Calculus: Predicates – Statement function – Variables – Quantifiers – Universe of discourse – Theory of inference for Predicate calculus – Rules of universal specification and generalization – Rules of Existential specification and generalization.		
Unit - II	**Relations and Functions**	**9+3**
Relations: Definition – Partial ordered relation – Poset – Hasse diagram – Lattices – Properties of lattices – Boolean algebra – Definition – Properties. Functions: Definition – Types of functions – Composition of functions – Inverse functions – Recursive functions.		
Unit - III	**Algebraic Structures**	**9+3**
Groups and Subgroups (Definitions only) – Cosets – Lagrange's theorem – Rings andFields (Definitions and examples) – Coding Theory – Group codes – Basic notions of error correction – Error recovery in group codes (Excluding theorems in coding theory).		
Unit - IV	**Vector spaces**	**9+3**
Real vector spaces – Subspaces – Linear combinations and Span – Linear independence – Bases and dimension –Row space, Column space andNull Space – Rank and nullity.		
Unit - V	**Inner Product Spaces**	**9+3**
Inner products – Angle and Orthogonality in inner product spaces – Orthonormal vectors – Gram Schmidt orthonormalization process – QR decomposition – Singular value decomposition.		

Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1. Veerarajan T., "Discrete Mathematics with Graph Theory and Combinatorics", Reprint Edition, Tata McGraw Hill Publishing Company, New Delhi, 2013. for Unit I, II, III, IV and V.
2. Howard Anton, Chris Rorres, "Elementary Linear Algebra", 11th Edition, John Wiley & Sons, 2014. for Unit IV and V.

REFERENCES:

1. Kenneth H. Rosen , "Discrete Mathematics and its applications", 8th Edition, Tata McGraw Hill, 2019
2. Gilbert Strang, "Introduction to Linear Algebra", 4th Edition, Wellesley-Cambridge Press, Wellesley, USA, 2016.
3. David C. Lay, Steven R. Lay, Judith McDonald, "Linear Algebra and Its Applications", 5th Edition, Pearson Education Limited, England, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply propositional and predicate logic to validate the arguments.	Applying (K3)
CO2	understand various types of relations and functions which has applications in cryptography and combinatorial optimization.	Understanding (K2)
CO3	apply the concepts of group structures in coding theory.	Applying (K3)
CO4	illustrate the concept of vector spaces commonly used in intelligent systems.	Understanding (K2)
CO5	apply the concepts of inner product spaces in orthogonalization and decomposition in data reduction.	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	3	2	1	1									1	
CO2	3	2	1										2	
CO3	3	2	1	2									2	
CO4	3	2	1										1	
CO5	3	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	70				100
CAT2	10	20	70				100
CAT3	10	20	70				100
ESE	10	20	70				100

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

DIGITAL PRINCIPLES AND DESIGN
(Common to AI & DS and AI & ML branches)

Programme& Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	2	ES	3	0	2	4

Preamble	This course enables the students to gain knowledge about the basic principles of number system, Binary Codes, Boolean algebra, digital logic gates and its minimization techniques and to design different combinational and sequential logic circuits.	
Unit - I	**Number Systems and Boolean Algebra:**	**9**
Number Systems and Boolean Algebra: Number Systems and their conversions - Complements – Signed Binary Numbers – Binary Codes – Binary Logic - Boolean Algebra –Theorems of Boolean Algebra – Boolean functions: Realization of functions using Logic gates.		
Unit - II	**Gate Level Minimization:**	**9**
Gate Level Minimization: Canonical and Standard Forms of Boolean functions – Minimization of functions using Karnaugh Map up to four variable – Don't–Care Conditions – NAND and NOR Implementation– Minimization of functions using Quine-McCluskey method.		
Unit - III	**Combinational Logic:**	**9**
Combinational Logic: Half Adder – Full Adder - Half Subtractor – Full Subtractor – Binary Adder - Subtractor – Magnitude Comparator – Decoders – Encoders – Multiplexers – Demultiplexers – Boolean Functions implementation using Multiplexers.		
Unit - IV	**Synchronous Sequential Logic:**	**9**
Sequential Logic: Introduction – Latches and Flip-flops – Analysis of clocked sequential circuits: State Equations – State Table – State Diagram – State Reduction and Assignment.-Shift Registers-Counters.		
Unit - V	**Asynchronous Sequential Logic and Programmable Logic Devices:**	**9**
Introduction to Asynchronous Sequential Circuits: Concepts of Analysis Procedure - Race conditions - types.– Programmable Logic devices: PROM – PLA – PAL.		

Lecture: 45, Practical: 30, Total: 75

List of Exercises / Experiments:

1.	Verification of Boolean theorems using digital logic gates
2.	Design and implementation of combinational circuits using basic gates
3.	Design and implementation of binary adder and subtractor
4.	Design and implementation of multiplexer and de-multiplexer
5.	Design and implementation of encoder and decoder
6.	Truth table verification of flip flops
7.	Design and implementation of shift registers using suitable ICs
8.	Design and implementation of counters

Lecture: 45, Practical:30, Total:75

TEXT BOOK:

1.	Morris Mano M, "Digital Design", 6th Edition, Pearson Education Pvt. Ltd, New Delhi, 2020. for Unit I, II, III, IV and V.

REFERENCES:

1.	Anandkumar A, "Fundamentals of Digital Circuits", 4th Edition, Prentice Hall of India, New Delhi, 2016.
2.	Salivahanan S &Arivazhagan S, "Digital Circuits and Design", 5th Edition, Oxford University Press, New Delhi, 2020

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	verify the Boolean Algebra	Applying (K3)
CO2	realization of Boolean Functions	Applying (K3)
CO3	apply Karnaugh map techniques for gate level logic minimization	Applying (K3)
CO4	design adders and subtractors	Applying (K3)
CO5	design multiplexers and demultiplexers	Applying (K3)
CO6	design the combinational circuits	Applying (K3)
CO7	design the sequential circuits	Applying (K3)
CO8	realize boolean functions using PLDs	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	3	1	3	2		2						1	2	2
CO2	3	2	3	2	2	2			2	2		1	3	2
CO3	3	2	3	2	2	2			2	2		1	3	2
CO4	3	2	3	2	2	2			2	2		2	3	2
CO5	3	2	3	2		2						2	3	2
CO6	3	2	3	2		2						2	3	2
CO7	3	2	3	2		2						2	3	2
CO8	3	2	3	2		2						2	3	2

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	45	45				100
CAT2	10	45	45				100
CAT3	10	45	45				100
ESE	10	45	45				100

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

DATA STRUCTURES
(Common to AI & DS and AI & ML branches)

Programme & Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	2	PC	3	0	0	3

Preamble	The course focuses on the basic concepts and applications of linear data structures and non linear data structures.	
Unit - I	**List:**	**9**
Data Structures – Abstract Data Types (ADT)–List ADT and Array Implementation – Linked List – Doubly Linked List – Circular Linked List – Applications of Linked Lists.		
Unit - II	**Stack and Queue:**	**9**
Stack ADT – Array and Linked List implementation of Stacks – Applications of Stacks – Queue ADT – Array and Linked List implementation of Queue – Circular Queue – Applications of Queue.		
Unit - III	**Trees:**	**9**
Preliminaries: Implementation of trees –Tree Traversals – Binary trees: Implementation– Expression trees – The Search Tree ADT – Binary Search Trees: Construction – Searching – Insertion – Deletion – Find Min – Find Max – AVL trees: Rotation – Insertion – Deletion.		
Unit - IV	**Graphs:**	**9**
Definitions – Representation of Graphs – Types of Graph – Depth-first traversal – Breadth-first traversal – Topological Sort – Applications of DFS: Bi-connectivity – Euler circuits – Finding Strongly Connected Components – Applications of BFS: Bipartite graph – Graph Coloring.		
Unit - V	**Searching, Sorting and Hashing:**	**9**
Searching: Linear search – Binary Search – Sorting: Internal sorting: Bubble sort – Shell sort – Bucket sort – External sorting: Multiway Merge – Polyphase Merge - Hashing: Hash Functions – Separate Chaining – Open Addressing: Linear Probing – Quadratic Probing – Double Hashing – Rehashing – Extendible Hashing.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Weiss M. A., "Data Structures and Algorithm Analysis in C", 2nd Edition, Pearson Education, 2016. for Unit I, II, III, IV and V.

REFERENCE:

1.	Thomas H. Cormen, Charles E. Leiserson, Ronald L.Rivest, Clifford Stein, "Introduction to Algorithms", 3rd Edition, Mcgraw Hill, 2009 for Unit IV.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	solve problems using various implementations of linked list.	Applying (K3)
CO2	make use of ADTs like stack and queue for solving real world problems.	Applying (K3)
CO3	implement the tree structure and its operations.	Applying (K3)
CO4	apply appropriate graph algorithms for computing problems.	Applying (K3)
CO5	demonstrate the concept of sorting, searching and hashing techniques.	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	3	2	2										3	2
CO2	3	2	2										3	2
CO3	3	2	2										3	2
CO4	3	2	2										3	2
CO5	3	2	2										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	5	20	75				100
CAT2	10	20	70				100
CAT3	10	20	70				100
ESE	10	20	70				100

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

PYTHON PROGRAMMING
(Common to AI & DS and AI & ML branches)

Programme & Branch	BTech.& Artificial Intelligence and Data Science	Sem.	Category	L	T	P	Credit
Prerequisites	C Programming	2	ES	3	0	2	4

Preamble	To provide practical exposure to basic concepts of Python Programming including object oriented programming, GUI and Web programming	
Unit – I	**Introduction**	**9**
Basic Concepts: Keywords, identifiers and variables- Data types - type casting – user input – modules – operators – Flow control statements- Strings – Calendars and clocks.		
Unit - II	**Functions and Data types**	**9**
Functions: Basics –function arguments – modules – Recursion – Special functions. **Lists**: Creating, traversing and slicing - functions – nested lists. **Tuples:** Creating, initializing and accessing – tuple functions – swapping tuples, unpacking tuples – **Dictionaries:** Basics of Creating, initializing and accessing – dictionary functions and methods-view objects.		
Unit - III	**Object Oriented Programming**	**9**
Concepts of OOP- OOP concepts for Python – Built in Attributes and methods –polymorphism- operator overloading - Inheritance and Namespace – Method types - Exceptions: Built-in and User defined exceptions.		
Unit - IV	**Strings, Files and Regular Expressions**	**9**
Strings: Built-in methods for string manipulation – Case studies. Modules and Packages : import statement – creating user defined modules and packages. **Files:** File operations –Reading and Writing a file. **Regular Expressions**: match, search, sub, find all and finite functions - Case studies.		
Unit - V	**User Interface and GUI Programming**	**9**
User Interface design: Tkinter - Events – Connecting with databases. **Web Frameworks:** - Web servers - Introduction to web server frameworks (Bottle, Django and Flask)		

Lecture: 45, Practical:30, Total:75

List of Exercises / Experiments :

1.	Program using user-defined functions with different types of argument passing methods
2.	Demonstrate tuple, list and dictionary operations
3.	Program to illustrate the concept of constructors
4.	Program to implement different types of inheritance
5.	Program to demonstrate the usage of exception handling
6.	Explore string manipulation functions
7.	Find the most frequent words from a given text file and copy the same into another file
8.	Perform validation of inputs using Regular Expressions
9.	Design applications using TKInter
10.	Develop web pages using Web frameworks

TEXT BOOK:

1.	Anurag Gupta, G P Biswas. Python Programming, McGraw Hill Education,1st edition, 2020. for Unit I, II, III, IV and V.

REFERENCES:

1	Bill Lubanovic, —Introducing Python Modern Computing in Simple Packages, 2nd Edition O'Reilly Media, 2019.
2.	Samuel Dauzon, Aidas Bendoraitis and Arun Ravindran. Django: Web Development with Python: Web Development with Python. Packt Publisher, 1st edition, 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	apply basic constructs of Python Programming to solve simple problems	Applying (K3)
CO2:	write programs using functions and data types	Applying (K3)
CO3:	get familiar with implementation of object oriented concepts in python	Applying (K3)
CO4:	Perform string, file and Regular expression operations and process data	Applying (K3)
CO5:	use TKinter and other web frameworks for addressing solutions for various real life problems	Applying (K3)
CO6	implement basic concepts of python programming and use it to solve the given problem	Applying (K3), Precision (S3)
CO7	make use of object oriented concepts to solve real world problems	Applying (K3), Precision (S3)
CO8	develop applications using GUI and web frameworks	Applying (K3), 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	2	3		3								3	2
CO2	3	2	2		2								3	3
CO3	3	2			3								3	3
CO4	3	2			3								3	3
CO5	3	2	2		3								3	3
CO6	3	2	1	2	1								3	2
CO7	3	2	1	2	1								3	2
CO8	3	2	1	2	1								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 %
CAT 1	15	30	55				100
CAT 2	15	30	55				100
CAT 3	15	30	55				100
ESE	15	30	55				100

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

DATA STRUCTURES LABORATORY
(Common to AI & DS and AI & ML branches)

Programme & Branch	B.Tech. &Artificial Intelligence and Data Science	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	2	PC	0	0	2	1

Preamble	The course provides knowledge to develop applications using the concepts of Linear and Non-linear Data Structures.

List of Exercises / Experiments:

1.	Implementation of singly linked list and its operations
2.	Implementation of doubly linked list and its operations
3.	Implementation of stack and its operations
4.	Infix to postfix conversion using stack ADT
5.	Evaluating postfix expression using stack ADT
6.	Implementation of queue and its operations
7.	Implementation of circular queue and its operations
8.	Reverse a queue using stack
9.	Implementation of binary search tree traversals
10.	Implementation of graph traversal techniques
11.	Implementation of linear and binary search algorithms
12.	Implementation of sorting algorithms

Total: 30

REFERENCES/MANUAL/SOFTWARE:

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

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	implement linear and non linear data structures to solve the given problem	Applying (K3), Precision (S3)
CO2	use a data structure to implement another data structure	Applying (K3), Precision (S3)
CO3	implement searching and sorting operations for a given problem	Applying (K3), Precision (S3)

Mapping of COs with POs and PSOs

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

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

OPEN SOURCE LABORATORY
(Common to AI & DS and AI & ML branches)

Programme& Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	2	BS	0	0	2	1
Preamble	This course provides knowledge about basic Linux commands, shell script programming and Internet hosting for software development and version control using Git						

List of Exercises / Experiments:

1.	Implementation of Linux Commands
2.	Implementation of Shell programming for constructs like loops and patterns
3.	Implementation of Shell programming for string operations
4.	Git Installation and Setup
5.	Experiment on basic Git Commands
6.	Creation of Git local and remote repository
7.	Creation of branches and merging branches
8.	Experiment on merge conflicts and resolution
9.	Working with multiple repositories and configuration files
10.	Experiment on Fetch, Pull, Clone and rebasing on repositories
11.	Working with Patches and Hooks
12.	Experiment on Git graph model and version tracking

Total: 30

REFERENCES/MANUAL/SOFTWARE:

1.	Operating System : Linux
2.	Software: GitHub Desktop
3.	Laboratory Manual

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explore linux commands and apply it for various operations at terminal	Applying (K3), Precision (S3)
CO2	solve the given problem using shell script	Applying (K3), Precision (S3)
CO3	explore the functionality of Git	Applying (K3), 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	2	1	2	1								3	2
CO2	3	2	1	2	1								3	2
CO3	3	2	1	2	1								3	2

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

ENGINEERING PRACTICES LABORATORY
(Common to all Engineering and Technology Branches)

Programme & Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	2	ES	0	0	2	1

List of Exercises / Experiments:

	PART A – MECHANICAL ENGINEERING
1.	To prepare square or rectangular shaped MS plates using power tools for cutting, polishing and shaping to the required dimensions.
2.	To carryout drilling, tapping and assembly on the given MS plates.
3.	To carryout thread forming on a GI/PVC pipes and prepare water leak proof water line from overhead tank.
4.	To prepare a wood or plywood box/tray/any innovative models using modern power tools like cutting machine, router, jigsaw, power screw driver etc.
5.	To prepare a leak proof sheet metal tray/box/funnel using modern power tools.
6.	Welding practice using welding simulator.
7.	Project: Preparing innovative articles using wood/sheet metal.
	PART B – ELECTRICAL AND ELECTRONICS ENGINEERING
8.	Safety Aspects of Electrical Engineering, Electrical Symbols, Components Identification, Fuse selection and installation, Circuit Breakers selection
9.	Wiring circuit for fluorescent lamp and stair case wiring
10.	Measurement of earth resistance
11.	Soldering of simple circuits and trouble shooting
12.	Implementation of half wave and full wave rectifier using diodes

Total:30

REFERENCES/MANUAL/SOFTWARE:

1.	Engineering Practices Laboratory Manual.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	plan the sequence of operations for effective completion of the planned models/innovative articles	Creating (K6), Precision(S3)
CO2	identify and use appropriate modern power tools and complete the exercises/models accurately	Applying (K3), Precision(S3)
CO3	select fuses and Circuit breakers	Understanding (K2), Manipulation(S2)
CO4	perform house wiring and realize the importance of earthing	Applying(K3), Manipulation(S2)
CO5	trouble shoot the electrical and electronic circuits	Applying(K3), Manipulation(S2)

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	2	3		
CO2	3	2	1	1					3	2	2	3		
CO3	2	1							3	2	2	3		
CO4	3	2	1	1					3	3	2	3		
CO5	3	2	1	1					3	2	2	3		

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

YOGA AND VALUES FOR HOLISTIC DEVELOPMENT
(Common to all Engineering and Technology Branches)

Programme& Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	2	HS	1	0	1	1

Preamble	ProvidingValueEducationtoimprovetheStudents"character-understanding yogic life and physical health-maintaining youthfulness- Measure and method in five aspects of life	
Unit- I	**Physical Health:**	**2**
Manavalakalai (SKY) Yoga: Introduction - Education as a means for youth empowerment - Greatness of Education - Yoga for youthEmpowerment. **Simplified Physical Exercises:** Need and Objectives of Simplified Physical Exercise - Hand, Leg, Breathing, Eyeexercises - Kapalabathi, Makarasana Part I, Makarasana Part II, Body Massage, Acu pressure, Relaxation exercises - Benefits.**Yogasanas:** Pranamasana - HasthaUttanasana - Pada Hasthasana - AswaSanjalana Asana - ThuvipathaasvaSanjalana asana -AstangaNamaskara - Bhujangasana - Atha Muktha Savasana - AswaSanjalana Asana - Pada Hasthasana - HasthaUttanasana -Pranamasana.**Pranayama:**Naddisuddi-Clearance Practice- Benefits.		
Unit- II	**LifeForce:**	**2**
Reasons for Diseases: Body Function - Reason for Diseases and Prevention - Natural reasons (Genetic / imprints, Planetary Position,Natural calamities and climatic changes) - Unnatural reasons (Food habits, Thoughts, Deeds). **Philosophy of Kaya kalpa:** EnrichingBio-Magnetism-Physicalbody-Sexualvitalfluid-Lifeforce-Bio-Magnetism-Mind.**Maintainingyouthfulness:**Postponingold age - Transformation of food into seven components - Importance of sexual vital fluid - Measure and method in five aspects of life -ControllingunduePassion.**Kayakalpapractice:** AswiniMudra- Ojasbreath-BenefitsofKayaKalpa.		
Unit- III	**MentalHealth:**	**2**
Mental Frequencies: Beta, Apha, Theta and Delta wave- Agna Meditation explanation - benefits. Shanti meditation: ShanthiMeditation explanation – benefits. **Thuriya Meditation:** Thuriya Meditation explanation – benefits. **Benefits of Blessing**: Self blessing(Autosuggestion)-Familyblessing-Blessing theothers-Worldblessing-Divine protection.		
Unit- IV	**Values:**	**2**
Human Values: Self control - Self confidence - Honesty Contentment - Humility – Modesty - Tolerance - Adjustment - Sacrifice –Forgiveness - Purity (Body, Dress, Environment) - Physical purity - Mental purity - Spiritual purity. **Social Values:** Non violence –Service. Patriotism –Equality. Respect for parents and elders- care and protection - Respect for teacher. Punctuality- TimeManagement.		
Unit- V	**Morality(Virtues):**	**2**
ImportanceofIntrospection:I-Mine(Ego,Possessiveness).SixEvilTemperaments-Greed-Anger-Miserliness-Immoralsexualpassion-InferiorityandsuperiorityComplex–Vengeance.ManeuveringofSixTemperaments:Contentment-Tolerance-Charity- Chastity-Equality-Pardon(Forgiveness).FiveessentialQualitiesacquiredthroughMeditation:Perspicacity-Magnanimity-Receptivity- Adaptability - Creativity(Improved MemoryPower).		

Lecture:10,Practical:10,Total:20

TEXT BOOK:

1.	ThathuvagnaniVethathiriMaharishi,"YogaforYouthEmpowerment",VethathiriPublications,2019. for Unit I, II, III, IV and V.

REFERENCES:

1.	ThathuvagnaniVethathiriMaharishi,"YogaforModernAge",VethathiriPublications,2019.
2.	ThathuvagnaniVethathiriMaharishi,"SimplifiedPhysicalExercises",VethathiriPublications,2019.
3.	NeelamSharma,"HolisticEducationandYoga",ShipraPublications,2017.
4	Dr.JosephMurphy,"ThePowerofYourSubconsciousMind",PushpakPublication,2019.

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		2	1			1		
CO2						3		2				1		
CO3						3		3				1		
CO4						3		2	1			1		
CO5						3		3				1		
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom"s Taxonomy														

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

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

SEMESTER –III

20MAT35 PROBABILITY THORY AND INFERENTIAL STATISTICS
(Common to AI & DS and AI & ML branches)

Programme & Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	3	BS	3	0	0	3

Preamble	To impart knowledge and problem solving capability in probability and statistical concepts necessary for handling real time applications in Artificial intelligence.	
Unit - I	**Probability and Random Variables**	**9**
Probability – Axioms of probability – Conditional probability – Total probability – Baye's theorem – Random variable – Discrete and Continuous random variables – Probability mass function – Probability density function – Cumulative distribution function – Moments – Moment generating functions.		
Unit - II	**Standard Probability Distributions**	**9**
Discrete Distributions: Binomial distribution – Poisson distribution – Geometric distribution – Continuous Distributions: Uniform distribution – Exponential distribution – Gaussian distribution.		
Unit - III	**Correlation and Estimation Theory**	**9**
Correlation and Regression: Covariance – Correlation – Karl Pearson's Coefficient of Correlation – Regression – Lines of Regression – Properties of Regression lines and coefficients. Estimation Theory: Concept of Estimation – Characteristics of estimators – Unbiasedness – Consistency –Methods for Estimation: Method of Maximum Likelihood Estimation - Method of Moments.		
Unit - IV	**Testing of Hypothesis**	**9**
Introduction – Critical region and level of significance – Types of Errors – Large sample tests - Z-test for single mean and difference of means – Small sample tests: Student's t-test for testing significance of single mean and difference of means – F-test for comparison of variances – Chi-square test: Test of goodness of fit – Test of independence of attributes.		
Unit - V	**Design of Experiments**	**9**
Analysis of variance – One way classification: Completely Randomized Design – Two way classification: Randomized Block Design – Three way classification: Latin Square Design.		

Lecture: 45, Total: 45

TEXT BOOK:

1. Jay L. Devore, "Probability and Statistics for Engineering and Sciences", 9th Edition, Cengage Learning USA, 2016. for Unit I, II, III, IV and V.

REFERENCES:

1. Douglas C. Montgomery & George C. Runger, "Applied Statistics and Probability for Engineers ", 7th Edition, John Wiley and Sons, USA, 2020.
2. Veerarajan, T, "Probability, Statistics, Random Processes and Queuing Theory", 1st Edition, Tata McGraw-Hill, New Delhi, 2019.
3. Gupta S.C. and Kapoor V.K. "Fundamentals of Mathematical Statistics", 11th Edition, Sultan Chand and Sons, 2002.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret the concept of random variables.	Applying (K3)
CO2	apply different types of distributions in engineering problems.	Applying (K3)
CO3	utilize the concepts of correlation and point estimation in intelligent systems	Applying (K3)
CO4	apply statistical tests for solving engineering problems involving small and large samples.	Applying (K3)
CO5	apply the concepts of analysis of variance to experimental data.	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	3	3	1										1	
CO2	3	3	2										2	
CO3	3	3	2	3									2	
CO4	3	3	2	3									3	
CO5	3	3	2	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	70	-	-	-	100
CAT2	10	20	70	-	-	-	100
CAT3	10	20	70	-	-	-	100
ESE	10	20	70	-	-	-	100

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

FOUNDATIONS OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Programme & Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	Python Programming	3	ES	3	0	2	4

Preamble	The course focuses on the methodology of how to translate a data driven business problem into an effective solution by using the powerful AI technologies according to the Machine Learning paradigm.	
Unit - I	**Revolution of AI and ML, Prediction using Regression**	**9**
Introduction to Machine Learning – Machine Learning vs Classical Programming – The ability to predict – Introduction to Regression – Regression Models – Linear Regression Model and Machine Learning – Evaluating Model Quality using different metrics – Insurance cost prediction problem		
Unit - II	**Non-Linear Models and Feature Engineering**	**9**
Non-Linear Models – Feature Engineering - Insurance cost modeling problem – Reasons for Model Errors – Rectification of Model Errors – Overfitting and Underfitting – Deriving Data to Train the Model – Train/Test Split on the Insurance Problem		
Unit - III	**Classification Problems and Confusion Matrix**	**9**
Introduction to Classification – Approach followed by Classification Algorithms – A Visual Representation of Logistic Regression – Evaluating Classification Model Accuracy – Classification with Logistic Regression – Introduction to Confusion Matrix – Hands-on with Confusion Matrix- Importance of Class wise Accuracy.		
Unit - IV	**Decision Trees and Random Forest Classifier**	**9**
Introduction – Decision Trees as Classifiers – Overfitting in Decision Trees – Preventing Decision Trees from Overfitting – Ensemble Models – Random Forest Classifier – Random Forests for Bank Note Classification – Controlling Overfitting in Random Forests.		
Unit - V	**Unsupervised Learning**	**9**
Clustering – Clustering with K-means – Customer Segmentation using K-means – Collaborative Filtering – Recommender Systems –Recommender System for Book Ratings Data.		

List of Exercises / Experiments:

1.	Study tools/packages in Weka / RapidMiner / Python
2.	Perform data preprocessing tasks for the given dataset
3.	Demonstration of classification using ID3, J48 and Naïve Bayes Algorithm
4.	Demonstrate performing clustering on dataset
5.	Demonstrate performing Linear Regression and Logistic Regression on datasets
6.	Demonstrate performing k-Nearest Neighbors on dataset
7.	Explore Weka Experimenter to find the performance of classification algorithms
8.	Explore Weka knowledge flow for implementing a project

Lecture: 45, Practical:30, Total:75

TEXT BOOK:

1.	Sujit Bhattacharyya, Subhrajit Bhattacharyya, “Practical Handbook of Machine Learning”, Career Launcher Infrastructure Pvt Ltd and G.K. Publications Pvt Ltd, First Edition, 2021. for Unit I, II , III, IV and V.

REFERENCES:

1.	Rajendra Akerkar, “Introduction to Artificial Intelligence”, PHI Learning Pvt Ltd, Second Edition August,2014.For Unit I.
2.	Gopinath Rebala, Ajay Ravi, Sanjay Churiwala, “An Introduction to Machine Learning”, Springer Nature, Switzerland, 1st Edition, 2019.For Unit II.
3.	Oliver Theobald, “Machine Learning for Absolute Beginners”, Independently Published, Second Edition, 2017. For Unit III, IV and V.

REFERENCES/MANUAL/SOFTWARE:

1.	Operating System : Linux / Windows
2.	Software: Weka / Rapid Miner / Python
3.	Laboratory Manual

	COURSE OUTCOMES: On completion of the course, the students will be able to	**BT Mapped (Highest Level)**
CO1	apply regression problems for prediction	Applying (K3)
CO2	understand the metrics of the machine learning problems	Understand(K2)
CO3	apply the logistic regression model and analyze confusion matrix	Applying (K3)
CO4	apply decision tree and random forest classifiers for given problem	Applying (K3)
CO5	create model using unsupervised learning methods	Applying (K3)
CO6	exhibit proficiency to build and assess data based models using weka / Rapid Miner tools	Applying (K3), Precision (S3)
CO7	demonstrate various classification model	Applying (K3), Precision (S3)
CO8	demonstrate various clustering and regression model	Applying (K3), 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	2	1	1									3	1
CO2	3	2	1	1									3	1
CO3	3	2	1	1									3	1
CO4	3	2	1	1									3	1
CO5	3	2	1	1									3	1
CO6	3	2	1	2	1								3	2
CO7	3	2	1	2	1								3	2
CO8	3	2	1	2	1								3	2

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

ASSESSMENT PATTERN - THEORY

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

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

DESIGN AND ANALYSIS OF ALGORITHMS
(Common to AI & DS and AI & ML branches)

Programme & Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	Data Structures	3	PC	3	0	2	4

Preamble	This course offers formal introduction to common algorithm design techniques and methods for analyzing the performance of algorithms.	
Unit - I	**Introduction**	**9**
Notion of an Algorithm – Fundamentals of Algorithmic Problem Solving – Important Problem Types – Fundamentals of the Analysis of Algorithm Efficiency – Analysis Framework – Asymptotic Notations and its properties – Mathematical analysis for Recursive and Non-recursive algorithms – Empirical analysis of algorithm – Algorithm visualization.		
Unit - II	**Brute Force & Divide and Conquer**	**9**
Selection sort– Sequential search and String Matching – closest pair and convex hull problem – Divide and Conquer methodology: Merge sort – Quick sort – Binary search – Binary tree traversals and related properties – Multiplication of large integers and Strassen's Matrix Multiplication – closest pair and convex hull problem.		
Unit - III	**Decrease and Conquer & Transform and Conquer**	**9**
Insertion sort – Topological Sorting – Fake coin problem – Computing a Median and the Selection Problem – Transform and conquer: Presorting – Balanced search trees – AVL trees – 2-3Trees – Heaps and Heap sort.		
Unit - IV	**Dynamic Programming & Greedy technique**	**9**
Warshall's and Floyd's algorithm – Optimal Binary Search Trees – Knapsack Problem and Memory functions – Greedy Technique: Prim's algorithm – Kruskal's Algorithm – Dijkstra's Algorithm – Huffman Trees.		
Unit - V	**Backtracking & Branch and Bound**	**9**
n-Queens problem – Hamiltonian Circuit Problem – Subset Sum Problem – Branch and Bound: Assignment problem – Knapsack Problem – Traveling Salesman Problem – Overview of P, NP and NP-Complete Problems – Randomized algorithms.		

List of Exercises:

1.	Find the order of growth of the given problems. Identify the basic operation and count the number of times the basic operation is executed.
2.	Analyze the different sorting algorithms and find out the best algorithm with respect to space and time.
3.	Using Decrease and conquer technique, compute the k^{th} smallest element in the list of 'n' numbers. Also, find the time complexity.
4.	Write the heap sort algorithm to sort 'n' numbers using transform and conquer.
5.	Compare top down and bottom-up approaches of solving the Knapsack problem using Dynamic Programming.
6.	Construct huffman code for the given data. Also perform encoding and decoding (use Greedy technique).
7.	Apply backtracking to solve the given instance of subset sum problem.
8.	Solve the travelling salesman problem of the given graph using branch and bound technique.

Lecture: 45, Practical:30, Total:75

TEXT BOOK:

1.	Anany Levitin, "Introduction to the Design and Analysis of Algorithms", 3rd Edition, Pearson Education, 2012. for Unit I, II, III, IV and V.

REFERENCES:

1.	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, "Introduction to Algorithms", 3rd Edition, Prentice Hall of India, 2009.
2.	Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman, "Data Structures and Algorithms", Reprint Edition, Pearson Education, 2006.

REFERENCES/MANUAL/SOFTWARE:

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

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	analyze the efficiency of algorithms using various frameworks	Analyzing (K4)
CO2	apply brute force and divide-and-conquer techniques to solve various problems and analyze their efficiency.	Analyzing (K4)
CO3	utilize decrease-and-conquer and transform-and-conquer strategies for solving problems	Applying (K3)
CO4	make use of dynamic programming and greedy techniques to solve problems	Applying (K3)
CO5	solve difficult combinatorial problems with backtracking and branch & bound techniques	Applying (K3)
CO6	evaluate the Space and Time efficiency of various algorithms	Analyzing (K4) Precision (S3)
CO7	estimate the performance of various algorithm design techniques	Analyzing (K4) Precision (S3)
CO8	use appropriate design strategies for solving a given problem	Applying (K3) 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	2										3	2
CO2	3	3	2										3	2
CO3	3	2	2										3	2
CO4	3	2	2										3	2
CO5	3	2	2										3	2
CO6	3	2	2	2	2								3	2
CO7	3	2	2	2	2								3	2
CO8	3	2	2	2	2								3	2
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

7ASSESSMENT PATTERN - THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	30	40	20			100
CAT2	10	30	50	10			100
CAT3	10	30	60				100
ESE	10	20	50	20			100

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

COMPUTER ORGANIZATION
(Common to CSE, IT, AI & DS and AI & ML branches)

Programme& Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	3	PC	3	0	0	3

Preamble	This course provides knowledge on basics of computer organization, introduces various arithmetic operations and discusses the performance issues of processor, memory and I/O units.	
Unit - I	**Basic Structure of Computers and Machine Instructions**	**9**
Functional Units – Basic Operational Concepts – Number Representation and Arithmetic Operations – Performance – Memory Locations and Addresses – Memory Operations – Instruction and Instruction Sequencing – Addressing Modes – CISC Instruction Sets – RISC and CISC Styles.		
Unit - II	**Arithmetic Unit**	**9**
Addition and Subtraction of Signed Numbers – Design of Fast Adders – Multiplication of Unsigned Numbers – Multiplication of Signed Numbers – Fast Multiplication – Integer Division – Floating Point Numbers and Operations.		
Unit - III	**Processing Unit**	**9**
Fundamental Concepts – Instruction Execution – Hardware Components – Instruction Fetch and Execution Steps – Control Signals - Hardwired control – CISC Style Processors. Pipelining : Pipelining – Basic concepts – Pipeline Organization – Pipelining Issues - Data Dependencies – Memory Delay – Branch Delay – Performance Evaluation.		
Unit - IV	**Memory System**	**9**
Basic Concepts – Semiconductor RAM Memories – Read-Only Memories – Direct Memory Access – Memory Hierarchy – Cache Memories : Mapping Functions – Performance Consideration – Virtual Memory – Secondary Storage : Magnetic Hard Disks.		
Unit - V	**I/O Organization**	**9**
Accessing I/O Devices – Interrupts – Enabling and Disabling Interrupts – Handling Multiple Devices – Bus Structure – Bus Operation – Arbitration – Interface Circuits – Interconnection Standards : USB.		

Total: 45

TEXT BOOK:

1.	Carl Hamacher, ZvonkoVranesic, SafwatZaky and NaraigManjikian, “Computer Organization and Embedded Systems”, 6th Edition, McGraw Hill International Edition, 2012. for Unit I, II, III, IV and V.

REFERENCES:

1.	Patterson David, A. and Hennessy John L., “Computer Organization and Design: The Hardware / Software Interface”, 5th Edition, Harcourt Asia, Morgan Kaufmann, Singapore, 2014.
2.	Stallings William, “Computer Organization and Architecture: Designing for Performance”, 9th Edition, Pearson Education, New Delhi, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	describe the basic structure, arithmetic and memory operations of a digital computer and determine the addressing modes for the set of instructions.	Applying (K3)
CO2	describe and apply algorithms for performing different arithmetic operations.	Applying (K3)
CO3	make use of the data path in a processor to write the sequence of steps to fetch and execute a given instruction and apply the concepts of pipelining to determine and handle the hazards.	Applying (K3)
CO4	distinguish between different types of memory, and apply the mapping functions between main memory and cache.	Applying (K3)
CO5	demonstrate the need for and types of interrupts in I/O transfer and the role of different types of bus and arbitration in I/O operations.	Applying (K3)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1										3	1
CO2	3	2	1										3	1
CO3	3	2	1										3	1
CO4	3	2	1										3	1
CO5	3	2	1										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	20	60	20				100
CAT2	20	50	30				100
CAT3	20	55	25				100
ESE	20	40	40				100

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

DATABASE MANAGEMENT SYSTEMS
(Common to AI & DS and AI & ML branches)

Programme & Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	3	PC	3	0	0	3

Preamble	The course provides an emphasis on how to organize, maintain and retrieve information from a database management systemmore efficiently and effectively.	
Unit - I	**Data Models**	**9**
Introduction – Database System Applications – Purpose of database systems – View of data – Database Languages – Relational Databases – Database Architecture – Database Users and administrators – Relational Model – Structure of Relational Databases – Database Schema – Keys – Schema Diagrams – Relational Query Languages – Relational Algebra – Fundamental Relational Operations – Additional Relational Operations.		
Unit - II	**SQL and Database Design**	**9**
Database Design – ER model – Constraints – ER diagrams – Reduction to Relational Schema – ER design issues – SQL: Basic structure – Operations – Aggregate Functions –Sub queries – Nested Sub queries – modification of the database – Intermediate SQL: Joins – views– Index – Integrity Constraints – SQL data types and schemas – Authorization.		
Unit - III	**Relational Database Design**	**9**
Features of good relational designs – Functional dependency – Decomposition using functional dependencies – Normal Forms: 1NF, 2NF, 3NF, BCNF, 4NF, 5NF.		
Unit - IV	**Indexing and Hashing**	**9**
Ordered indices – B tree index files – B+ Tree index files – Multiple key access – Static and Dynamic Hashing – Bitmap indices – Overview of Query Processing.		
Unit - V	**Transactions**	**9**
Transaction concept – Transaction model –Storage structure – Transaction atomicity and durability – Isolation – Serializability– Concurrency control: Lock-based Protocols – Deadlock Handling.		

Total: 45

TEXT BOOK

1.	Silberschatz Abraham, Korth Henry F. and Sudarshan S., "Database System Concepts", 7th Edition , McGraw Hill, New York, 2019. for Unit I, II, III, IV and V.

REFERENCES

1.	ElmasriRamez and NavatheShamkant B., "Fundamental Database Systems", 6th Edition, Pearson Education, New Delhi, 2010.
2.	Date C.J., Kannan A. and Swamynathan S., "An Introduction to Database Systems", 8th Edition, Pearson Education, New Delhi, 2006.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	determine various keys and sketch a suitable schema for a given application.	Applying (K3)
CO2	design an ER model and write SQL queries for a queries for a given scenario.	Applying (K3)
CO3	design relational database using normalization methods for a given application.	Applying (K3)
CO4	apply indexing and hashing techniques in the design of relational database.	Applying (K3)
CO5	apply the concept of concurrency control in transaction processing.	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	3	2	2										3	2
CO2	3	2	2						2				3	2
CO3	3	2	2						2				3	2
CO4	3	2	2										3	2
CO5	3	2	2										3	2

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

ASSESSMENT PATTERN - THEORY

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

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

DATA VISUALIZATION

Programme & Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	Python Programming	3	PC	2	0	2	3

Preamble	This course provides practical exposure to Python Programming frameworks required for visualizing data	
Unit - I	**Numpy:**	**6+3**
Basics of Numpy arrays – Computation on Numpy arrays: Universal functions – Aggregations – Computation on arrays: Broadcasting – Comparisons, Masks and Boolean Logic – Fancy Indexing – Sorting arrays.		
Unit - II	**Data Manipulation with Pandas:**	**6+3**
Introducing Pandas Objects – Data Indexing and Selection – Operating on Data in Pandas: Index Preservation – Index Alignment – Operations between DataFrame and Series – Handling missing data – Hierarchical Indexing: Creating, Indexing, Slicing, Rearranging and Data Aggregations.		
Unit - III	**Advanced Operations with Pandas:**	**6+3**
Combining Datasets: Concat and Append – Combining Datasets: Merge and Join – Aggregation and Grouping – Pivot Tables – Vectorized String Operations – Working with Time Series – High-Performance Pandas:Eval() and query().		
Unit - IV	**Visualization with Matplotlib:**	**6+3**
Line Plots – Scatter Plots – Visualizing errors – Density and Contour Plots – Histograms, Binnings and Density – Customizing Plot Legends – Customizing Colorbars – Multiple Subplots – Text and Annotation – Customizing Ticks.		
Unit - V	**Customiizing Matplotlib and Visualization with Seaborn**	**6+3**
Customizing Matplotlib: Configurations and Stylesheets – Three-Dimensional Plotting in Matplotlib – Geographic data with Basemap – Visualization with Seaborn.		

List of Exercises:

1.	Perform operations on arrays using Numpy.
2.	Perform Data Manipulation using Pandas.
3.	Combine datasets using concat, append, merge and join functions
4.	Perform aggregation, grouping and vectorized string operations using Pandas
5.	Visualize data using line, scatter, density and contour plots.
6.	Perform three-dimensional plotting using Matplotlib.
7.	Visualize geographic data using Basemap.
8.	Perform data visualization using Seaborn.

Lecture: 30, Practical:30, Total:60

TEXT BOOK:

1. Jake VanderPlas, " Python Data Science Handbook: Essential Tools for working with Data", 1st Edition, O'Reilly Media, Inc, 2016.

REFERENCES:

1. Dr. Ossama Embarak, " Data Analysis and Visualization using Python ", APress, 2018 (Units : I, II and III)
2. Wes McKinney, "Python for Data Analysis", 2nd Edition, Or'reilly, 2018 (Units IV and V)

REFERENCES/MANUAL/SOFTWARE:

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

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	perform array operations using Numpy	Applying (K3)
CO2	manipulate data using Pandas	Applying (K3)
CO3	apply data transformations such as aggregation and grouping using Pandas	Applying (K3)
CO4	visualize data using Matplotlib	Applying (K3)
CO5	use Seaborn to perform data visualization	Applying (K3)
CO6	prepare and Manipulate data using Numpy and Pandas	Analyzing (K4) Precision (S3)
CO7	construct 2-D and 3-D plots using Matplotlib	Analyzing (K4) Precision (S3)
CO8	use Seaborn for data visualization	Applying (K3) 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	2										3	2
CO2	3	3	2										3	2
CO3	3	2	2										3	2
CO4	3	2	2										3	2
CO5	3	2	2										3	2
CO6	3	2	2	2	2								3	2
CO7	3	2	2	2	2								3	2
CO8	3	2	2	2	2								3	2

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	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)**

DATABASE MANAGEMENT SYSTEMS LABORATORY
(Common to AI & DS and AI & ML branches)

Programme& Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	3	PC	0	0	2	1
Preamble	The course explores the features of database management systems and how to interface with front end tools.						

List of Exercises / Experiments:

1.	Demonstrate Data Definition Language and integrity constraints.
2.	Demonstrate Data Manipulation Language, Data Control Language commands and TCL commands.
3.	Execute nested and sub queries in SQL.
4.	Demonstrate Join operations in SQL.
5.	Create Views and index and perform SQL operations in it.
6.	Demonstrate the concept of looping using PL/SQL statements.
7.	Implement Cursors and its operations.
8.	Implement Triggers and its operations.
9.	Develop Procedures and Functions to perform operations in SQL.
10.	Embed SQL queries in high level languages.
11.	Mini project on Application Development using Oracle/ SQL SERVER / MYSQL.

Total: 30

REFERENCES/MANUAL/SOFTWARE:

1.	Front End: Microsoft Visual Studio 6.0, Microsoft .NET Framework SDK v2.0, Java etc.,
2.	Back End : ORACLE / SQL SERVER / MYSQL
3.	Manuals: https://docs.oracle.com/cd/E11882_01/server.112/e41085.pdf
4.	Laboratory Manual

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	develop PL/SQL commands to create and manipulate databases	Applying (K3), Precision (S3)
CO2	execute queries using concepts of embedded query languages	Applying (K3), Precision (S3)
CO3	solve real world problems using database concepts	Applying (K3), 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	2	2	2	2					2	2		3	2
CO2	3	3	2	2	2					2	2		3	2
CO3	3	2	2	2	2					2	2		3	2

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

20EGL31 - ENGLISH FOR WORKPLACE COMMUNICATION LABORATORY
(Common to all Engineering and Technology Branches)

Programme & Branch	All BE/BTech Engineering & Technology branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	3	HS	0	0	2	1

Preamble	This course is designed to impart required levels of fluency in using the English Language at B1/B2 level in the CEFR through activities, hands-on training and application.	
Unit - I	**Listening**	**6**
Techniques for effective listening and note taking; listening to audio scripts, podcasts and TED talks; listening to discourse samples of native speakers and imitating; improving pronunciation; introduction to the basics of phonetics and understanding different accents		
Unit - II	**Reading**	**6**
Speed reading skills; reading to gain knowledge; reading newspaper articles to improve writing; academic journals to enrich vocabulary and word power; reading aloud with proper stress and intonation; reading to draw inferences		
Unit – III	**Soft Skills**	**6**
Importance of soft skills at workplace - understanding soft skills through case studies - developing positive attitude; goal setting; time management; team work; telephone etiquette; developing professionalism, interpersonal skills and work ethics.		
Unit – IV	**Writing**	**6**
Introduction to pre-writing, style and mechanics of writing; mind mapping; creating content from an outline; paragraph and resume writing; nuances of academic writing; writing Statement of Purpose (SOP), editing, revising and proof reading for clarity and readability; structural and grammatical accuracy.		
Unit – V	**Speaking**	**6**
Verbal and non-verbal communication; fluency and spoken English; introducing oneself and others; making presentations on topics using prepared material; mock interviews; dynamics of Group Discussion.		

List of Exercises / Experiments:

1.	Mock Interview
2.	Presentation
3.	Reading Aloud
4.	Group Discussion
5.	Soft Skills through Case Studies
6.	Listening Test

Total:30

TEXT BOOK

1.	Jeff Butterfield, “Soft Skills for Everyone”, 1st Edition, Cengage Learning, New Delhi, 2011.
2.	Bob Dignen, Steve Flinders and Simon Sweeney, “Professional English for Work and Life, English 365, Student"s Book 2”, 1st Edition, Cambridge University Press, New Delhi, 2004.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1:	acquire effective listening and reading skills	Understanding (K2), Imitation (S1)
CO2:	acquire and demonstrate appropriate professional skills for the workplace	Applying (K3), Naturalization (S5)
CO3:	speak fluently and write meaningfully in English in the given context	Applying (K3), Articulation (S4)

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	3			2	
CO2									2	3			2	
CO3									2	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	30	50				
CAT2	20	30	50				
CAT3	20	30	50				
ESE	10	40	50				

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

UNIVERSAL HUMAN VALUES
(Common to all Engineering and Technology Branches)

Programme & Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	3	HS	2	0	0	2

Preamble	To make the student to know what they 'really want to be' in their life and profession, understand the meaning of happiness and prosperity for a human being. Also to facilitate the students to understanding of harmony at all the levels of human living, and live accordingly	
Unit - I	**Introduction**	**6**
Need and Basic Guidelines of Value Education – Content and Process of Value Education – Self Exploration – purpose of self-Exploration – Content and Process of Self exploration – Natural Acceptance – Realization and Understanding – Basic Human Aspirations – Continuous Happiness and Prosperity – Exploring Happiness and Prosperity – Basic Requirement for Fulfillment of Human Aspirations – Relationships – Physical Facilities – Right Understanding.		
Unit - II	**Harmony in the Self and Body**	**6**
Human Begin and Body – Understanding Myself as Co–existence of Self ('I') and Body, Needs of the Self and Body, Activities in the Self and Body, Self ('I') as the Conscious Entity, the Body as the Material Entity – Exercise – Body as an Instrument– Harmony in the Self ('I) – Understanding Myself – Harmony with Body.		
Unit - III	**Harmony in the Family and Society**	**6**
Harmony in the Family – Justice – Feelings (Values) in Human Relationships – Relationship from Family to Society – Identification of Human Goal – Five dimensions of Human Endeavour.		
Unit - IV	**Harmony in Nature and Existence**	**6**
Order of Nature – Interconnectedness – Understanding the Four order – Innateness – Natural Characteristic – Basic Activity – Conformance – Introduction to Space – Co–existence of units of Space – Limited and unlimited – Active and No–activity – Existence is Co–existence.		
Unit - V	**Implications of the above Holistic Understanding of Harmony on Professional Ethics**	**6**
Values in different dimensions of Human Living – Definitiveness of Ethical Human Conduct –Implications of Value based Living – Identification of Comprehensive Human Goal – Humanistic Education – Universal Human Order – Competence and Issues in Professional Ethics.		

Lecture: 45; Total: 45

TEXT BOOK:

1.	Gaur R.R., Sangal R., Bagaria G.P., "A Foundation Course in Human Values and Professional Ethics", 1st Edition, Excell Books Pvt. Ltd., New Delhi, 2016. for Unit I, II, III, IV and V.

REFERENCES:

1.	Ivan Illich, "Energy & Equity", The Trinity Press, USA, 1974.
2.	Schumacher E.F., "Small is Beautiful: a study of economics as if people mattered", Britain, 1973.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand the significance of value inputs in a classroom, distinguish between values and skills, understand the need, basic guidelines, content and process of value education, explore the meaning of happiness and prosperity and do a correct appraisal of the current scenario in the society.	Understanding (K2)
CO2	distinguish between the Self and the Body, understand the meaning of Harmony in the Self the Co–existence of Self and Body.	Understanding (K2)
CO3	understand the value of harmonious relationship based on trust, respect and other naturally acceptable feelings in human–human relationships and explore their role in ensuring a harmonious society.	Understanding (K2)
CO4	understand the harmony in nature and existence, and work out their mutually fulfilling participation in the nature.	Understanding (K2)
CO5	distinguish between ethical and unethical practices, and start working out the strategy to actualize a harmonious environment wherever they work.	Understanding (K2)

Mapping of COs with POs and PSOs

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1						1		3						
CO2								2						
CO3						1		3						
CO4								2						
CO5								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	25	75					100
CAT2	25	75					100
CAT3	NA						
ESE	NA						

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

SEMESTER IV

OPTIMIZATION TECHNIQUES

(Common to AI & DS and AI & ML branches)

Programme & Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	4	PC	3	1	0	4

Preamble	The course focuses on the basic concepts, various techniques and applications of engineering optimization.	
Unit - I	**Classical Optimization Techniques**	**9 + 3**
Introduction to Optimization– Statement of an Optimization problem – Mathematical formulation– Multi variable optimization with equality constraints – Lagrange multipliers method – Multi variable optimization with inequality constraint – KuhnTucker conditions.		
Unit - II	**Non-Linear Programming: One-Dimensional Minimization Method**	**9 + 3**
Introduction – Unimodal function – Elimination Methods: Unrestricted search – Exhaustive search– Dichotomous search– Interval halving method– Fibonacci method – Golden section method – Direct root methods: Newton method – Secant method.		
Unit - III	**Non-Linear Programming: Unconstrained Optimization Techniques**	**9 + 3**
Introduction to Unconstrained optimization – Direct Search Methods: Random search methods – Grid search method – Univariate method –Hookes and Jeeve's method – Powell's method – Indirect Search Methods: Steepest descent method – Fletcher-Reeves method – Newton's method.		
Unit - IV	**Non-Linear Programming: Constrained Optimization Techniques**	**9 + 3**
Introduction – Characteristics of a Constrained Problem – Direct Methods: Random search method – Sequential linear programming – Indirect methods: Transformation techniques – Exterior penalty function method – Interior penalty function method.		
Unit - V	**Advanced Non-Linear Optimization**	**9 + 3**
Genetic Algorithms – Introduction – Working Principle –Genetic operators –Particle swarm optimization – Computational Implementation – Ant colony optimization – Working principle – Neural network based optimization.		

Total: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1. S.S.Rao, Engineering Optimization Theory and Practice,5th Edition, New Age International, 2019. for Unit I, II, III, IV and V.

REFERENCES:

1. David Luenberger and Yinyu Ye, Linear and Nonlinear Programming, 4th edition, Springer-Verlag, 2015
2. A.Ravindran, K.M.Ragsdell, G.V.Reklaitis, Engineering Optimization: Methods andapplications, 2ndEdition, Wiley India Pvt. Ltd., 2006.
3. Yang, Xin-She. Optimization Techniques and Applications with Examples. 1st Edition, John Wiley & Sons, United Kingdom: Wiley, 2020.

	COURSE OUTCOMES: On completion of the course, the students will be able to	**BT Mapped (Highest Level)**
CO1	solve problems with equality and inequality constraints.	Applying (K3)
CO2	solve nonlinear programming problems of functions of single variable.	Applying (K3)
CO3	use methods of unconstrained optimization to solve non linear problems	Applying (K3)
CO4	solve nonlinear optimization problems in the presence of inequality and equality constraints.	Applying (K3)
CO5	apply several modern methods of optimization for solving engineering problems	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	3	2	1										3	1
CO2	3	2	1										3	1
CO3	3	2	1										3	1
CO4	3	2	1										3	1
CO5	3	2	2										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	5	10	85				100
CAT2	5	10	85				100
CAT3	5	10	85				100
ESE	5	20	75				100

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

WEB TECHNOLOGY
(Common to CSE, AI & DS and AI & ML branches)

Programme& Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	Object Oriented Programming	4	ES	3	0	0	3

Preamble	This course provides an introduction to HTML, CSS, Bootstrap, Client-Side JS and Server-Side JS Framework. The course also addresses the web application development using React JS	
Unit - I	**UI Design**	**9**
Introduction – Basic tags – HTML5 Forms Element – Page Structured Elements – Media Tags. Cascading Style Sheet: Types of CSS – Positioning Elements – Backgrounds – Box Model – Dropdown Menus. Responsive Web Design: Introduction – Bootstrap – Grid basics – Nav – Nav Bar – List – Drop down – Tables – Button –Images – Forms-Input – Input Groups.		
Unit - II	**JavaScript**	**9**
Introduction – Operators – Control Structures: Selection- Repetition- Functions: Function Definition – Scope Rules – Recursion. Array: Declaration – Initialization – Growing Arrays – Passing Arrays to Function. Event Handling. Introduction to REST API-GET-POST-PUT Methods.		
Unit - III	**Server-side JS Framework**	**9**
Node JS: Introduction – Architecture – Features – Creating Web Servers with HTTP Request – Response – Event Handling – GET and POST Methods – Modules – Connect to NoSQL Database using Node JS – Implementation of CRUD operations.		
Unit - IV	**ReactJS – Part 1**	**9**
React: Introduction – Installation – create React app - components – state – props - props validation – state vs props – constructor – Component API – Component Life cycle - Forms – controlled and uncontrolled component – Events – conditional rendering.		
Unit - V	**ReactJS - Part 2**	**9**
List – keys – refs – Fragments - Router – CSS – Animation – Map – Table –Code splitting – hooks – API Integration.		

Lecture:45, Total:45

TEXT BOOKS:

1.	Paul Deitel, Harvey M.Deitel and Abbey Deitel, —Internet and World Wide Web - How To Program, 5th Edition, Prentice Hall, 2011. for Unit I(first half), II.
2.	Infosys campus connect material shared by infy. for Unit I (Second Half), III.
3.	https://www.javatpoint.com for Unit IV and V.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	design static web pages using HTML, CSS and Bootstrap.	Applying (K3)
CO2	develop interactive and dynamic web pages using javascript	Applying (K3)
CO3	develop a web application using node JS with database connectivity	Applying (K3)
CO4	apply the features of ReactJS to develop web applications.	Applying (K3)
CO5	demonstrate client-side JS framework to develop web applications	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	3	2	2	1	2								3	2
CO2	3	2	2	1	2								3	2
CO3	3	2	2	1	2								3	2
CO4	3	2	2	1	2								3	2
CO5	3	2	2	1	2								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	20	60				100
CAT2	20	20	60				100
CAT3	10	20	70				100
ESE	10	30	60				100

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

OBJECT ORIENTED PROGRAMMING
(Common to CSE, AI & DS and AI & ML branches)

Programme & Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	4	PC	2	0	2	3

Preamble	This course provides a concise introduction to the fundamental concepts of Java programming including inheritance, interfaces, exception handling and threads.	
Unit - I	**Introduction to OOP and Java**	**6**
Overview of OOP – Object oriented programming paradigms – Features of Object Oriented Programming – Java Buzz words – Evolution of Java – Overview of Java–Data Types, Variables and Arrays – Operators – Control Statements.		
Unit - II	**Classes, objects and Methods**	**6**
Classes: Class Fundamentals-objects–Assigning Object Reference Variables – Introducing Methods – Constructors – this keyword – Garbage Collection – Stack Class. Overloading Methods – Objects as Parameters – Argument Passing – Returning Objects – Recursion – Access Control–Static – Nested and Inner Classes – Command–Line Arguments – Variable Length Arguments.		
Unit - III	**Inheritance, Packages and Interfaces**	**6**
Inheritance: Basics – Super keyword -Multilevel Hierarchy–Method Overriding – Dynamic Method Dispatch –Abstract Classes – final with Inheritance - Packages and Interfaces: Packages – Packages and Member Access –Importing Packages – Interfaces.		
Unit - IV	**Exception handling, Multithreading and I/O**	**6**
Exception Handling basics – Multiple catch Clauses – Nested try Statements – Java's Built-in Exceptions – User defined Exception. Multithreaded Programming: Java Thread Model–Creating a Thread and Multiple Threads – Priorities – Synchronization – Inter Thread Communication- Suspending –Resuming, and Stopping Threads –Multithreading- I/O Basics – Reading and Writing Console I/O – Reading and Writing Files.		
Unit - V	**String handling, Generics and Collections**	**6**
Generics: Introduction – Example –Parameters – General Form – Generic Methods, Constructors and Interfaces. Strings: Basic String class, methods and String Buffer Class. Collection frameworks: Overview – Collection Classes – Collection Interfaces.		

List of Exercises / Experiments:

1.	Write simple Java programs using operators, arrays and control statements.
2.	Develop stack and queue data structures using classes and objects.
3.	Demonstrate the concepts of inheritance & polymorphism.
4.	Develop an application using interfaces by accessing super class constructors and methods.
5.	Develop an employee payroll application using packages.
6.	Implement exception handling and creation of user defined exception.
7.	Implement program to demonstrate multithreading and inter thread communication.
8.	Write a program to perform file operations.
9.	Develop applications to demonstrate the features of generics classes and interfaces.
10.	Implement the concepts of collection frameworks.

Lecture: 30; Practical: 30; Total: 60

TEXT BOOK:

1.	Herbert Schildt, "Java: The Complete Reference", 11th Edition, McGraw Hill Education, New Delhi, 2019 for Unit I, II, III, IV and V.

REFERENCES/MANUAL/SOFTWARE:

1.	Cay S. Horstmann, "Core Java Fundamentals", Volume 1, 11th Edition, Prentice Hall, 2020.
2.	Linux / Windows
3.	Eclipse IDE / Netbeans IDE
4.	Lab manual

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret the role of object oriented programming, java and its variations	Applying (K3)
CO2	apply the concepts of classes, objects and methods to solve simple problems	Applying (K3)
CO3	develop programs using inheritance, packages and interfaces	Applying (K3)
CO4	make use of exception handling mechanisms and multithreaded model along with i/o packages to solve real world problems	Applying (K3)
CO5	build java applications with string classes, collections and generics concepts	Applying (K3)
CO6	design and develop java programs using object oriented programming concepts	Applying (K3) Precision (S3)
CO7	develop simple applications using package, exceptions and multithreading.	Applying (K3) Precision (S3)
CO8	develop a solution for real world problems using i/o, generics and collections.	Applying (K3) 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	2	1										3	1
CO2	3	2	1										3	1
CO3	3	2	1										3	1
CO4	3	2	1										3	1
CO5	3	2	1										3	1
CO6	3	2	2	2	1								3	2
CO7	3	2	2	2	1								3	2
CO8	3	2	2	2	1								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	20	65				100
CAT3	15	20	65				100
ESE	10	20	70				100

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

OPERATING SYSTEMS
(Common to CSE, AI & DS and AI & ML branches)

Programme & Branch	B.Tech. & Artificial Intelligence and Machine Learning.	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	4	PC	3	0	0	3

Preamble	This course provides basic operating system abstractions, system call interface, process, threads, and inter-process communication. Various management functions of an operating system will also be explored.	
Unit - I	**Operating Systems Overview**	**9**
Introduction – Computer System Organization – Computer System Architecture – Operations – Resource Management – Security and Protection – Virtualization – Computing Environments. Operating Systems Structures: Services – User and OS Interface – System Calls – Linkers and Loaders – Operating system Structure – Building and Booting OS.		
Unit - II	**Process Management**	**9**
Process Concept – Process Scheduling – Operations on Processes – Interprocess Communication – IPC in Shared Memory and Message Passing Systems. CPU Scheduling: Scheduling Criteria – Scheduling Algorithms. Multithreaded Programming: Threads Overview – Multicore Programming – Multithreading Models.		
Unit - III	**Process Synchronization**	**9**
The Critical Section Problem - Peterson's solution – Hardware support for Synchronization – Mutex Locks – Semaphores – Monitors. Deadlocks: Deadlock Characterization – Methods for handling deadlocks - Deadlock Prevention and Avoidance – Deadlock Detection – Recovery from Deadlock.		
Unit - IV	**Memory Management**	**9**
Main Memory: Background – Contiguous Memory Allocation – Segmentation – Paging – Swapping. Virtual Memory: Background – Demand Paging – Page Replacement – Case study: Intel 32 Architecture.		
Unit - V	**Storage Management**	**9**
Mass Storage Structure: Overview – HDD Scheduling. File System: File Concept – Access Methods – Directory Structure – Protection. File System Implementation: File System Structure – File System Operations – Directory Implementation – Allocation Methods - Free Space Management – Case study: Linux System.		

Lecture: 45; Total: 45

TEXT BOOK:

1. Silberschatz, Peter Baer Galvin and Greg Gagne, "Operating System Concepts", 10th Edition, John Wiley & Sons Inc., 2020. for Unit I, II, III, IV and V.

REFERENCES:

1. William Stallings, "Operating Systems Internals and Design Principles", 9th Edition, Prentice Hall, 2020.
2. Andrew S. Tanenbaum, "Modern Operating Systems", 4th Edition, Pearson Education, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain operating system structure, services and system calls and identify appropriate system calls for a given service	Applying (K3)
CO2	make use of process management strategies for scheduling processes	Applying (K3)
CO3	apply different methods for process synchronization and deadlock handling	Applying (K3)
CO4	make use of memory management strategies and apply page replacement policies to address demand paging	Applying (K3)
CO5	apply various disk scheduling algorithms and elaborate file systems concepts	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	3	2	1										3	2
CO2	3	2	1										3	2
CO3	3	2	1										3	2
CO4	3	2	1										3	2
CO5	3	2	1										3	2

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

ASSESSMENT PATTERN - THEORY

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

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

APPLIED MACHINE LEARNING
(Common to AI & DS and AI & ML branches)

Programme& Branch	B.Tech. & Artificial Intelligence and Data Science	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	4	PC	3	0	0	3

Preamble	The course provides the concepts and algorithms in machine learning and the methods to apply them in real time problems	
Unit - I	**Introduction to Machine Learning and Learning Theory**	**9**
Need for Machine Learning –Machine Learning in relation to other fields – Types of Machine Learning – Challenges of Machine Learning – Machine Learning Process and Applications – Data – Data Analytics –Descriptive Statistics– Univariate, Bivariate and Multivariate Data – Feature Engineering – Dimensionality Reduction techniques– Learning and its Types – Computation Learning Theory – Concept Learning – Induction Biases – Modeling – Learning Frameworks		
Unit - II	**Similarity based Learning and Regression Analysis**	**9**
Introduction to Similarity based Learning – Nearest Neighbor Learning – Weighted K-Nearest Neighbor Algorithm – Nearest Centroid Classifier – Locally weighted Regression – Introduction to Regression – Linearity, Correlation and Causation – Linear Regression – Multiple Linear Regression – Polynomial Regression – Logistic Regression – Ridge, Lasso and Elastic net Regression		
Unit - III	**Decision Tree and Rule-based Learning**	**9**
Decision Tree learning Model – Decision Tree Induction Algorithms – Validating and Pruning of Decision Trees– Sequential Covering Algorithm – First Order Rule Learning – Induction as Inverted Deduction – Inverting Resolution – Analytical Learning – Active Learning		
Unit - IV	**Bayesian Learning, Probabilistic Graphical Models and Support Vector Machines**	**9**
Probability based Learning – Bayes Theorem – Classification using Bayes Model – Naïve Bayes Algorithm for Continuous Attributes – Other Naïve Bayes Classifiers – Bayesian Belief Network – Markov Chain – Problems Solved with HMM– Introduction to Support Vector Machine – Optimal Hyperplane – Functional and Geometric Margin – Hard Margin – Soft Margin – Kernels and Non-Linear Regression		
Unit - V	**Ensemble Learning, Clustering Algorithms and Reinforcement Learning**	**9**
Introduction – Parallel Ensemble Models – Incremental Ensemble Models – Sequential Ensemble Models –Introduction to Clustering Approaches – Proximity Measures – Hierarchical Clustering Algorithms –Partitional Clustering Algorithm – Density Based Methods – Grid Based Approach – Probability Model-based Methods – Cluster Evaluation Methods – Overview of Reinforcement Learning – Reinforcement Learning as Machine Learning – Components – Markov Decision Process		

Lecture:45, Total: 45

TEXT BOOK:

1. S.Sridhar, M.Vijayalakshmi, “Machine Learning”, 1st Edition, Oxford University Press, 2021. for Unit I, II, III, IV and V.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	adapt to basic concepts of machine learning, to understand data and concept learning	Applying (K3)
CO2	demonstrate similarity based learning and various regression techniques	Applying (K3)
CO3	carry out decision tree learning and rule-based learning	Applying (K3)
CO4	develop Bayesian , probabilistic and support vector machine models	Applying (K3)
CO5	apply learned models to create ensemble models and to work with clustering algorithms, reinforcement learning	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	3	2	2										3	2
CO2	3	2	2										3	2
CO3	3	2	2										3	2
CO4	3	2	2										3	2
CO5	3	2	2										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	35	50				100
CAT2	15	35	50				100
CAT3	15	35	50				100
ESE	10	40	50				100

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

WEB TECHNOLOGY LABORATORY
(Common to CSE, AI & DS and AI & ML branches)

Programme& Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	Object Oriented Programming	4	ES	0	0	2	1
Preamble	This course provides an introduction for developing web applications using html, CSS, Bootstrap, Node. js and ReactJS.						

List of Exercises / Experiments:

1.	Design a web page using HTML tags and host it in github repository
2.	Design an attractive webpage using style sheets
3.	Design a responsive website using Bootstrap
4.	Design a webpage to create simple interactive calculator using Event Handling
5.	Design a web application using HTTP Request and HTTP Response
6.	Develop simple login page by performing event handling using GET and POST method
7.	Design a simple calculator using “Modules” in Node.js
8.	Design a webpage to maintain personal information using CRUD operations in MongoDB
9.	Design a web application using components and forms in React
10.	Design a reactive form to maintain personal information and perform validation using React
11.	Implementation of simple project using ReactJS

Practical:30, Total:30

REFERENCES / MANUAL /SOFTWARE

1.	Visual Studio code/ GEdit, Node JS+NPM, MongoDB
2.	ReactJS, Github

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	Develop interactive web pages using HTML, CSS, JavaScript and Bootstrap.	Applying (K3), Precision (S3)
CO2	Develop a web application to maintain information in a database using server-side scripting.	Applying (K3), Precision (S3)
CO3	Apply the concepts of React to design full-fledged web applications.	Applying (K3), 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	2	2	2	3								3	2
CO2	3	2	2	2	3								3	2
CO3	3	2	2	2	3								3	2

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

APPLIED MACHINE LEARNING LABORATORY
(Common to AI & DS and AI & ML branches)

Programme & Branch	B.Tech. & Artificial Intelligence and Data Science	Sem.	Category	L	T	P	Credit
Prerequisites	**Python Programming**	**4**	**PC**	**0**	**0**	**2**	**1**
Preamble	This course provides hands-on experience in applying machine learning algorithms for real world problems.						

List of Exercises / Experiments:

1.	Create a sample dataset and explore statistical operations using Pandas and visualize the results through plots
2.	Create a sample dataset and apply preprocessing techniques
3.	Perform dimensionality reduction using Principal Component Analysis
4.	Apply Find-S algorithm on sample dataset and find maximally specific hypothesis
5.	Implement K-Nearest Neighbor Algorithm
6.	Implement linear regression and multiple linear regression algorithms
7.	Implement and demonstrate decision tree based ID3 algorithm
8.	Implement and demonstrate the working of Naive Bayesian classifier
9.	Implement and demonstrate Hidden Markov Model
10.	Implement Support Vector Machine
11.	Implement and compare the working of Random Forest classifier with Adaboost model
12.	Implement K-Means clustering algorithm

Practical: 30; Total: 30

REFERENCES/MANUAL/SOFTWARE:

1.	Laboratory Manual
2.	Python / MATLAB

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	create dataset and apply preprocessing techniques	Applying (K3), Precision (S3)
CO2	implement supervised learning algorithms with sample dataset	Applying (K3), Precision (S3)
CO3	apply ensemble and clustering methods for sample dataset	Applying (K3), 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	2	2	2	1								3	2
CO2	3	2	2	2	1								3	2
CO3	3	2	2	2	1								3	2
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

20MNT31 - ENVIRONMENTAL SCIENCE
(Common to all Engineering and Technology Branches)

Programme & Branch	All BE/BTech Engineering & Technology branches	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	4	MC	2	0	0	0

Preamble	This course provides an approach to understand the various natural resources, ecosystem, bio-diversity, pollution control & monitoring methods for sustainable life and also to provide knowledge and to create awareness for engineering students on biological sciences.	
Unit - I	**Environmental Studies and Natural Resources**	**5**
Introduction to Environmental Science – uses, over-exploitation and conservation of forest, water, mineral, food, energy and land resources–case studies		
Unit - II	**Ecosystem and Biodiversity**	**5**
Ecosystems: concept and components of an ecosystem -structural and functional features – Functional attributes (Food chain and Food web only). Biodiversity: Introduction – Classification – Bio geographical classification of India- Value of biodiversity – Threats and Conservation of biodiversity - case studies.		
Unit - III	**Environmental Pollution**	**5**
Environmental Pollution: Definition – causes, effects and control measures of: (a) Air pollution - Climate change, global warming, acid rain, ozone layer depletion (b)Water pollution (c) Soil pollution - Role of an individual in prevention of pollution - case studies.		
Unit - IV	**Environmental Monitoring**	**5**
Sustainability -three pillars of sustainability- factors affecting environmental sustainability-approaches for sustainable development - Introduction to EIA - objectives of EIA - environment protection act – air (prevention and control of pollution) act – water (prevention and control of pollution) act.		
Unit - V	**Introduction to Biological Science**	**5**
Functions of Carbohydrates, lipids, proteins and nucleic acids - Cells and its organelles - plasma membrane, mitochondria and nucleus- Heredity and DNA - organization of DNA in cells - Genes and chromosomes- Cell division -Types of cell division- mitosis & meiosis - Cell cycle and molecules that control cell cycle.		

Total: 25

TEXT BOOK:

1. Anubha Kaushik, and Kaushik C.P., “Environmental Science and Engineering”, 6th Multicolour Edition, New Age International Pvt. Ltd., New Delhi, 2018.
2. Lodish. H., Berk A., Zipurursky S.L., Matsudaria P., Baltimore D. and Darnell J., “Molecular Cell Biology”, 4th Edition, Freeman Press, 2000.

REFERENCES:

1. Palanisamy P.N., Manikandan P., Geetha A., Manjula Rani K., Kowshalya V.N., “Environmental Science”, Pearson Education, New Delhi, Revised Edition 2019.
2. Satyanarayan U.,& Chakrapani U., “Textbook of Biochemistry”,1999 Ed. June 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	illustrate the various natural resources and role of individual for its conservation	Understanding (K2)
CO2	elaborate the features of ecosystem and biodiversity to find the need for conservation.	Understanding (K2)
CO3	manipulate the sources, effects and control methods of various environmental pollution.	Applying (K3)
CO4	make use of the knowledge of EIA and environmental legislation laws towards sustainability	Applying (K3)
CO5	explain the functions of carbohydrates, lipids, proteins, nucleic acids, Cells and its organelles	Understanding (K2)

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							
CO2	2	1					3							
CO3	3	2	1				3							
CO4	3	2	1				3							
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	25	40	35				100
CAT2	25	40	35				100
CAT3	NA						100
ESE	NA						100

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

SEMESTER V
ARTIFICIAL INTELLIGENCE
(Common to AI & DS and AI & ML branches)

Programme & Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	PC	3	0	0	3

Preamble	The course focuses on search methods, game playing, constraint satisfaction,planning and knowledge representation in artificial intelligence.	
Unit - I	**Intelligent Agents**	**9**
Introduction to AI – Agents and Environments – Concept of rationality – Nature of environments – Structure of agents– Problem Solving agents – search algorithms – uninformed search strategies.		
Unit - II	**Problem Solving**	**9**
Heuristic search strategies – heuristic functions–Local search and optimization problems – local search in continuous space – search with non- deterministic actions – search in partially observable environments – online search agents and unknown environments.		
Unit - III	**Game Playing and CSP**	**9**
Game theory – optimal decisions in games – alpha-beta search – monte-carlo tree search – stochastic games – partially observable games–Constraint satisfaction problems – constraint propagation – backtracking search for CSP – local search for CSP – structure of CS.		
Unit - IV	**Logical Agents**	**9**
Knowledge-based agents – propositional logic – propositional theorem proving – propositional model checking – agents based on propositional logic–First-order logic – syntax and semantics – knowledge representation and engineering – inferences in first-order logic – forward chaining – backward chaining – resolution.		
Unit - V	**Knowledge Representation and Planning**	**9**
Ontological engineering – categories and objects – events – mental objects and modal logic – reasoning systems for categories – reasoning with default information–Classical planning – algorithms for classical planning – heuristics for planning – hierarchical planning – non-deterministic domains – time, schedule, and resources – analysis.		

Theory:45; Total:45

TEXTBOOK:

1. Stuart Russell and Peter Norvig, “Artificial Intelligence: A Modern Approach”, 3rd Edition, Pearson Education, 2013. for Unit I, II, III, IV and V.

REFERENCE:

1. Khemani D., “A First Course in Artificial Intelligence”, 1st Edition, 9th reprint, McGraw Hill Education (India) Private Limited, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	paraphrase Artificial Intelligence, intelligent agents, and apply blind search to solve problems.	Applying (K3)
CO2:	demonstrate the effectiveness of heuristics in informed search methods.	Applying (K3)
CO3:	apply game playing in problem solving.	Applying (K3)
CO4:	make use of propositional logic and first order logic in knowledge-based reasoning.	Applying (K3)
CO5:	apply knowledge representation and planning to real world problems.	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	3	2	2										3	2
CO2	3	2	2										3	2
CO3	3	2	2										3	2
CO4	3	2	2										3	2
CO5	3	2	2										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	40	40				100
CAT2	20	30	50				100
CAT3	20	30	50				100
ESE	20	30	50				100

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

DEEP LEARNING
(Common to AI & DS and AI & ML branches)

Programme& Branch	BTech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	PC	3	0	0	3

Preamble	This course is designed to impart the skills required to build different deep neural network architectures.	
Unit - I	**Neural Networks:**	**9**
Introduction – Basic Architecture of Neural Networks – Training Neural Network with Backpropagation - Practical Issues in Neural Network Training - Power of Function Composition – Common Neural Architecutres – Neural Architectures : Binary Classification Models – Multiclass Models – Matrix Factorization with Autoencoders: Basic Principles – Nonlinear Activations – Deep Autoencoders		
Unit - II	**Training Deep Neural Networks:**	**9**
Introduction – Backpropagation- Setup and Initialization Issues – Vanishing and Exploding Gradient Problems – Gradient Descent Strategies – Batch Normalization - Practical Tricks for Acceleration and Compression – Bias- Variance Trade-Off – Generalization Issues in Model Tuning and Evaluation – Penalty-based Regularization – Ensemble Methods – Early Stopping – Unsupervised Pretraining – Transfer Learning		
Unit - III	**Radial Basis Function Networks and Boltzmann Machines:**	**9**
Radial Basis Function : Introduction - Training an RBF Network – Hopfield Network – The Boltzman Machine – Restricted Boltzman Machine – Applications of Restricted Boltzman Machines		
Unit - IV	**Recurrent Neural Networks**	**9**
Introduction – Architecture of Recurrent Neural Networks – Challenges of training Recurrent Networks – Echo-State Networks – Long Short-Term Memory (LSTM) – Gated Recurrent Units (GRUs) – Applications of Recurrent Neural Networks		
Unit - V	**Convolution Neural Networks:**	**9**
Introduction – Basic Structure of Convolutional Network – Training a Convolutional Network - Case Studies of Convolutional Architectures - Applications of Convolutional Networks - Attention Mechanism – Generative Adversarial Networks(GANs)		

Theory:45; Total: 45

TEXT BOOK:

1.	Aggarwal, Charu C, Neural networks and deep learning, Springe,r 2018. for Unit I, II, III, IV and V.

REFERENCES:

1.	Ian Goodfellow, YoshuaBengio, and Aaron Courvill, “Deep Learning”, MIT Press, USA, 2016
2.	Josh Patterson and Adam Gibson, “Deep Learning – A Practitioner’s Approach”, First Edition, O’Reilly Series, August 2017.
3.	Indra den Bakker, “Python Deep Learning Cookbook”, First Edition, Packt Publishing, October 2017.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	use Artificial Neural Network .concepts to solve real world problems	Applying (K3)
CO2	solve simple real world problems using deep neural networks.	Applying (K3)
CO3	use the concepts of RBF and Boltzman machines to solve real world problems	Applying (K3)
CO4	exemplify the concepts of CNN models and apply it for solving computer vision related problems.	Applying (K3)
CO5	explicate the concepts of RNN models and apply it for solving Natural Language problems.	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	3	2	3										2	3
CO2	3	2	3										2	3
CO3	3	2	3										2	3
CO4	3	2	3										2	3
CO5	3	2	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	45	45				100
CAT2	10	45	45				100
CAT3	10	45	45				100
ESE	10	45	45				100

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

DESIGN PATTERNS AND PRINCIPLES

Programme& Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	PC	3	0	2	4

Unit - I	**Introduction To UML**	**9**
Overview of UML : Basics and Details : Diagram Types – Class Diagrams – Sequence Diagram – Use Cases – Object Diagrams – State Diagrams - Examples		
Unit - II	**Design Principles**	**9**
Principles of OOD: SOLID Principles: The Single Responsibility Principle - The Open-Closed Principle -The Liskov Substitution Principle - The Interface Segregation Principle - The Dependency Inversion Principle – Implementation in Java		
Unit - III	**Creational Design Pattern** :	**9**
Design Pattern – Introduction - Classification of Design Patterns ; Creational Design Patterns – Factory Method – Abstract Factory – Builder – Prototype - Singleton		
Unit - IV	**Structural Design Pattern**	**9**
Use and Solution of Structural Design Pattern : Adapter – Bridge – Composite – Decorator – Façade – Flyweight – Proxy – Examples - Implementations		
Unit - V	**Behavioral Design Patterns**	**9**
Use and Solutions of Behavioral Patterns: Chain of Responsibility – Command – Iterator – Mediator – Memento – Observer – State – Strategy – Template Method – Visitor – Examples – Implementations		

Lecture: 45, Practical:30, Total:75

List of Exercises / Experiments:

1.	Write a program to implement the following concepts in java. a. Method overriding. b. Interface. c. Abstract class.
2.	Write programs to implement SOLID principles
3.	a. Write a Program to implement Factory pattern. b. Write a program to implement abstract factory.
4.	a. Write a Program to implement Singleton pattern. b. Write a Program to implement Composite design pattern.
5.	a. Write a program to implement decorator pattern. b. Write a Program to implement proxy design pattern.
6.	a. Write a Program to design chain of responsibility pattern. b. Write a Program to design mediator pattern
7.	Write a program to implement iterator pattern.
8.	Write a program to implement visitor pattern.
9.	Case Study Draw UML diagrams and implement Railway Reservation System
10	Case Study : Draw UML diagrams and implement Inventory Management System

TEXT BOOK:

1.	Martin, Robert C. *UML for Java programmers*. Prentice Hall PTR, 2003.(Units I and II)
2.	Vaskaran Sarkar, Java Design Patterns, Apress, 2016 (Units III, IV and V)

REFERENCES:

1.	Rohit Joshi, Java Design Patterns: Reusable Solutions to Common Problems, Java Code Geeks, 2021
2.	https://refactoring.guru/design-patterns/

REFERENCES / MANUAS / SOFTWARE:

1.	Operating System : Windows
2.	Software : IBM Rational Suite, Java SDK

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	design UML diagrams for a specified problem.	Applying (K3)
CO2	apply design principles for designing the code for a problem	Applying (K3)
CO3	use creational pattern to design the instantiation process	Applying (K3)
CO4	use structural pattern to compose interfaces	Applying (K3)
CO5	apply behavioral patterns to show communication between classes	Applying (K3)
CO6:	select and Implement appropriate SOLID principles for a given problem	Applying (K3) Precision(S3)
CO7:	implement Creational, Structural and Behavioral design patterns for real world problems	Applying (K3) Precision(S3)
CO8	design and implement solutions for real world problems using UML and design patterns	Applying (K3) Precision(S3)

BIG DATA ANALYTICS
(Common to AI & DS and AI & ML branches)

Programme & Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	5	PC	3	0	2	4

Preamble	This course focuses on the fundamentals of big data models , processing Frameworks , machine learning models and stream processing using Spark	
Unit - I	**Bigdata and Ingestion**	**9**
Introduction to Bigdata and Analytics - Four vs of Big Data - Challenges of Traditional System Data Ingestion into Big Data Systems: Introduction to data Ingestion -Tools for data Ingestion- **Apache Sqoop** -Sqoop Processing- Sqoop Import Process - Sqoop Connectors -Importing and Exporting Data from MySQL to HDFS - **Apache Flume** - Components in Flume's Architecture -Configuring Flume Components - Ingest Twitter Data		
Unit - II	**Distributed Processing Framework**	**9**
Distributed Processing in Map reduce –-Distributed Systems - Word Count Example - Map Execution Phases -Map reduce Jobs - Mapreduce Job Work Interaction – Data Types in Hadoop -Output formats in Map Reduce -A**pache Hive** -Hive Architecture - Hive Queries- Hive Metastore -Hive DDL and DML - Table Data Types -Validation of Data -File Format Types -Data Serialization -Hive Table and Avro Schema- Hive Optimization - Dynamic Partitioning in Hive Bucketing -Hive Analytics UDF and UDAF.		
Unit - III	**SPARK RDD**	**9**
Apache Spark – Introduction - Components of Spark -In-memory Processing - Spark Architecture -Spark Cluster - Spark RDD Introduction -Creating Spark RDD - RDD Operations - transformation- Actions –Caching and Persistence -Storage Levels - Lineage and DAG -Need for DAG -Debugging in Spark -Partitioning in Spark -Scheduling in Spark -Shuffling in Spark -Sort Shuffle -Aggregating Data.		
Unit - IV	**Machine Learning with MLib**	**9**
Data Analytics using Spark - Spark SQL- Data Analysis Operations- Dataset ETL Process-Machine Learning Supervised Learning -Classification of Linear SVM Linear Regression with Real World Case Studies - Unsupervised Learning K-means clustering -Reinforcement Learning -Semi-supervised - Mlib Pipelines		
Unit - V	**Spark Stream Processing**	**9**
Apache Kafka – Introduction to Publish subscribe systems-Requirements of Kafka - Kafka architecture-Kafka Internals- Kafka Development- Java/Scala Coding - Kafka Cluster -Kafka Streams - Kafka Connect -Encryption and Authentication using SSL -- Kafka – HDFS- Stream queries- stream processing- stream computing-Frequent item sets-Real Time Analytics platform -Graph analytics with graphx platform		

List of Exercises / Experiments:

1.	Installing and Configuring Hadoop for single node and Multinode architecture
2.	Implement Word count/frequency program using Map reduce
3.	Perform ingestion of data from relational database to HDFS using Apache Sqoop/Flume
4.	Installation of HIVE and apply Hive to create, alter, and drop databases, tables, views, functions and indexes
5.	Implementation of supervised learning application using Spark Mlib
6.	Implementation of unsupervised learning application using Spark Mlib
7.	Implement producer consumer application using Kafka
8.	Apply stream processing using Kafka in spark Environment

Lecture: 45, Practical:30, Total:75

TEXT BOOK:

1.	Raj Kamal, PreetiSaxena, "Big Data Analytics, Introduction to Hadoop, Spark, and Machine-Learning", 1st Edition, McGraw Hill Education,2019. for Unit I, II, III, IV.
2.	Neha Narkhede,Gwen shaper and Todd Palino, "Kafka The Definitive Guide-Real-Time Data and stream processing at scale", 1st Edition, Oreilly, 2019. for Unit V.

REFERENCES:

1.	Seema Acharya, SubhashiniChellappan, “Big Data and Analytics”, 2nd Edition,Wiley, 2019.
2.	DT Editorial Services, “Big Data, Black Book: Covers Hadoop 2, MapReduce, Hive, YARN, Pig, R and Data Visualization”, 1st Edition, Dreamtech Press; 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply various tools to extract value from data sources	Applying (K3)
CO2	apply map reduce programming andHive queries to perform data analysis on real world datasets	Applying (K3)
CO3	use Spark and Spark SQL environment for developing applications	Applying (K3)
CO4	apply machine learning modelling on big data in spark	Applying(K3)
CO5	apply stream processing on big data in spark	Applying (K3)
CO6	apply map reduce programming for big data	Applying (K3), Precision (S3)
CO7	apply Hive queries to perform data analysis on real world datasets	Applying (K3), Precision (S3)
CO8	apply Machine Learning and stream processing using Kafka and Spark	Applying (K3), 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	2	2	1									3	2
CO2	3	2	2	1									3	2
CO3	3	2	2	1									3	2
CO4	3	2	2	1									3	2
CO5	3	2	2	1									3	2
CO6	3	2	2	1	2								3	2
CO7	3	2	2	1	2								3	2
CO8	3	2	2	1	2								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	20	30	50				100
ESE	20	30	50				100

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

DEEP LEARNING LABORATORY

Programme& Branch	BTech - Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	PC	0	0	2	1
Preamble	This course provides hands-on experience in applying deep learning algorithms for solving real world problems						

List of Exercises / Experiments:

1.	Create a multi-layer neural network and apply it to MNIST dataset.
2.	Test the performance of multi-layer neural network with various activation and loss functions and tune the performance with hyper parameters
3.	Implement Logistic Regression.
4.	Develop an application for outlier detection using autoencoder
5.	Implement Convolutional neural networks and use them to classify images
6.	Implement a movie recommender system using RBM
7.	Implement Recurrent neural networks to generate new text.
8.	Implement Stock Price prediction application using LSTM
9.	Develop a image captioning application using RNN
10.	Develop a image recognition application using CNN
11.	Develop a hand written character recognition application using CNN
12.	Implement GAN model to simulate realistic images

Total : 30

REFERENCES / MANUAS / SOFTWARE:

1.	Operating System : Windows / Linux
2.	Software : Python

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	apply deep neural network for simple problems.	Applying (K3), Precision (S3)
CO2:	apply CNN for image processing and RNN for text analysis.	Applying (K3), Precision (S3)
CO3	develop a real world application using suitable deep neural networks.	Applying (K3), Precision (S3)

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO 7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	3	3								2	3
CO2	3	2	3	3	3								2	3
CO3	3	2	3	3	3								2	3

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

THEORY OF COMPUTATION

(Common to CSE, AI & DS and AI & ML branches)

Programme & Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	5	PE	3	0	0	3

Preamble	This course helps the learners to know the models of computation, along with their variants in the context of formal languages and their recognizers and to familiarize students with the foundations and principles of computer science.	
Unit - I	**Automata and Regular Expressions**	**9**
Introduction to formal proof – Finite Automata (FA) – Deterministic Finite Automata (DFA) – Non-deterministic Finite Automata (NFA) – Equivalence between NFA and DFA – Finite Automata with Epsilon transitions – Conversion of NFA into DFA – Equivalence and minimization of automata.		
Unit - II	**Regular Expressions and Languages**	**9**
Regular expression – Equivalence of finite automata and regular expressions – Proving languages not to be regular (Pumping Lemma) – Closure properties of regular languages.		
Unit - III	**Context Free Grammar and Languages**	**9**
Context-Free Grammar (CFG) – Parse trees – Ambiguity in grammars and languages – Definition of the pushdown automata (PDA) – Languages of pushdown automata – Equivalence of pushdown automata and CFG – CFG to PDA-PDA to CFG – Deterministic Pushdown Automata.		
Unit - IV	**Context Free Languages and Turing Machines**	**9**
Normal forms for CFG – Chomsky Normal Form and Greibach Normal Form – Pumping lemma for CFL – Closure properties of Context Free Languages. Turing machines: Basic model – definition and representation – Instantaneous Description – Language acceptance by TM – Variants of Turing Machine – TM as Computer of Integer functions – Programming techniques for Turing machines (subroutines).		
Unit - V	**Computational complexity theory**	**9**
A language that is not Recursively Enumerable (RE) – An undecidable problem that is RE – Undecidable problems about Turing machine – Post's correspondence problem – The classes P and NP – Kruskal's algorithm – Traveling Salesman Problem.		

Lecture:45, Total:45

TEXT BOOK:

1.	Hopcroft J.E., Motwani R. and Ullman J.D., "Introduction to Automata Theory, Languages and Computations", 3rd Edition, Pearson Education, New Delhi, 2008. for Unit I, II, III, IV and V.
2.	Martin J., "Introduction to Languages and the Theory of Computation", 4th Edition, Tata McGraw-Hill, New Delhi, 2010.
3.	Linz P., "Introduction to Formal Language and Computation", 4th Edition, Narosa Publishing, 2007.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply induction and contradiction methods for theorem proving.	Applying (K3)
CO2	design finite automata and regular expression for regular languages.	Applying (K3)
CO3	develop and normalize context free grammar for context free languages and demonstrate the recognition of context free languages using push down automata.	Applying (K3)
CO4	construct Turing Machine to accomplish specific task and argue formally about its correctness.	Applying (K3)
CO5	make use of Turing machines to distinguish decidable / undecidable problems and compare different classes of problems.	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	3	2	1										3	1
CO2	3	2	1										3	1
CO3	3	2	1										3	1
CO4	3	2	1										3	1
CO5	3	2	1										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	30	60				100
CAT3	10	30	60				100
ESE	10	20	70				100

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

MULTICORE ARCHITECTURE
(Common to CSE, AI & DS and AI & ML branches)

Programme& Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	Computer Organization	5	PE	3	0	0	3

Preamble	This course focuses on performance improvement using instruction level, data level, thread level and request level parallelism.	
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 Multicore Architectures.		
Unit - II	**Memory Hierarchy Design**	**9**
Introduction – Basics of Memory Hierarchies – Memory Technology and Optimizations – Ten Advanced Optimizations of Cache Performance – Virtual Memory and Virtual Machines – Design of Memory Hierarchies – Case Studies		
Unit - III	**Data Level Parallelism**	**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	**Thread Level Parallelism**	**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 – Shared Memory 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		

Lecture: 45, Total:45

TEXT BOOK:

1. John L. Hennessey and David A. Patterson, "Computer Architecture – A Quantitative Approach", 6th Edition, Morgan Kaufmann, Elsevier, 2019. for Unit I, II, III, IV and V.

REFERENCE

1. Richard Y. Kain, "Advanced Computer Architecture: A Systems Design Approach", 1st Edition, Prentice Hall, 2015.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret the limitations of ILP and the need for multicore architectures	Applying (K3)
CO2	know the importance of memory hierarchy and benefits of cache memory	Applying (K3)
CO3	achieve data level parallelism by applying loop level parallelism and understand the architecture of Vector/GPU processor	Applying (K3)
CO4	explore the cache coherence issues using different memory architectures and different types of inter connection networks	Applying (K3)
CO5	interpret the architectures of GPUs, warehouse scale computers and choose an appropriate model for a given problem	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	3	3	2										3	2
CO2	3	3	2										3	2
CO3	3	2	1										3	2
CO4	3	3	2										3	2
CO5	3	3	2										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	40	40	20			100
CAT2	20	40	40				100
CAT3	20	45	35	20			100
ESE	20	40	40	30			100

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

COMPUTER NETWORKS
(Common to CSE, IT, AI & DS and AI & ML branches)

Programme& Branch	B. Tech. & Artificial Intelligence and Data Science	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	5	PE	3	0	0	3

Preamble	This course deals with the fundamental concepts of computer networks. It presents bottomup approach of different layers along with their concepts and protocols.	
Unit - I	**Network Models and Physical Layer**	**9**
Data Communications – Networks – Networks Types. Network Models: TCP/IP Protocol model - The OSI Model. Digital-to-digital conversion: Line coding – Line Coding Schemes – Transmission Modes – Transmission media: Guided – Unguided media.		
Unit - II	**Data Link Layer**	**9**
Introduction – Link Layer Addressing – Error Detection and Correction: Introduction – Block Coding – CRC – Checksum– Framing – HDLC - Point-to-point protocol. Media Access Control Protocols: Random Access Protocols – Channelization - Wired LAN: Standard Ethernet – Connecting Devices – Virtual LANs.		
Unit - III	**Network Layer**	**9**
Network Layer Services- Network layer performance - IPV4 addresses – Internet Protocol (IP) - ICMPv4. Unicast Routing Algorithms: Distance Vector and Link-state routing – Routing Protocols: RIP and OSPF - IPV6 addressing- IPV6 protocol.		
Unit - IV	**Transport Layer**	**9**
Introduction – Transport layer protocols: Simple – Stop-and-wait - Go-back-N – Selective Repeat - Piggybacking – UDP – TCP. Quality of Service: Data Flow Characteristics -Techniques to improve QoS.		
Unit - V	**Application Layer**	**9**
WWW - HTTP- FTP - Electronic mail –Telnet - SSH, DNS. Network Management: Introduction - SNMP.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Behrouz A. Forouzan, “Data Communications and Networking”, McGraw-Hill, 5th Edition, 2013. for Unit I, II, III, IV and V.

REFERENCES:

1.	Kurose James F. and Ross Keith W., “Computer Networking: A Top-Down Approach”, 6th Edition, Pearson Education, New Delhi, 2017.
2.	Stallings, “Data and Computer Communications”, PHI, 10th Edition, New Delhi, 2015.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the basic fundamentals of networks for data communication and apply the different line coding schemes for digital-to-digital conversion	Applying (K3)
CO2	demonstrate the knowledge of error detection and correction methods and protocols at data link layer	Applying (K3)
CO3	interpret the different addressing schemes and apply various routing protocols at network layer	Applying (K3)
CO4	illustrate the different transport layer protocols and employ suitable flow control and QoS techniques	Applying (K3)
CO5	generalize the various protocols and their working principles at application layer	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	3	2	1	1									3	2
CO2	3	2	1	1									3	2
CO3	3	2	1	1									3	2
CO4	3	2	1	1									3	2
CO5	3	2	1	1									3	2

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

ASSESSMENT PATTERN - THEORY

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

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

SOFT COMPUTING TECHNIQUES

Programme& Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites		5	PE	3	0	0	3

Preamble	To learn and understand Neural Network algorithms and Fuzzy inference systems for solving real time problems	
Unit - I	**Introduction To Neural Networks**	**9+3**
Introduction, Humans and Computers, Organization of the Brain, Biological Neuron, characteristics of ANN, Types of Neuron Activation Function, Terminologies of ANN - Learning Strategy (Supervised, Unsupervised, Reinforcement) - McCulloch-Pitts Model – Hebb Rule.		
Unit - II	**Learning Networks**	**9+3**
Supervised Learning Networks: Perceptron Network : Theory – Architecture- Learning Rule, Back Propagation Network : Theory – Architecture- Training and Testing Algorithm - Adaptive linear neuron - Radial Basis Function Network (RBFN) - Associative memory networks: Discrete hop field network - Kohonen self organising feature maps.		
Unit - III	**Advanced Neural Network**	**9+3**
Support Vector Machine Classifier – Decision tree classifier-Random Forest Classifier – Extreme Learning Machine (Training and testing algorithmsonly)		
Unit - IV	**Basic Concepts of Fuzzy Logic**	**9+3**
Introduction to fuzzy logic - Classical sets and fuzzy sets - Fuzzy relations - Membership function: Features of membership function – Fuzzification - Methods of membership value assignments - Fuzzy rules and reasoning: Fuzzy If-Then Rules.		
Unit - V	**Fuzzy Inference Systems (FIS)**	**9+3**
Introduction – Methods of FIS: Mamdani - Sugeno and Tsukamoto. Defuzzification: Lambda-Cuts for Fuzzy sets and Fuzzy Relations, Defuzzification Methods Applications of Neural networks and Fuzzy logic: In image processing- forecasting – communication-business		

Lecture: 45, Total: 45

TEXT BOOK:

1. S.Rajasekharan& G. A. VijayalakshmiPai, "Neural Networks, Fuzzy Systems and Evolutionary algorithms: synthesis and applications", 2nd Edition, Prentice Hall of India, New Delhi, 2018. for Units I,II,III,IV,V.

REFERENCE:

1. Timothy J.Ross, "Fuzzy Logic with Engineering Applications", 3rd Edition, John Wiley, New Delhi, 2010
2. Sivanandam S.N, Sumathi S &Deepa S.N, "Introduction to Neural Networks using MATLAB 6.0", 1st Edition, Tata McGraw-Hill, New Delhi, 2006.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret the concepts of neural network to solve real world problem	Applying (K3)
CO2	develop neural network architecture using supervised and unsupervised learning	Applying (K3)
CO3	interpret the concepts of svm, elm and random forest classifiers to solve simple problems	Applying (K3)
CO4	develop fuzzy sets and rules for realtime applications	Applying (K3)
CO5	apply fis models and neural network for real time applications	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	3	1												
CO2	3	2	1	1									1	
CO3	3	2	1	1										
CO4	3	2	1	1									1	
CO5	3	2	1	1	3	3		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	40	50				100
CAT2	25	45	30				100
CAT3	10	30	60				100
ESE	20	30	50				100

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

SEMESTER VI

ARTIFICIAL INTELLIGENCE AND ROBOTICS
(Common to AI & DS and AI & ML branches)

Programme & Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	PC	3	0	0	3

Preamble	This course describes the fundamental concepts of AI in robotics and the major paradigms for achieving it.It also provides the knowledge aboutRobot Kinematics, Dynamics, sensor and vision system.	
Unit - I	**Introduction to Robotics**	**9**
Types and components of a robot- Classification of robots - Closed loop and open loop control systems. Kinematics systems: Definition of mechanisms and manipulators- Social issues and safety.		
Unit - II	**Autonomy Robot and Hierarchical Paradigm**	**9**
Overview –Use of Robots – Teleoperation - Areas of AI. Hierarchical Paradigm:Attributes of the Hierarchical Paradigm - Closed World Assumption - Representative Architectures - Advantages and Disadvantages.		
Unit - III	**Reactive Paradigm**	**9**
Overview - Reflexive behaviors - Coordination and Control of Behaviors - Perception in Behaviors - Schema Theory - Principles and Issues in Transferring Insights to Robots - Attributes of Reactive Paradigm - Subsumption Architecture - Potential Fields Methodologies - Evaluation of Reactive Architectures.		
Unit - IV	**Robot Kinematics and Dynamics**	**9**
Kinematic Modelling: Translation and rotation representation- Coordinate transformation- DH parameters- Jacobian-Singularity and Statics. Dynamic Modelling: Equations of motion- Euler-Lagrange formulation.		
Unit - V	**Sensors and Vision System**	**9**
Sensor: Contact and Proximity, Position, Velocity, Force, Tactile. Introduction to Cameras- Camera calibration- Geometry of image formation- Euclidean/Similarity/Affine/Projective transformations- Vision applications in robotics.		

Theory:45,Total: 45

TEXT BOOK:

1.	Ronald C. Arkin, Robin R. Murphy, “An Introduction to AI Robotics”, 1st edition, MIT Press, USA, 2001 for Unit I, II.
2	Saha S.K., "Introduction to Robotics", 2nd Edition, McGraw-Hill Higher Education, New Delhi, 2014. for Unit III, IV and V.

REFERENCES:

1.	Niku Saeed B., "Introduction to Robotics: Analysis", PHI Learning, New Delhi, 2011.
2.	Ghosal A., "Robotics", Oxford, New Delhi, 2006.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret the features of an industrial robots with end effectors	Applying (K3)
CO2	identify the characteristics of Autonomy Robot and use Hierarchical Paradigm for organizing intelligence in Robots.	Applying (K3)
CO3	apply reactive paradigm for AI Robots	Applying (K3)
CO4	perform kinematic and dynamic analyses with simulation	Applying (K3)
CO5	design sensor and vision system for robots	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	3	2	1										3	1
CO2	3	2	1										3	1
CO3	3	2	1										3	1
CO4	3	2	1										3	1
CO5	3	2	1										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	25	50	25				100
CAT2	25	45	30				100
CAT3	25	45	30				100
ESE	20	40	40				100

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

NATURE INSPIRED OPTIMIZATION TECHNIQUES

Programme& Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	6	PC	3	0	0	3

Preamble	This course provides an introduction to nature inspired techniques and applications.	
Unit - I	**Introduction**	**9**
Philosophy of Natural Computing - Three Branches: A Brief Overview - Conceptualization -Individuals- Entities and agents - Parallelism and Distributivity - Interactivity – Adaptation - Feedback-Self-Organization-Complexity- Emergence and Reductionism- Bottom-up Vs Top-Down - Determination- Chaos and Fractals.		
Unit - II	**Computing Inspired By Nature**	**9**
Evolutionary Computing- Hill Climbing and Simulated Annealing- Evolutionary biology - Darwin's Dangerous Idea- Genetics Principles- Standard Evolutionary Algorithm - Genetic Algorithms - Selection-Crossover- Mutation- Neurocomputing- Artificial neurons - network architectures- learning approaches - Hebbian learning- Single layer perceptron- Multi-layer perceptron - Self organization maps- discrete Hopfield network.		
Unit - III	**Swarm Intelligence**	**9**
Introduction - Ant Colonies- Ant Foraging Behavior- Ant Colony Optimization- Simple ACO and scope of ACO algorithms- Ant Clustering Algorithm (ACA)- Swarm Robotics- Foraging for food- Social Adaptation of Knowledge - Particle Swarm Optimization (PSO) - Scope of PSO- social systems to particle swarm.		
Unit - IV	**Immuno Computing**	**9**
Introduction- Immune System - Physiology and main components- Pattern Recognition and Binding -adaptive immune response- Self/Non-self discrimination- Immune Network Theory- Danger Theory- artificial immune systems- Evaluating Interaction - Immune Algorithms- Bone Marrow Models - Negative selection algorithms- Clonal selection and affinity maturation- Artificial Immune Networks.		
Unit - V	**Computing With New Natural Materials**	**9**
DNA Computing - Basic concepts - DNA Molecule - Filtering models- Adleman's experiment - Test tube programming language- Formal models - Universal DNA Computers - Scope of DNA Computing - From Classical to DNA Computing - Quantum computing- Introduction- basic concepts from quantum theory- principles from quantum mechanics.		

Lecture:45, Total: 45

TEXT BOOK:

1. Leandro Nunes de Castro, "Fundamentals of Natural Computing, Basic Concepts, Algorithms and Applications", Chapman & Hall/ CRC, Taylor and Francis Group, 1st Edition, 2007 for Units I,II,III,IV,V.

REFERENCES:

1. Floreano D. and Mattiussi C., "Bio-Inspired Artificial Intelligence: Theories, Methods, and Technologies", MIT Press, Cambridge, 1st Edition, 2008.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply fundamental concepts in Nature Inspired Systems to solve computational problems.	Applying (K3)
CO2	manipulate the evolutionary and neuro Computing techniques inspired by nature.	Applying (K3)
CO3	implement collective intelligence of biological systems to computing.	Applying (K3)
CO4	develop immune systems behavior to computing and optimization.	Applying (K3)
CO5	make use of the characteristics of DNA computing and Quantum Computing.	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	3	2	1											
CO2	3	2	1											
CO3	3	2	1											
CO4	3	2	1											
CO5	3	2	1											

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	45	35				100
CAT2	20	30	50				100
CAT3	20	30	50				100
ESE	10	40	50				100

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

INFORMATION RETRIEVAL TECHNIQUES

Programme& Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	Applied Machine Learning	6	PC	3	1	0	4

Preamble	This course discusses the basics of information retrieval, search engine operations and multimedia information retrieval techniques.	
Unit - I	**Introduction**	**9**
Information Retrieval - The IR Problem - The users task - Information versus data retrieval - The IR System - Software architecture of IR system - Retrieval and ranking processes - The web - Web changed search - Practical issues on the web - How people search - Search interfaces today - Visualization in Search Interfaces		
Unit - II	**Modeling and Retrieval Evaluation**	**9**
Basic IR Models – Boolean Model – TF-IDF (Term Frequency/Inverse Document Frequency) Weighting – Vector Model – Probabilistic Model – Latent Semantic Indexing Model – Neural Network Model – Retrieval Evaluation – Retrieval Metrics – Precision and Recall – Reference Collection – User-based Evaluation		
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	**Multimedia Information Retrieval**	**9**
Content-based image retrieval – Audio and music retrieval – Retrieving and browsing video – Fusion models – Segmentation – Compression and MPEG standards –Case study: Digital Library		

Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOK:

1.	Ricardo Baeza-Yate, BerthierRibeiro-Neto, “Modern Information Retrieval”, 2nd Edition, Pearson Education Asia, 2011 for Units I,II,III,IV,V

REFERENCE:

1.	Chowdhury G.G., “Introduction to Modern Information Retrieval”, 2nd Edition, Neal-Schuman Publishers, 2003.

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	Applying (K3)
CO2	apply the various modeling techniques	Applying (K3)
CO3	discuss the concepts of text operations, indexing and searching	Applying (K3)
CO4	learn about web information retrieval and web crawling	Applying (K3)
CO5	explore audio, music and video information retrieval techniques	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	3	2	1										3	1
CO2	3	2	1										3	1
CO3	3	2	1										3	1
CO4	3	2	1										3	1
CO5	3	2	1										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	15	35	50				100
CAT2	15	35	50				100
CAT3	15	35	50				100
ESE	10	40	50				100

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

ARTIFICIAL INTELLIGENCE AND ROBOTICS LABORATORY

Programme& Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	PC	0	0	2	1
Preamble	The laboratory course on AI and Robotics is intended to provide a practical realization of industrial robotand mobile robot for real time applications.						

List of Exercises / Experiments:

1.	Study the functions of ABB IRB 1410 industrial robot- components, drive system and end effectors.
2.	Virtual reality robot programming for different tasks.
3.	Creation of Tool Centre Point (TCP) and Work Object using ABB IRB 1410 industrial robot.
4.	Robot programming exercises: Point-to-point and Continuous path programming.
5.	Pick and place operation in teach mode using ABB IRB 1410 industrial robot.
6.	Vision based on line Inspection and sorting of components using ABB IRB 1410 industrial robot.
7.	Development of embedded programming for motion control using Fire Bird – V robot.
8.	Development of embedded programming for velocity control using Fire Bird – V robot.
9.	Development of embedded programming for path planning using Fire Bird – V robot.
10.	Development of embedded programming for obstacle avoidance using Fire Bird – V robot.

Total: 30

REFERENCES/MANUAL/SOFTWARE:

1.	ABB Robot Studio Manual
2.	Fire Bird – V Software and Hardware manual
3.	Laboratory Manual

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	analyze the industrial robot work cell problems and develop robot programming through ON/OFF line mode	Applying (K3), Precision (S3)
CO2	develop an embedded programming for autonomous mobile robot	Applying (K3), Precision (S3)
CO3	develop an on line inspection system using machine vision techniques	Applying (K3), 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	2	1	2	1								3	2
CO2	3	2	1	2	1								3	2
CO3	3	2	1	2	1								3	2

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

SEMESTER VII

ENGINEERING ECONOMICS AND MANAGEMENT

(Common to All Engineering And Technology Branches except Chemical Engineering)

Programme& Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	7	HS	3	0	0	3

Preamble	The aim of the course is to create fundamental knowledge on management by introducing concepts like economics, national income, marketing, operations management, accounting principles etc.	
Unit - I	**Micro Economics:**	**9**
Economics – Basics Concepts and Principles – Demand and Supply – Law of demand and Supply – Determinants – Market Equilibrium – Circular Flow of Economic activities and Income.		
Unit - II	**Macro Economics, Business Ownership and Management concepts:**	**9**
National Income and its measurement techniques. Inflation - Causes of Inflation – Controlling Inflation – Business Cycle. Forms of business – Ownership types. Management concepts: Taylor and Fayol's Principles – Functions of Management - Managerial Skills - Levels of Management - Roles of manager.		
Unit - III	**Marketing Management:**	**9**
Marketing - Core Concepts of Marketing - Four P's of Marketing - New product development – Intellectual Property rights (IPR), Product Life Cycle - Pricing Strategies and Decisions.		
Unit - IV	**Operations Management:**	**9**
Operations Management - Resources - Types of Production system - Site selection, Plant Layout, Steps in Production Planning and Control - Inventory - EOQ Determination.		
Unit - V	**Financial Management:**	**9**
Accounting Principles – Financial Statements and its uses – Depreciation: Straight Line and Diminishing Balance Method – Break Even Analysis – Capital Budgeting: Significance –Traditional and discounted cash flow methods.		

Total:45

TEXT BOOK:

1.	Compiled by Department of Management Studies, Kongu Engineering College, "Economics and Management for Engineers", 1st Edition, McGraw Hill Education, Noida, 2013. for Unit I, II, III, IV and V.

REFERENCES:

1.	Geetika, Piyali Ghosh and Purba Roy Choudhury, "Managerial Economics", 3rd Edition, McGraw-Hill, New Delhi, 2018.
2.	William J. Stevenson, "Operations Management", 14th Edition, McGraw-Hill Education, 2021.
3.	William G. Nickels, James M. McHugh, Susan M. McHugh, "Understanding Business", 12th Edition, McGraw-Hill Education, New York, 2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	identify market equilibrium and interpret national income calculations and inflation issues	Applying (K3)
CO2	choose a suitable business ownership for their enterprise and illustrate managerial functions	Applying (K3)
CO3	infer marketing management decisions	Understanding (K2)
CO4	apply appropriate operation management concept in business situations	Applying (K3)
CO5	interpret financial and accounting statements and evaluate new proposals	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	1	1	2			3		2	2	2	3	2	1	2
CO2		1	2			2	2	2	2	2	3	2	1	2
CO3	1	2	1			2		2	2	2	3	2	2	2
CO4	1	2	1			2		2	2	2	3	2	1	2
CO5	2	2				2		2	2	2	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	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)**

INTERNET OF THINGS AND EDGE ANALYTICS

Programme& Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites		7	PC	3	0	2	4

Preamble	The course describes about IoT, various communication protocols and technologies required for edge analytics. This course also explores machine learning in edge analytics and describes about security and privacy issues in edge analytics.	
Unit - I	**Introduction to Internet of Things:**	**9**
Definition and Characteristics of IoT, Physical Design of IoT – IoT Protocols, IoT Communication Models - IoT Communication APIs – IoT enabling Technologies- IoT Levels and Templates – Domain Specific IoT- IoT and M2M - IoT Platform Design methodologies		
Unit - II	**Edge Analytics and Communication Protocols**	**9**
Edge Analytics: Introduction – Applying and comparing architecture - Key benefits of edge analytics – Edge analytics architectures – Components used in edge analytics application - Connecting the components together – Examples of real-world edge analytics applications – **Communication Protocols used in Edge Analytics:** Wi-Fi – Bluetooth – Cellular technologies – Long-distance Communication using LoRa and Sigfox		
Unit – III	**Edge Analytics Technologies**	**9**
Microsoft Azure – Azure IoT Hub – Using Raspberry Pi with Azure IoT: Installing Azure IoT Edge on Raspberry Pi - Connecting Rasppberry Pi edge device - Adding simulated temperature sensor to edge device		
Unit - IV	**Machine Learning and Edge Analytics**	**9**
MicroPython for Edge Analytics: MicroPython – Exploring the hardware that runs MicroPython – Using MicroPython for an edge analytics application – Machine Learning in edge analytics – Using edge intelligence with microcontroller – Azure Machine learning designer – Azure IoT edge custom vision. Case study : Designing a smart doorbell with visual recognition		
Unit - V	**Security and Privacy in Edge Analytics**	**9**
Internet of Things Security aspects = Types of attacks against edge analytics applications – Protecting edge analytics applications – Monitoring and auditing edge analytics applications – Future of edge analytics		

List of Exercises / Experiments:

1.	Study Azure machine learning Python SDK
2.	Create Azure machine learning workspace
3	Explore data with Azure machine learning
4	Train a classification model using Azure
5	Create a web service for diabetes prediction
6	Implement Diabetes Prediction from Automated ML Endpoint using auto-predict-diabetes service
7	Implement Diabetes Prediction from a designer pipeline using auto-predict-diabetes service
8	Create a real time inferencing service using Azure

Lecture:45, Practical:30, Total:75

TEXT BOOK:

1.	Arshdeep Bahga and Vijay Madisetti, “Internet of Things - A Hands-on Approach”, Universities Press, 2015 for Unit – I
2.	Colin Dow, “Hands-On Edge Analytics with Azure IoT”, Packt , 2020 for Units II, III, IV and V

REFERENCES/MANUAL/SOFTWARE:

1.	Operating System : Linux / Windows
2.	Software: Microsoft Azure / Python / Raspberrry Pi
3.	Laboratory Manual

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply various IoT levels and choose an appropriate level and develop design methodologies for a given application	Applying (K3)
CO2	select the architecture and design edge analytics based IoT solution and also use the communication protocols for edge analytics	Applying (K3)
CO3	work with Azure IoT services and process logic using Raspberry Pi	Applying (K3)
CO4	explore the MicroPython language, and design a MicroPython-based edge analytics application using Machine Learning	Applying (K3)
CO5	examine possible attacks to edge analytics applications, monitor and protect the edge analytics application	Applying (K3)
CO6	build a classification model using Azure machine learning	Applying (K3) Precision (S3)
CO7	demonstrate how to publish and consume a web service using Azure	Applying (K3) Precision (S3)
CO8	use the web service and perform machine learning based prediction	Applying (K3) 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	2	2										2	3
CO2	3	2	2										2	3
CO3	3	2	2										2	3
CO4	3	2	2										2	3
CO5	3	2	2										2	3
CO6	3	2	2	2	3								2	3
CO7	3	2	2	2	3								2	3
CO8	3	2	2	2	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	20	30	50				100
CAT2	20	30	50				100
CAT3	20	30	50				100
ESE	10	40	50				100

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

WIRELESS SENSOR NETWORKS
(Common to AI & DS and AI & ML branches)

Programme& Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	Computer Networks	7	PE	3	0	0	3

Preamble	This course provides the fundamental concepts of wireless sensor networks and explains functionalities of different layers. It also helps to devise appropriate node and network management strategies and throws light on sensor networks security.	
Unit - I	**Introduction**	**9**
Introduction-Motivation and Wireless Sensor Nodes: Definitions and Background, Challenges and Constraints - Applications: Structural Health Monitoring, Traffic Control, Health Care, Pipeline Monitoring, Precision Agriculture, Active Volcano, Underground Mining - Node Architecture: The Sensing Subsystem, The Processor Subsystem, Communication Interfaces, Prototypes - Operating Systems: Functional Aspects, Nonfunctional Aspects, Prototypes, Evaluation.		
Unit - II	**Basic Architectural Framework and Medium Access Control**	**9**
Physical Layer: Basic Components, Source Encoding, Channel Encoding, Modulation, Signal Propagation. Medium Access Control: Overview, Wireless MAC Protocols, Characteristics of MAC Protocols in Sensor Networks, Contention-Free MAC Protocols, Contention-Based MAC Protocols, Hybrid MAC Protocols.		
Unit - III	**Routing Protocols and Power Management**	**9**
Network Layer: Overview, Routing Metrics, Flooding and Gossiping, Proactive Routing, On-Demand Routing, Hierarchical Routing, Location-Based Routing, QoS-Based Routing Protocols. Power Management: Local Power Management Aspects, Dynamic Power Management, Conceptual Architecture.		
Unit - IV	**Node and Network Management, Localization**	**9**
Node and Network Management: Time Synchronization: Clocks and the Synchronization Problem, Time Synchronization in Wireless Sensor Networks, Basics of Time Synchronization, Time Synchronization Protocols. Localization: Overview, Ranging Techniques, Range-Based Localization, Range-Free Localization, Event-Driven Localization.		
Unit - V	**Security and Sensor Network Programming**	**9**
Security: Fundamentals of Network Security, Challenges of Security in Wireless Sensor Networks, Security Attacks in Sensor Networks, Protocols and Mechanisms for Security, IEEE 802.15.4 and ZigBee Security. Sensor Network Programming: Challenges in Sensor Network Programming, Macro programming, Dynamic Reprogramming, Sensor Network Simulators.		

Total: 45

TEXT BOOK:

1. WaltenegusDargie, Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice", 1st Edition, John Wiley & Sons, 2011. for Unit I, II, III, IV and V.

REFERENCES:

1. Mohammad S. Obaidat, SudipMisra, "Principles of Wireless Sensor Networks", 1st Edition, Cambridge University Press, London, 2014.
2. Feng Zhao, Leonidas Guibas, "Wireless Sensor Networks", 1st Edition, Elsevier, 2004.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply the basic concepts of wireless sensor networks in real life applications	Applying (K3)
CO2	illustrate the basic architectural framework using physical and MAC layer protocols	Applying (K3)
CO3	utilize various network layer protocols for inter and intra communication patterns	Applying (K3)
CO4	apply different synchronization and localization algorithms for managing node and network level functions	Applying (K3)
CO5	develop software and hardware components required for a sensor network application	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	3	2	1	1									3	2
CO2	3	2	1	1									3	2
CO3	3	2	1	1									3	2
CO4	3	2	1	1									3	2
CO5	3	2	1	1									3	2

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

ASSESSMENT PATTERN - THEORY

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

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

CLOUD COMPUTING
(Common to AI & DS and AI & ML branches)

Programme & Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	**Operating Systems**	**7**	**PE**	**2**	**0**	**2**	**3**

Preamble	This course provides cloud computing evolution and its services, along with design and development. It also focuses on key challenges and issues in cloud computing.	
Unit - I	**Distributed System Models**	**6**
Scalable computing – Network Based Systems – System Models – Software Environment for Distributed and Cloud computing – Performance – Security – Energy Efficiency.		
Unit - II	**Virtualization**	**6**
Implementation levels of Virtualization – Virtualization Structures – Tools and Mechanisms – CPU, Memory, I/O devices Virtualization – Virtual Clusters and Resource Management – Virtualization for Data-Center Automation.		
Unit - III	**Cloud Platform Architecture over Virtualized Data Centers**	**6**
Cloud computing Service models – Data-Center Design and Interconnection Networks – Architectural Design of Compute and Storage Clouds – Public Cloud Platforms: Google App Engine – AWS – Azure – Inter-cloud Resource Management – Cloud Security – Trust Management.		
Unit - IV	**Cloud Programming and Software Environments**	**6**
Cloud and Grid Platforms – Parallel and Distributed Programming Paradigms – Programming Support : Google App Engine – Amazon AWS – Microsoft Azure – Cloud Frameworks: Eucalyptus – Nimbus – OpenNebula – Sector – Sphere – OpenStack – Manjrasoft Aneka Cloud and Appliances.		
Unit - V	**Ubiquitous Clouds and the Internet of Things**	**6**
Cloud Trends in supporting Ubiquitous Computing – Performance of Distributed Systems and the Cloud – Enabling technologies for the Internet of Things – Innovative Applications of the Internet of Things – Online Social and Professional Networking.		

List of Exercises / Experiments:

1.	Find procedure to run the virtual machine of different configuration. Check how many virtual machines can be utilized at particular time in host machine. (Virtual Box or VM Ware or Hyper-V)
2.	Install a C compiler in the virtual machine and execute a sample program.
3.	Show the virtual machine migration from one node to another.
4.	Develop a web application to provide Storage as a Service that offers a simple interface which allows users to manage file systems quickly and easily.
5.	Explore public cloud services like Amazon, Google and Azure.
6.	Configure IaaS architecture for installing guest operating system using OpenNebula.
7.	Configure IaaS architecture in Nimbus for installing multiple operating systems in same host machine by sharing different core in the same processor.
8.	Implement PaaS-Mobile sensor based IoT application hosted via PaaS environment

Lecture:30, Practical:30, Total:60

TEXT BOOK:

1.	Kai Hwang, Geoffrey C Fox & Jack G Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", 1st Edition, (Reprint) Morgan Kauffmann, 2017. for Unit I, II, III, IV and V.

REFERENCES/MANUAL/SOFTWARE:

1.	VMware, Google App Engine
2.	C/Python/Java

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the concepts, characteristics and benefits of Distributed System Models and apply the same for internet computing	Applying (K3)
CO2	describe the importance of virtualization along with their technologies and apply in virtual resource management	Applying (K3)
CO3	use and examine different cloud computing services	Applying (K3)
CO4	analyze the components of Cloud Programming and Software Environments	Applying (K3)
CO5	develop strategies for Ubiquitous Clouds and the Internet of Things	Applying (K3)
CO6	demonstrate the use of cloud computing in various applications	Applying (K3), Precision (S3)
CO7	apply different cloud programming model for the real world problems	Applying (K3), Precision (S3)
CO8	develop and deploy cloud architecture and model	Applying (K3), 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	2	1										3	1
CO2	3	2	1										3	1
CO3	3	2	1										3	1
CO4	3	2	1										3	1
CO5	3	2	1										3	1
CO6	3	2	1	1	1								3	2
CO7	3	2	1	1	1								3	2
CO8	3	2	1	1	1								3	2

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

ASSESSMENT PATTERN - THEORY

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

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

WEB MINING

Programme& Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	Applied Machine Learning	7	PE	3	0	0	3

Preamble	This course provides knowledge about web searching, indexing, query processing and web content mining.	
UNIT – I	**Information Retrieval and Web Searc**	**9**
Basic Concepts – Information Retrieval Models – Relevance Feedback – Evaluation Measures – Text and Web Page Pre-processing – Inverted Index and its compression – Latent Sematic Indexing – Web Search – Meta-Searching and Combining Multiple Rankings – Web Spamming		
UNIT – II	**Web Crawling**	**9**
Basic Crawler Algorithm – Implementation Issues – Universal Crawlers – Focused Crawlers – Topical Crawlers – Evaluation – Crawler Ethics and Conflicts		
UNIT – III	**Wrapper Generation**	**9**
Preliminaries –Wrapper Induction-Instance-Based Wrapper Learning –Automatic Wrapper Generation: Problems –String Matching and Tree Matching – Multiple Alignment – Building DOM Trees –Extraction Based on a Single List Page and Multiple pages –Introduction to Schema Matching –Pre-Processing for Schema Matching-Schema – Level Match – Domain and Instance-Level Matching –Combining similarities		
UNIT – IV	**Web Usage Mining**	**9**
Web Usage Mining – Clickstream Analysis – Log Files – Data Collection and Pre-Processing – Data Modeling for Web Usage Mining – The BIRCH Clustering Algorithm –Affinity Analysis and the A Priori Algorithm – Discretizing the Numerical Variable: Binning –Applying the A Priori Algorithm to CCSU Web Log Data– Discovery and Analysis of Web Usage Patterns –Recommender Systems and Collaborative Filtering		
UNIT – V	**Opinion Mining**	**9**
The Problem of Opinion Mining – Document Sentiment Classification – Sentence Subjectivity and Sentiment Classification – Opinion Lexicon Expansion – Aspect-Based Opinion Mining – Mining Comparative Opinions Search and Retrieval – Opinion Spam Detection		

Lecture:45, Total:45

TEXT BOOK:

1. Bing Liu, "Web Data Mining: Exploring Hyperlinks, Contents, and Usage Data (Data Centric Systems and Applications)", Springer; 2nd Edition 2011for Units I,II,III,V & Unit-IV part 1
2. Zdravko Markov, Daniel T. Larose, "Data Mining the Web: Uncovering Patterns in Web Content, Structure, and Usage", John Wiley & Sons, Inc., 2010 for Unit-IV part 2

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	determine information retrieval models and methods related to Web search	Applying (K3)
CO2	apply algorithms for Web crawling applications	Applying (K3)
CO3	make use of wrapper to extract structured data	Applying (K3)
CO4	capture and model the behavioural patterns and profiles of users interacting with a Web site	Applying (K3)
CO5	apply opinion mining techniques to classify opinions	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	3	2	1										3	1
CO2	3	2	1		1								3	1
CO3	3	2	1		1								3	1
CO4	3	3	2										3	2
CO5	3	2	1										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	20	50	30				100
CAT2	20	50	30				100
CAT3	20	40	40				100
ESE	20	40	40				100

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

MODELING AND SIMULATION
(Common to AI & DS and AI & ML branches)

Programme& Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	PE	3	0	0	3

Preamble	This course focuses on applications of computer simulation and modelling to real world simple and complex problems.	
Unit - I	**Modeling Process**	**9**
Classification of modeling – Steps of modeling – System Dynamics: Unconstrained Growth and Decay - Constrained Growth – Drug Dosage – Force and Motion: Modeling Falling and Skydiving		
Unit - II	**System Dynamics Models**	**9**
Competition – Modeling of Competition – Predator – Prey Model – Modeling the spread of SARS – SIR Model– SAR Model – Enzyme Kinetics – Enzymatic Reactions		
Unit - III	**Data Driven Models**	**9**
Functions – Empirical Models – Simulating with Randomness: Simulations – Random numbers from various distributions – Random Walk		
Unit - IV	**Cellular Automation**	**9**
Diffusion – Spreading of Fire – Periodic Boundary Conditions – Movement of Ants – Formulating a Model - -High Performance Computing: Concurrent Processing – Parallel Algorithms		
Unit - V	**Matrix Models**	**9**
Matrices for Population Studies – Population Matrices and High-Performance Computing -Time after Time – Age-Structured Model- Modeling with Markov Chains- Problems from Psychology to Genetics		

Lecture:45, Total:45

TEXT BOOK:

1. Angela B. Shiflet, George W. Shiflet, “Introduction to Computational Science: Modelling and Simulation for the Sciences”, 2nd Edition, Princeton University Press, 2014. for Unit I, II, III, IV and V.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	model system dynamics with and without constraints	Applying (K3)
CO2	construct models for systems with interactions	Applying (K3)
CO3	make use of randomness and data for modelling	Applying (K3)
CO4	utilize cellular automation for modelling natural processes and explain concurrent processing and parallel algorithms	Applying (K3)
CO5	apply matrix theory in problem solving	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	3	2	1										3	1
CO2	3	2	1										3	1
CO3	3	2	1										3	1
CO4	3	2	1										3	1
CO5	3	2	1										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	30	45	25				100
CAT2	10	45	45				100
CAT3	25	45	30				100
ESE	20	40	40				100

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

INFORMATION SECURITY
(Common to AI & DS and AI & ML branches)

Programme& Branch	BTech – Artificial Intelligence and Data Science	Sem.	Category	L	T	P	Credit
Prerequisites	Computer Networks	7	PE	3	0	0	3

Preamble	This course focuses on wide spectrum of topics from legal and ethical issue, risk management, and implementation in the context of information security.	
Unit - I	**Information Security and The Need for Security**	**9**
The history of Information Security – CNSS Security model-Components of an Information System – Security in the system life cycle – Security professionals and the organization – Communities of interest – Information Security: Threat and Attacks – Compromises to intellectual property – Deviations in Quality of Service-Espionage – Force of nature – Human Error – Information Extortion – Sabotage-Software attacks – Technical hardware failures – Technical software failures		
Unit - II	**Issues in Information Security and Planning for Security**	**9**
Law and ethics in information Security – Relevant U.S. Laws-International laws and legal bodies – Ethics and Information security – Codes of ethics of professional organizations – Key U.S. Federal agencies – Planning for Security: Information security policy, standards, and practices – The Information security blueprint – Security education, training, and awareness program		
Unit - III	**Risk Management**	**9**
Risk Identification: Planning and organizing the process – Identifying, inventorying and categorizing assets- Classifying and prioritizing threats – Specifying asset vulnerabilities; Risk assessment : Planning and organizing risk assessment- Determining the loss frequency – Calculating risk – Assessing risk acceptability – The FAIR approach to risk assessment – Risk control-Quantitative versus qualitative risk management practices-Recommended risk control practices		
Unit - IV	**Security Technology**	**9**
Access Control: Access control mechanisms – Biometrics – Access control architecture models – Firewalls: Firewall processing modes – Firewall architecture – Selecting the right firewalls – Configuring and managing firewalls – Content filters – Protecting remote connections – Intrusion detection and prevention systems –Honeypots, Honeynets, and padded cell systems – Scanning and analysis tools.		
Unit - V	**Implementing Information Security and Security &Personnel**	**9**
Information security project management – Technical aspects of implementation-Nontechnical aspect of implementation-Information security certification and accreditation-Credentials for information security professionals-Employment policies and practices-Security considerations for temporary employees, consultants, and other workers-Internal control strategies – Privacy and the security of personnel data.		

Lecture:45, Total:45

TEXT BOOK:

1.	Michael E. Whitman and Herbert J. Mattord, “Principles of Information Security”, 6th Edition, Cengage Learning, India, 2018. for Unit I, II, III, IV and V.

REFERENCES:

1.	Charles P. Pfleeger and Shari Lawrence Pfleeger, “Security in Computing”, 5th Edition, Prentice Hall, 2018.
2	Micki Krause, Harold F. Tipton, “Handbook of Information Security Management”, Vol. 6, 6th Edition, CRC Press, 2012.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	explore the basic concepts in information security and determine the type of attacks in a security breach	Applying (K3)
CO2:	identify the legal, ethical, professional issues in information security and apply security policies, standards and practices	Applying (K3)
CO3:	identify the risks involved in information security and carry out risk assessment	Applying (K3)
CO4:	utilize security technologies for protecting information	Applying (K3)
CO5:	make use of various aspects of implementing information security and, paraphrase the issues and concerns related to staffing the information security	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	3	2	1										2	1
CO2	3	2	1										2	1
CO3	3	2	1										2	1
CO4	3	2	1										2	1
CO5	3	2	1										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)**

REGRESSION ANALYSIS

Programme& Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	7	PE	2	0	2	3

Preamble	This course enables to learn and use different regression models to predict outcomes.	
Unit - I	**Linear Regression**	**6**
Basics of regression – Python packages for regression analysis – Linear models and supervised learning – linear regression – Evaluation and prediction- Minimizing the cost function		
Unit - II	**Multiple Regression**	**6**
Multiple Features – Model building – Correlation matrix – Feature scaling – Estimating features – Interaction models – Polynomial regression		
Unit - III	**Logistic Regression and Data Preparation**	**6**
Binary classification – Probability based approach – gradient descent – Multiclass logistic regression – Numeric feature scaling – Qualitative feature encoding – Numeric feature transformation – Missing data and outlier handling		
Unit - IV	**Generalization**	**6**
Checking on out-of sample data – Greedy feature selection – Regularization optimized by grid search – Stability selection – online learning – Batch learning		
Unit - V	**Advanced Regression Methods**	**6**
Lest angle regression – Bayesian regression – SGD classification with hinge loss – Regression Trees – Bagging and Boosting – Real world applications of regression models		

List of Exercises / Experiments:

1.	Working with Numpy, Scipy, Stasmodels and Scikit-Learn
2.	Implement linear regression with Scikit-Learn
3.	Implement multiple regression
4.	Implement polynomial regression
5.	Implement logistic regression
6.	Prepare the data for regression analysis
7.	Apply regularization techniques
8.	Implement and compare the performance of any 2 advanced regression methods

REFERENCES/MANUAL/SOFTWARE:

1.	Laboratory Manual
2.	Python, Keras Framework

Lecture: 30, Practical: 15, Total: 45

TEXT BOOK:

1.	Luca Massaron,Alberto Boschetti, “Regression Analysis with Python”, Packt Publishing, 2016.for Units I,II,III,IV,V

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	describe the basics of regression and linear regression model	Applying (K3)
CO2	explore multiple regression model	Applying (K3)
CO3	learn about logistic regression and preparing the data for analysis	Applying (K3)
CO4	explore various feature selection strategies	Applying (K3)
CO5	learn advanced regression methods and apply it into real world problems	Applying (K3)
CO6	work with linear and multiple regression	Applying (K3) Precision (S3)
CO7	work with polynomial and logistic regression	Applying (K3) Precision (S3)
CO8	work with advanced regression methods	Applying (K3) 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	2	2		2							2	3	2
CO2	3	2	2		2							2	3	2
CO3	3	2	2		2							2	3	2
CO4	3	2	2		2							2	3	2
CO5	3	2	2		2							2	3	2
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

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

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

REINFORCEMENT LEARNING
(Common to AI & DS and AI & ML branches)

Programme& Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	7	PE	3	0	0	3

Preamble	This course deals with modeling, analysis tools and techniques for problems of dynamic decision making under uncertainty. It also deals with convergence and accuracy of such algorithms.

Unit - I	**Introduction and Basics of RL**	**9**
Reinforcement Learning- Examples- Elements of Reinforcement Learning- Limitations and Scope- An Extended Example: Tic-Tac-Toe- History of Reinforcement Learning.		
Unit - II	**Tabular Solution Methods**	**9**
Multi-arm Bandits - An n-Armed Bandit Problem- Action-Value Methods- Incremental Implementation- Tracking a Nonstationary Problem- Optimistic Initial Values- Upper-Confidence-Bound Action Selection- Gradient Bandit- Associative Search.		
Unit - III	**Finite Markov Decision Processes**	**9**
The Agent–Environment Interface- Goals and Rewards- Returns- Unified Notation for Episodic and Continuing Tasks- The Markov Property- Markov Decision Processes- Value Functions- Optimal Value Functions- Optimality and Approximation.		
Unit - IV	**Dynamic Programming and Monte Carlo Methods**	**9**
Dynamic Programming - Policy Evaluation- Policy Improvement- Policy Iteration- Value Iteration- Generalized Policy Iteration. Monte Carlo Methods: Monte Carlo Prediction- Monte Carlo Estimation of Action Values- Monte Carlo Control- Monte Carlo Control without Exploring Starts.		
Unit - V	**Temporal-Difference Learning**	**9**
TD Prediction- Advantages of TD Prediction Methods- Optimality of TD(0) -Sarsa: On-Policy TD Control- Q-Learning: Off-Policy TD Control- Games, After states, and Other Special Cases		

Lecture: 45, Total: 45

TEXT BOOK:

1	Richard S. Sutton and Andrew G. Barto, “Reinforcement Learning: An Introduction", 2nd Edition, MIT Press, London, 2018. for Unit I, II, III, IV and V.

REFERENCES:

1	Phill winder, “Reinforcement Learning: Industrial applications of intelligent agents", 1st Edition, O'Reilly Media, 2020.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	illustrate RL tasks and the core principles behind the RL	Applying (K3)
CO2	apply tabular methods to solve classical control problems	Applying (K3)
CO3	utilize Markov decision process in optimization of complex problems	Applying (K3)
CO4	solve problems using dynamic programming and Monte-Carlo methods	Applying (K3)
CO5	outline temporal-difference learning and Q-learning	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	3	2	1	1									3	2
CO2	3	2	1	1									2	2
CO3	3	2	1	1									2	2
CO4	3	2	1	1									3	2
CO5	3	2	1	1									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	50	30				100
CAT3	20	40	40				100
ESE	30	40	30				100

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

EMBEDDED SYSTEMS AND PROGRAMMING

Programme& Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	Python programming and problem solving techniques	7	PE	3	0	0	3

Preamble	This course provides knowledge on real-time programming with embedded systems using raspberrypi.	
Unit - I	**Exploring Embedded Linux Systems**	**9**
Introducing Embedded Linux-Managing Linux Systems -Raspberry Pi Hardware: Introduction to the Platform - RPi Documentation-The RPi Hardware- RaspberryPi Accessories- HATs- RaspberryPi Software: Linux on the Raspberry Pi-Connecting to a Network-Communicating with the RPi-Controlling the Raspberry Pi-Configuring the Raspberry Pi.		
Unit - II	**Programming on the RaspberryPi**	**9**
Introduction-Scripting Languages-Dynamically Compiled Languages-C and C++ on the RPi-Overview of Object Oriented Programming-Interfacing to the LinuxOS-Improving the Performance of Python-Interfacing to the RaspberryPi. Input/Outputs: Introduction-General-Purpose Input/Outputs-C++-Control of GPIOs using sysfs-Memory-Based GPIO Control.		
Unit - III	**Cross-Compilation and the Eclipse IDE**	**9**
Setting up a Cross-Compilation Tool chain-Cross-Compilation using Eclipse-Building Linux-Interfacing to the RaspberryPi Buses: Introduction to Bus Communication-I2C-SPI-UART-Logic-Level Translation.		
Unit - IV	**Interacting with the Physical Environment**	**9**
Interfacing to Actuators, Interfacing to Analog Sensors, Interfacing to Local Displays, Building C/C++ Libraries-Real-Time Interfacing Using the Arduino: The Arduino-An Arduino Serial Slave-An Arduino I2C Slave-An Arduino SPI Slave-Programming the Arduino from the RPi Command Line		
Unit - V	**The Internet of Things**	**9**
The Internet of Things (IoT)-The RPi as an IoT Sensor-The RPi as a Sensor- Web Server-AC/C++Web Client-The RPi as a—Thingll-Large-Scale IoT Frameworks-The C++ Client/Server-IoT Device Management.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	DerekMolloy, —Exploring RaspberryPi Interfacing to the Real World with Embedded Linux, 1st Edition, JohnWiley&Sons, Inc.,Indianapolis,2016 for Units I,II,III,IV,V

REFERENCES:

1.	QingLi, CarolineL.Yao, "Real-TimeConceptsfor EmbeddedSystems",1stEdition, CMP Books, UK,2003.
2.	Rajkamal,"EmbeddedSystemsArchitecture,ProgrammingandDesign",3rdEdition,McGraw-Hill,NewDelhi,2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret various hardware and software features in embedded programming using Raspberry Pi.	Applying(K3)
CO2	experiment with programming and interfacing of RaspberryPi hardware.	Applying(K3)
CO3	manipulate cross compilation tools and bus communication of RaspberryPi.	Applying(K3)
CO4	illustrate interfacing concepts with real physical environment and Arduino	Applying(K3)
CO5	apply embedded programming knowledge for IoT application developments	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	3	2	1	1									3	2
CO2	3	2	1	1									3	2
CO3	3	2	1	1									3	2
CO4	3	2	1	1									3	2
CO5	3	2	1	1									3	2
1 – Slight, 2 – Moderate, 3 – Substantial, BT- Bloom's Taxonomy														

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

TIME SERIES ANALYSIS AND FORECASTING
(Common to AI & DS and AI & ML branches)

Programme & Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	PE	2	0	2	3

Preamble	The course familiarizes students with various forecasting approaches and new statistical methods for analyzing and evaluating time-series data.	
Unit - I	**Exploratory analysis**	**6**
Graphical displays – Numerical description of Time Series Data – Use of Data transformations and Adjustments –General Approach to Time Series Modeling and Forecasting – Evaluating and Monitoring Forecasting Model Performance.		
Unit - II	**Smoothing methods**	**6**
First-Order Exponential Smoothing – Modeling Time Series data – Second-Order Exponential Smoothing – Higher- Order Exponential Smoothing – Forecasting – Exponential Smoothing for Seasonal Data – Exponential Smoothing of Biosurveillance data – Exponential Smoothers and ARIMA models.		
Unit - III	**ARIMA models**	**6**
Linear Models for Stationary Time Series – Finite Order Moving Average Processes – Finite Order Autoregressive Processes – Mixed Autoregressive-Moving Average Processes – Nonstationary Processes – Time Series Model building – Forecasting ARIMA Processes – Seasonal Processes – ARIMA Modeling of Biosurveillance data.		
Unit - IV	**Transfer Functions and Intervention Models**	**6**
Transfer Function Models – Transfer Function-Noise Models – Cross Validation Function – Model Specification – Forecasting with Transfer Function-Noise Models – Intervention Analysis.		
Unit - V	**Other Forecasting Methods**	**6**
Multivariate Time Series Models and Forecasting – State Space Models – Arch and Garch models – Direct Forecasting of Percentiles – Combining Forecasts to improve Prediction Performance – Aggregation and Disaggregation of Forecasts – Neural Networks and Forecasting – Spectral Analysis – Bayesian Methods in Forecasting.		

List of Exercises / Experiments:

1.	Visualization of Stationary and Non-stationary time series data.
2.	Implement Moving Average Time Series Model and Differencing.
3.	Implement Exponential smoothing technique (Single, double and triple).
4.	Implement Auto-Regressive Model for Stationary Time Series.
5.	Implement Auto-Regressive Integrated Moving Average for Non-Stationary Time Series.
6.	Apply Univariate Models to forecast data
7.	Implement Transfer Functions and Autoregressive Distributed Lag Modeling.
8.	Apply Spectral density function to forecast data.

Lecture: 30, Practical:30, Total:60

TEXT BOOK:

1.	Douglas C. Montgomery, Cheryl L. Jennings, Murat Kulahci, "Introduction to Time Series Analysis and Forecasting", 2nd Edition, Wiley, 2016. for Unit I, II, III, IV and V.

REFERENCE:

1.	George E. P. Box, Gwilym M. Jenkins, Gregory C. Reinsel, Greta M. Ljung, "Time Series Analysis: Forecasting and Control", 5th Edition, Wiley, 2016.

REFERENCES/MANUAL/SOFTWARE:

1.	Python
2.	Laboratory Manual

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand the necessity of forecasting and apply in a given situation	Applying (K3)
CO2	apply smoothing methods in time series data	Applying (K3)
CO3	perform Stationary and Non-Stationary time series analysis	Applying (K3)
CO4	make use of variance transformation techniques for time series analysis and forecasting	Applying (K3)
CO5	understand and apply frequency-domain time series analysis	Applying (K3)
CO6	implement models for stationary and non-stationary time series analysis	Applying (K3), Precision (S3)
CO7	make use of various smoothing methods for time series data analysis	Applying (K3), Precision (S3)
CO8	implement models for frequency-domain time series analysis	Applying (K3), 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	2	2										3	2
CO2	3	2	2										3	2
CO3	3	2	2										3	2
CO4	3	2	2										3	2
CO5	3	2	2										3	2
CO6	3	2	2	2	2								3	2
CO7	3	2	2	2	2								3	2
CO8	3	2	2	2	2								3	2

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

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	50	40				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)**

PARALLEL COMPUTING ARCHITECTURE AND PROGRAMMING
(Common to AI & DS and AI & ML branches)

Programme& Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	Computer Organization	7	PE	3	0	0	3

Preamble	This course deals with computer architecture of uniprocessor and multiprocessor systems with an emphasis on parallel programming to achieve high performance.	
Unit - I	**Parallel Architectures**	**9**
Motivation: Modern scientific method – Evolution of supercomputing – Modern parallel computers – Seeking concurrency – Data clustering – Programming Parallel computers. Parallel Architectures: Introduction – Interconnection networks – Processor Arrays – Multiprocessors – Multicomputer – Flynn's Taxonomy.		
Unit - II	**Parallel Algorithm Design and Message-Passing Programming**	**9**
Parallel Algorithm Design: Introduction – Task/Channel model – Foster's Design methodology – Boundary value problem – finding the maximum – The n-Body problem – Adding data input. Message-Passing Programming: Message-passing model – Message-passing interface – Circuit satisfiability – Introducing collective communication – Benchmarking parallel performance.		
Unit - III	**Parallel Algorithms**	**9**
The Sieve of Eratosthenes: Sequential algorithm, Sources of parallelism – Data Decomposition options – Developing the parallel algorithm – Analysis of parallel Sieve algorithm – documenting the parallel program. Floyd's Algorithm: The All-Pairs shortest path problem – Creating arrays at run time – Designing the parallel algorithm – Point-to-point communication – Documenting the parallel program.		
Unit - IV	**Performance Analysis and Sorting**	**9**
Performance Analysis: Speedup and efficiency – Amdhal's Law – Gustafsan-Barsis's Law – The Karp-Flatt Metric – The Isoefficiency Metric. Sorting: Quick sort – A parallel quick sort – Hyper quick sort – parallel sorting by regular sampling		
Unit - V	**Shared-Memory Programming and Combining MPI and OPenMP**	**9**
Shared-Memory Programming: The Shared-memory model – Parallel for loops – Declaring private variables – Critical sections – Reductions – Performance Improvement – More general data parallelism – Functional parallelism. Combining MPI and OPenMP: Conjugate – Jacobi method.		

Lecture:45, Total:45

TEXT BOOK:

1. Michael J. Quinn., "Parallel Programming in C with MPI and OpenMP", 1st Edition, 2003, McGraw Hill Education(India), Reprint 2014 for Units I,II,III,IV,V

REFERENCES:

1. David E. Culler, Jaswinder Pal Singh, "Parallel Computing Architecture: A Hardware/ Software Approach", Morgan Kaufmann, Elsevier, 1st Edition, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the fundamental concept of computer architecture in the modern parallel computers and make use of it for designing parallel systems	Applying (K3)
CO2	utilize parallel algorithms and message passing interface methods for inter-process communication	Applying(K3)
CO3	make use of parallel programming concepts in developing parallel algorithms	Applying(K3)
CO4	measurethe performance of parallel algorithms	Applying(K3)
CO5	make use of MPI and openMP programming concepts for shared memory programming	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	3	2	1										3	2
CO2	3	2	1		1								3	2
CO3	3	2	1		1								3	2
CO4	3	3	2		1								3	2
CO5	3	2	1		1								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	55	30				100
CAT2	15	50	35				100
CAT3	15	55	30				100
ESE	15	55	30				100

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

SOCIAL MEDIA ANALYTICS

Programme & Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	PE	3	0	0	3

Preamble	The course gives exposure to perform analytical operations on different types of data in social media	
Unit - I	**Foundations of social media analytics**	**9**
Creating value with Social media analytics – Understanding social media: Core characteristics – Understanding Social media analytics: Emergence – layers – types – social media analytics value creation cycle – challenges – social media analytics industry.		
Unit - II	**Analytics Business Alignment and social media network analytics**	**9**
Analytics Business Alignment : Digital analytics maturity model – Role of CIO and its management – Formulation of strategy. **Social media network analytics:** Social network terms – network structures – network topologies – types of networks – network strategies - Network analysis tools.		
Unit - III	**Text and Social media actions analytics**	**9**
Text Analytics : Types of social media text – deployment models – purpose – social media text analytics for Business Intelligence – text analytics value creation cycle – common terms – issues – Case studies. **Social media actions analytics**: Common social media actions - actions analytics tools -		
Unit - IV	**Search Engine, location and hyperlink analytics**	**9**
Search Engine analytics: types of search engines - working - analytics – developing search engine optimization strategy and implementing – search engine data analytics - **Location analytics:** Sources of location data – data collection – location metrics – tools**. Social media hyperlink analytics:** types – hyperlink analytics – tools**.**		
Unit - V	**Mobile and multimedia analytics**	**9**
Mobile analytics: types of apps- development perspective – classifying apps by their purpose – characteristics of mobile apps – tools**. Multimedia analytics:** Types – image analytics tools - video analytics. Social media legal, privacy and security issues.		

Lecture:45;Total:45

TEXT BOOK:

1.	Gohar F. Khan. Creating Value With Social Media Analytics. 1st edition, Create space, 2018. for Unit I, II, III, IV and V.

REFERENCES:

1	Marshall Sponder. Social Media Analytics: Effective Tools for Building, Interpreting, and Using Metrics. 1st edition, McGrawHill, 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1:	get familiar with basic foundations of social media analytics	Understanding (K2)
CO2:	recall concepts Analytics Business Alignment and social media network analytics	Understanding (K2)
CO3:	implement techniques for Text and Social media actions analytics	Applying (K3)
CO4:	demonstrate different methods for Search Engine, location and hyperlink analytics	Applying (K3)
CO5:	use Mobile and multimedia analytics for various real life social media applications	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	3	3	3										3	2
CO2	3	3	2										3	2
CO3	3	2	3										3	3
CO4	3	2	3										3	3
CO5	3	2	2										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 %
CAT 1	15	30	55				100
CAT 2	15	30	55				100
CAT 3	15	30	55				100
ESE	15	30	55				100

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

REAL TIME ANALYTICS
(Common to AI & DS and AI & ML branches)

Programme & Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	7	PE	3	0	0	3

Preamble	This course provides a comprehensive knowledge about data analysis technologies to build an effective real-time analytics platform.	
Unit - I	**Streaming Data and analytics**	**9**
Introduction to Streaming Data: Sources – Why Streaming Data is Different – Infrastructures and Algorithms. Streaming Analytics Architecture: Real-Time Architecture Components – Feature of Real-Time Architecture – Languages for Real-Time programming – A Real-Time Architecture Checklist.		
Unit - II	**Processing and Storing Streaming Data**	**9**
Processing Streaming Data: Distributed Streaming Data Processing – Processing Data with Storm: Components, Configuring of a Storm Cluster – Distributed Clusters – Local Clusters – Storm Topologies. Storing Streaming Data : Consistent Hashing – No SQL Storage Systems – Other Storage Technologies – Choosing a Technology – Warehousing.		
Unit - III	**Visualization and Aggregation**	**9**
Visualization: Visualizing Data – Mobile Streaming Applications – Exact Aggregation and Delivery: Timed Counting and Summation – Multi –Resolution Time-Series Aggregation – Stochastic Optimization		
Unit - IV	**Statistical Approximation of Streaming Data and Sketching**	**9**
Statistical Approximation of Streaming Data: Sampling from a streaming Population – Biased Streaming Sampling. Sketching : Registers and Hash Functions – Working with Sets – The Bloom Filter – Distinct Value Sketches – The Count-Min Sketch – Other Applications		
Unit - V	**Real-Time Models, Monitoring and Forecasting**	**9**
Real-Time Models and Monitoring: Simple Time-Series Models – Linear Models – Logistic Regression – Neural Network Models – Forecasting: Exponential Smoothing Methods – Regression Methods - Neural Network Methods. Monitoring: Outlier Detection - Change Detection		

Lecture: 45, Total: 45

TEXT BOOK:

1. Ellis, Byron. “Real-time analytics: Techniques to analyze and visualize streaming data”, John Wiley & Sons, 1st Edition, 2014 for Unit I, II, III, IV and V.

REFERENCE:

1. Goetz, P. Taylor, and Brian O'Neill, “Storm blueprints: patterns for distributed real-time computation”, Packt Publishing Ltd, 1st Edition, 2014.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	describe the concepts of streaming data and analyze various architectures for streaming data	Applying (K3)
CO2	make use of processing and storage techniques to build real time analytics applications	Applying (K3)
CO3	apply visualization and aggregation techniques for real time analytics	Applying (K3)
CO4	employ statistical approximation and sketching techniques for solving the real world problems	Applying (K3)
CO5	develop models and use it for forecasting and monitoring to solve real time problems	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	3	2	2										3	2
CO2	3	2	1		2								3	1
CO3	3	2	1										3	1
CO4	3	2	1										3	1
CO5	3	2	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	10	20	30	40			100
CAT2	15	35	50				100
CAT3	20	40	40				100
ESE	20	20	40	20			100

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

MULTI VARIATE DATA ANALYSIS

Programme & Branch	B.Tech. & Artificial Intelligence & Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	**Multivariate Data Analysis**	**7**	**PE**	**3**	**0**	**0**	**3**

Preamble	This course enables the students to learn various multivariate data analysis	
Unit - I	Introduction to Multivariate Methods	**9**
Multivariate Analysis - Basic Concepts – Managing the Multivariate model – Classification of multivariate techniques – Types of multivariate techniques – Guidelines for multivariate analyses and interpretation – Approach to multivariate modeling		
Unit - II	**Preparing for Multivariate Analysis**	**9**
Introduction – Examination of the Data : Univariate – Bivariate – Multivariate – Missing Data : Impact – Missing Data Analysis – Process for identifying missing data and remedies – Outliers: Contexts for defining outliers – impact – classifying outliers – detecting and handling outliers – example – Testing the assumptions of multivariate Analysis – Data transformations – Illustrating of testing the assumptions		
Unit – III	**Interdependence Techniques**	**9**
Exploratory Factor Analysis : Introduction- Examples – Factor analysis decision process – Stages – Illustration -**Cluster Analysis** : Introduction to cluster analysis – working - Cluster analysis decision process : Stages - Illustration		
Unit – IV	**Dependence Technique**	**9**
Introduction to Multiple Regression Analysis – Simple and Multiple Regression – Decision process for multiple regression analysis – Stages – Illustration		
Unit – V	**MANOVA**	**9**
Introduction to MANOVA – Illustration – Decision process for MANOVA – Stages : Objectives – Issues – Assumptions of ANOVA and MANOVA – Estimation of MANOVA model and Assessing overall Fit – Interpretation of MANOVA results - Validation		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Joesph F. Hair Jr., William C. Black, Barry J. Babin, Rolph E.Anderson "Multivariate Data Analysis", Annabel Ainscow, Eigth Edition (2019). for Unit I, II, III, IV and V.

REFERENCES:

1.	Spencer, N. H. Essentials of multivariate data analysis. CRC press, (2013).

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	perform multivariate modeling by classifying and Interpreting multivariate data	Applying (K3)
CO2	examine multivariate data for missing data and outliers to perform multivariate analysis	Applying (K3)
CO3	assess the interdependence using factor and cluster analysis	Applying (K3)
CO4	explore the dependence relationship between variables using multiple regression analysis	Applying (K3)
CO5	test the statistical significance of the effect of one or more independent variables on a set of two or more dependent variables, using MANOVA	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	3	2	2										3	2
CO2	3	2	2										3	2
CO3	3	2	2										3	2
CO4	3	2	2										3	2
CO5	3	2	2										3	2

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

ASSESSMENT PATTERN - THEORY

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

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

COGNITIVE SCIENCE AND ANALYTICS

Programme & Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	Data analytics	7	PE	3	0	0	3

Preamble	To impart knowledge on cognitive science and various analytical methods	
Unit – I	**Introduction to Cognitive Science**	**9**
The Foundation of Cognitive Computing - Design Principles for Cognitive Systems: Components of a Cognitive System - Building the Corpus- Bringing Data into the Cognitive System - Machine Learning - Hypotheses -Generation and Scoring - Presentation and Visualization Services. 1.		
Unit - II	**Natural Language Processing, Big Data and Cognitive Computing**	**9**
Natural Language Processing in Support of a Cognitive System - The Relationship Between Big Data and Cognitive Computing: Dealing with Human-Generated Data - Defining Big Data - The Architectural Foundation for Big Data - Analytical Data Warehouses - Hadoop - Data in Motion and Streaming Data - Integration of Big Data with Traditional Data.		
Unit - III	**Taxonomies and Ontologies, Cloud and Distributed Computing**	**9**
Representing Knowledge in Taxonomies and Ontologies - Applying Advanced Analytics to Cognitive Computing - The Role of Cloud and Distributed Computing in Cognitive Computing.		
Unit - IV	**1. The Process of Building Cognitive Applications**	**9**
The Business Implications of Cognitive Computing - IBM's Watson as a Cognitive System - The Process of Building a Cognitive Application - Smarter Cities: Cognitive Computing in Government.		
Unit - V	**Applications and case studies**	**9**
Building a Cognitive Healthcare Application -Emerging Cognitive Computing Areas - Future Applications for Cognitive Computing.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Judith S. Hurwitz, Marcia Kaufman, Adrian Bowles. Cognitive Computing and Big Data Analytics. 1st edition, Wiley, 2015. for Unit I, II, III, IV and V.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	describe the basic concepts of cognitive science	Understanding (K2)
CO2:	interpret the principles of Natural Language Processing and Big Data with Cognitive Computing	Understanding (K2)
CO3:	exploreTaxonomies and Ontologies and Cloud and Distributed Computing in cognitive environment	Understanding (K2)
CO4:	implement Watson for Cognitive system and develop applications	Applying (K3)
CO5:	demonstrate case studies of applying cognitive computing for various real life problems	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	3	3	3										3	2
CO2	3	3	2										3	2
CO3	3	2	3										3	3
CO4	3	2	3										3	3
CO5	3	2	2										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 %
CAT 1	40	60					100
CAT 2	40	45	15				100
CAT 3	40	45	15				100
ESE	40	45	15				100

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

GRAPH THEORY AND ITS APPLICATIONS
(Common to AI & DS and AI & ML branches)

Programme& Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	7	PE	3	0	0	3

Preamble	To develop rigorous logical thinking and analytical skills by graph theoretic concepts which helps for solving real time engineering problems in networks, computer architecture, compiling techniques, model checking, artificial intelligence, software engineering, expert systems, software/hardware correctness problem.	
Unit - I	**Graphs:**	**9**
Introduction – Definition – Types of graphs – Degree of vertex – Walk, path and cycle – Isomorphism – Connected graph – Hamiltonian graph – Euler graph – Digraph – Representations of graphs: Adjacency matrix – Incidence matrix.		
Unit - II	**Trees:**	**9**
Introduction – Properties of trees – Pendant vertices in a tree – Distances and centers in a tree – Rooted and binary trees – Spanning tree – Construction of spanning tree: BFS algorithm – DFS algorithm – Tree traversal.		
Unit - III	**Graph Coloring:**	**9**
Vertex coloring – Chromatic number – Chromatic partitioning – Independent sets – Chromatic polynomial – Matching – Covering – Four color problem (statement only) – Simple applications.		
Unit - IV	**Basic Algorithms:**	**9**
Shortest paths – Shortest path algorithms: Dijkstra's algorithm – Warshall's algorithm – Minimum Spanning tree – Minimal spanning tree algorithms: Prim's algorithm – Krushkal's algorithm – Optimal assignment – Kuhn and Munkres algorithm – Travelling salesman problem: Two optimal algorithm – Closest Insertion Algorithm.		
Unit - V	**Network Flows and Applications:**	**9**
Flows and cuts in networks - Max-flow Min-cut Theorem – Algorithms: Flow Augmenting Path – Ford-Fulkerson Algorithm for Maximum Flow – Edmonds and Karp algorithm.		

Lecture:45, Total:45

TEXT BOOK:

1. NarsinghDeo, "Graph Theory with Applications to Engineering and Computer Science", Prentice Hall, New Delhi, 2010. for Unit I, II, III, IV and V.

REFERENCES:

1. Douglas B.West, "Graph Theory", 2nd Edition, Prentice Hall, New Delhi, 2017.
2. Jonathan L. Gross & Jay Yellen, "Graph Theory and its Applications", 2nd Edition, CRC Press, New York, 2006.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explain the types of graphs and illustrate isomorphism on graphs.	Understanding (K2)
CO2	use the concepts and properties of different types of trees in data structures.	Applying (K3)
CO3	estimate the chromatic partition, chromatic polynomial and matching of a given graph.	Applying (K3)
CO4	apply various graph theoretic algorithms to communication and network problems.	Applying (K3)
CO5	identify the maximal flow in network by means of algorithms.	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	3	2	1										3	2
CO2	3	1											3	2
CO3	3	1											3	2
CO4	3	2	1										3	2
CO5	3	2	1										3	2

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

ASSESSMENT PATTERN - THEORY

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

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

OPERATIONS AND SUPPLY CHAIN MANAGEMENT

Programme& Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	7	PE	3	0	0	3

Preamble	The course provides an insight on the operations, quality management and sampling tools and fundamentals of supply chain networks, tools andtechniques	
Unit - I	**Introduction to operations and supply chain management:**	**9**
Scope and Importance- Evolution of Supply Chain - Decision Phases in Supply Chain - Competitive and supply chain Strategies – Drivers of Supply Chain Performance and Obstacles - The Operations Function - The Evolution of Operations and Supply Chain Management – Globalization - Productivity and Competitiveness - Strategy and Operations-Operational Decision-Making Tools: Decision Analysis-Decision Analysis with and without Probabilities		
Unit - II	**Quality management:**	**9**
Quality and Value in Athletic Shoes -What Is Quality-Quality Management System-Quality Tools- Quality in Services-Six Sigma-Quality Costs and Productivity-Quality Awards-ISO 9000-Statistical Process Control-Operational Decision-Making Tools: Acceptance Samp		
Unit - III	**Network design and transportation:**	**9**
Factors influencing Distribution network design – Design options for Distribution Network-– factors affecting transportations decision – Design option for transportation network – Tailored transportation – Routing and scheduling in transportation		
Unit - IV	**Sourcing and coordination:**	**9**
Role of sourcing supply chain - supplier selection assessment and contracts- Design collaboration - sourcing planning and analysis - supply chain co-ordination - Bull whip effect – Effect of lack of co- ordination in supply chain and obstacles – Building strategic partnerships and trust within a supply chain.		
Unit - V	**Supply chain and information technology:**	**9**
The role IT in supply chain- The supply chain IT frame work - Customer Relationship Management – Internal supply chain management – supplier relationship management – future of IT in supply chain – E-Business in supply chain.		

Lecture: 45, Total: 45

TEXT BOOK:

1.	Roberta S. Russell, Bernard W. Taylor, “Operations and Supply Chain Management, 10th Edition, WileyPublications,2019(Units I,II,III,IV,V)

REFERENCES:

1.	Sunil Chopra, Peter Meindl and Kalra, Supply Chain Management, Strategy, Planning, and Operation, Pearson Education, 2010.
2.	Jeremy F.Shapiro, Modeling the Supply Chain, Thomson Duxbury,2002.
3.	Srinivasan G.S, Quantitative models in Operations and Supply Chain Management, PHI,2010
4.	David J.Bloomberg , Stephen Lemay and Joe B.Hanna, Logistics, PHI2002.
5.	James B.Ayers, Handbook of Supply Chain Management, St.Lucle press,2000
6.	F. RobertJacobs (Author), Richard, B.Chase, Operations and Supply Chain Management McGraw Hill2017

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	know about the operations and fundamentals of supply chain	Applying (K3)
CO2	explore the quality management tools and sampling process	Applying (K3)
CO3	learn about design factors and various design options of distribution networksin industries and the role of transportation and ware housing	Applying (K3)
CO4	elaborate various sourcing decisions in supply chain	Applying (K3)
CO5	explore the role of IT in supply chain	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	3	2	1										3	1
CO2	3	2	1										3	1
CO3	3	2	1										3	1
CO4	3	2	1										3	1
CO5	3	2	1										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	5	20	75				100
CAT2	10	20	70				100
CAT3	10	20	70				100
ESE	10	20	70				100

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

SEMESTER VIII

SOFTWARE DEFINED NETWORKS
(Common to AI & DS and AI & ML branches)

Programme& Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	Computer Networks	8	PE	3	0	0	3

Preamble	This course provides an insight on programmability protocols, interfaces, controllers and its applications in various environments like data centers and service provider networks.	
Unit - I	**Introduction to SDN**	**9**
Introduction: Basic packet switching terminology – The modern data center – Traditional switch architecture – Autonomous and dynamic forwarding table. Evolution of switches and control planes – Cost – Data center innovation – Data center needs. The Genesis of SDN: The evolution of networking technology – Forerunners of SDN – Getting started with mininet and experimenting with mininet.		
Unit - II	**SDN and OpenFlow**	**9**
Fundamental characteristics of SDN – SDN operation – SDN devices – SDN controllers – Alternate SDN methods. The OpenFlow specification: OpenFlow overview – OpenFlow 1.0 and OpenFlow basics - OpenFlow 1.1 Additions - OpenFlow 1.2 Additions - OpenFlow 1.3 Additions – OpenFlow Limitations. NetApp Development: Simple forwarding in OpenDayLight controller.		
Unit - III	**SDN Interfaces**	**9**
Alternative definitions of SDN: Potential drawbacks of open SDN – SDN via APIs- SDN via hypervisor based overlays – SDN via opening up the device – Network Functions virtualization – Alternatives overlap and ranking. SDN open source: Open source licensing issues – OpenFlow source code – Switch implementation – Controller implementations – Orchestration and Network virtualization – Simulation, Testing and Tools – OpenStack – Applying SDN open source		
Unit - IV	**SDN in the Data center**	**9**
Data center definition – Data center demands – Tunneling technologies for the data center – Path technologies in the data center – SDN and shortest path complexity – Ethernet fabrics in the data center – SDN use cases in the data center – Open SDN versus Overlays in the data center – Real-world data center implementation.		
Unit - V	**SDN environments and applications**	**9**
SDN in other environment – Wide area networks – Service provider and carrier networks – Campus networks – Hospitality networks – Mobile networks – In-Line network functions – Optical networks. SDN Applications: Reactive versus Proactive applications – A simple reactive Java application – Creating network virtualization tunnels – offloading flows in the data center – Access control for the campus – Traffic engineering for the service providers –NetApp Development: A simple Firewall.		

Lecture:45, Total:45

TEXT BOOK:

1. Paul Goransson and Chuck Black, "Software Defined Networks: A Comprehensive Approach", 1st Edition, Morgan Kaufmann, 2014.

REFERENCES:

1. SiamakAzodolmolky, "Software Defined Networking with OpenFlow", Packet Publishing, 1st Edition, 2013.
2. Thomas D. Nadeau and Ken Gray, "SDN: Software Defined Networks", O'Reilly Media, 1st Edition, 2013.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply the programmability in the network using software defined network	Applying (K3)
CO2	model a networking task using OpenFlow protocol	Applying (K3)
CO3	demonstrate the networking application using software defined network interfaces and open source tools	Applying (K3)
CO4	employ the software defined network architecture in the data centers	Applying (K3)
CO5	design and develop various applications of SDN	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	3	2	1		1								3	1
CO2	3	2	1		1								3	1
CO3	3	2	1										3	1
CO4	3	2	1										3	1
CO5	3	2	1		1								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	25	60				100
CAT3	15	25	60				100
ESE	10	30	60				100

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

SOFTWARE QUALITY AND TESTING
(Common to AI & DS and AI & ML branches)

Programme& Branch	B.Tech& Artificial Intelligence and Data Science	Sem.	Category	L	T	P	Credit
Prerequisites	Software Engineering	8	PE	3	0	0	3

Preamble	This course focuses on the implementation of appropriate functionality that satisfies the requirements/needs of its targeted client/users for the intended software system, product, or service correctly and efficiently.	
Unit - I	**Software Quality Assurance and Review Techniques**	**9**
Defining Quality – Importance of Quality –Quality Control Vs Quality assurance –Quality assurance at each phase of SDLC - Need for SQA group in an Organization. Structured walkthroughs –Inspections –Various roles and responsibilities involved in Inspections –Making review successful.		
Unit - II	**Software Measurement and Metrics**	**9**
Product quality – Models for software product Quality – Process Quality Aspects. Measurement and Metrics: Introduction – Measurement during software life cycle context –Defect metrics – Metrics for software maintenance– Requirements related metrics – Measurements and process improvement – Measurement principles.		
Unit - III	**Basics of Testing**	**9**
Introduction – Definition– Testing Approaches – Essentials – features and principles of software Testing. Testing Environment: Assessing Capabilities – Staff Competency and User Satisfaction – Creating an environment supportive of software testing – Building the software testing process: Testing Guidelines.		
Unit - IV	**Software Testing process**	**9**
Overview of Software Testing Process – Organizing for testing: Workbench – Input – Procedure. Developing the test plan:Workbench – Input – Procedure.Verification testing: Workbench – Input – Procedure. Validation testing :Workbench – Input – Procedure.		
Unit - V	**Analyzing and reporting**	**9**
Analyzing and reporting test results: Workbench – Input – Procedure. Testing software system security – Testing client/server systems – Testing web-based systems – Using Agile Methods to Improve Software Testing.		

Lecture:45, Total:45

TEXT BOOK:

1. Nina S. Godbole, "Software Quality Assurance Principles and Practice", 2nd Edition, Narosa Publishing House, 2017 for Unit I, II, III, IV and V.
2. Perry William, "Effective Methods for Software Testing", 3rd Edition, Wiley, India, 2013 (Units 3,4,5)

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply quality assurance steps at each phase of SDLC and conduct reviews and inspections	Applying (K3)
CO2	apply the concepts, metrics, and models in software quality assurance	Applying (K3)
CO3	apply the step by step activities and set up environment for software testing	Applying (K3)
CO4	develop procedures and workbenches for various testing process	Applying (K3)
CO5	apply testing for client server, web based and software security systems and identify the agile methods for improving the testing process	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	3	2	1										3	1
CO2	3	2	1										3	1
CO3	3	2	1										3	1
CO4	3	2	1										3	1
CO5	3	2	1										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	30	50	20				100
CAT2	20	50	30				100
CAT3	20	50	30				100
ESE	25	30	45				100

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

SOFTWARE PROJECT MANAGEMENT
(Common to AI & DS and AI & ML branches)

Programme& Branch	B.Tech& Artificial Intelligence and Data Science	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	8	PE	3	0	0	3

Preamble	This course provides an insight into detailed project management activities including project evaluation, planning, estimation, monitoring and control activities especially for software projects.	
Unit - I	**Introduction to Software Project Management**	**9**
Introduction - Importance – Types of project – Activities – Plans, methods and methodologies – Ways of Categorizing software projects – Stakeholders – Setting objectives – Business case – Project success and failure - Management and management control – Traditional vs. Modern project management practices. Project Evaluation: Introduction – A business case – Project Portfolio Management – Evaluation of Individual Projects – Cost Benefit Evaluation Techniques – Risk Evaluation – Programme management – Managing the allocation of resources within programme – Strategic programme management – Creating a programme – Aids – Reservations – Benefits.		
Unit - II	**Project Planning**	**9**
Introduction – Select project - Identify project scope and objectives, project infrastructure – Analyse project characteristics – Identify project products and activities – Estimate effort for activity – Identify activity risks - Allocate Resources – Review plan – Execute plan. Software Effort Estimation : Introduction – Estimates – Problems with over and under estimates – Basis – Techniques – Bottom-up Estimating – Top down approach and parametric models – Expert Judgement – Estimating by analogy – Albrecht FP – FP Mark II - COSMIC FFP – COCOMO II.		
Unit - III	**Activity Planning**	**9**
Objectives – Project Schedule – Projects and Activities – Sequencing and Scheduling Activities –Network Planning Models – Formulation –Time dimension - Forward Pass – Backward Pass – Identifying the critical path - Activity Float – Shortening Project Duration – Identifying critical activities – Activity on Arrow Networks. Risk Management: Risk – Categories of Risk – Framework – Risk Identification – Risk Assessment – Risk Planning – Risk management – Applying PERT Technique – Monte Carlo Simulation – Critical chain concepts.		
Unit - IV	**Monitoring and Control**	**9**
Creating Framework – Collecting The Data – Review - Visualizing Progress – Cost Monitoring – Earned Value Analysis – Prioritizing Monitoring – Getting Project Back To Target – Change Control. Managing Contracts: Introduction – Types of Contract – Stages In Contract Placement – Typical Terms of A Contract – Contract Management – Acceptance.		
Unit - V	**Managing People**	**9**
Introduction – Understanding Behaviour – Organizational Behaviour: A Background – Selecting The Right Person For The Job – Instruction in the best methods – Motivation – The Oldham–Hackman Job Characteristics Model – Stress –Health and Safety. Working in Teams: Introduction – Becoming A Team –Decision Making– Organizational & Team Structures – Coordination Dependencies – Dispersed and virtual teams – Communication Generes – Communication Plans – Leadership.		

Lecture:45, Total:45

TEXT BOOKS:

1. Bob Hughes, Mike Cotterell and Rajib Mall, “Software Project Management”, 6th Edition, Tata McGraw Hill, New Delhi, 2017. for Unit I, II, III, IV and V.
2. Pankaj Jalote, “Software Project Management in Practice”, 8th Edition, Pearson, 2002.
3. Watts S. Humphrey, “PSP: A self-improvement process for software engineers”, 1stEdition, Addison-Wesley, 2005.

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	make use of process of software project management and apply evaluation technique to choose best project.	Applying (K3)
CO2	prepare the project plan and calculate the efforts required.	Applying (K3)
CO3	plan, schedule and sequence the activities and determine the risks.	Applying (K3)
CO4	develop visualization charts to monitor the progress of projects and to control the risks involved.	Applying (K3)
CO5	apply the methods of managing people and organising teams while developing a software project.	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	3	2	1										3	1
CO2	3	2	1										3	1
CO3	3	2	1										3	1
CO4	3	2	1										3	1
CO5	3	2	1										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	20	35	45				100
CAT2	20	45	35				100
CAT3	20	35	45				100
ESE	10	45	45				100

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

CYBER FORENSICS
(Common to AI & DS and AI & ML branches)

Programme& Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	8	PE	3	0	0	3

Preamble	This course imparts fundamental principles and techniques for digital forensics investigation and security management.	
Unit - I	**Computer Forensics and Investigations**	**9**
Understanding computer forensics - Preparing Computer investigations – Taking a systematic approach –Assessing the case – Planning Investigation – Securing evidence– Procedures for Corporate High-Tech investigations – Conducting an Investigation – Completing the case.		
Unit - II	**Data Acquisition**	**9**
Understanding storage formats for digital evidence – Determining the best acquisition method - Contingency planning for image acquisitions – Using Acquisition tools: Windows XP Write-protection with USB Devices – Validating Data Acquisitions: Windows Validation Methods – Performing RAID Data Acquisitions – Using Remote Network Acquisition tools – Using other Forensics Acquisition tools.		
Unit - III	**Processing Crime and Incident Scenes**	**9**
Identifying Digital Evidence – Collecting Evidence in Private Sector Incident Scenes –Processing Law Enforcement Crime Scenes – Preparing for a Search –Securing a Computer Incident or Crime Scene –Seizing Digital Evidence at the Scene –Storing Digital Evidence –Obtaining a Digital Hash –Reviewing a Case.		
Unit - IV	**Computer Forensics Tools, Analysis and Validation**	**9**
Evaluating Computer Forensics Tool Needs –Computer Forensics Software Tools – Computer Forensics Hardware Tools – Validating and Testing Forensic Software – Computer Forensics Analysis and Validation: Determining Data Collection and Analysis –Validating Forensic Data –Addressing Data-Hiding Techniques –Performing Remote Acquisitions.		
Unit - V	**Recovering Graphics Files, Email Investigations**	**9**
Recognizing a Graphics File– Understanding Data Compression – Locating And Recovering Graphic Files- Identifying Unknown File Formats– Understanding Copyright Issues –Investigating Email Crimes And Violations- Understanding Email Servers– Using Specialized Email Forensics Tools.		

Lecture:45, Total:45

TEXT BOOK:

1.	Nelson Bill, Phillips Amelia and Steuart Christopher, “Guide to Computer Forensics and Investigations”, 3rd Edition, Cengage Learning, 2017. for Unit I, II, III, IV and V.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	apply systematic approach for digital forensic investigation	Applying (K3)
CO2	carry out acquisition of data using various tools	Applying (K3)
CO3	determine the seizure of digital evidence in a crime scene	Applying (K3)
CO4	make use of forensic tools in forensic examination	Applying (K3)
CO5	carry out investigationusing E-mail and graphic files	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	3	2	1										3	1
CO2	3	2	1										3	1
CO3	3	2	1										3	1
CO4	3	2	1										3	1
CO5	3	3	1										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	15	35	50				100
CAT2	15	35	50				100
CAT3	15	35	50				100
ESE	10	40	50				100

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

AGILE METHODOLOGIES FOR SOFTWARE DEVELOPMENT
(Common to AI & DS and AI & ML branches)

Pogramme& Branch	B.Tech. & Artificial Intelligence and Machine Learning	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	8	PE	3	0	0	3

Preamble	This course introduces agile methodologies such as Scrum, Extreme Programming (XP), Lean, and Kanban.	
Unit - I	**Agile Principles:**	**9**
Understanding the Agile Values – Silver Bullet Methodology – Agile to the Rescue – A fractured perspective - Agile Manifesto and Purpose behind each practice – Agile Elephant – Where to start with a new Methodology – 12 principles of Agile Software – The Customer is always Right – Delivering the project – Communicating and Working Together – Project Execution – Constantly improving the project and the team – Agile Project.		
Unit - II	**Scrum and Self-Organizing Teams:**	**9**
Basic pattern for a Scrum Project – Rules of Scrum – Command-and-Control Team – Self-Organizing Teams - Scrum Values – Daily Scrum – Sprints, Planning and Retrospectives.		
Unit - III	**Scrum Planning and Collective Commitment:**	**9**
User stories – Conditions of Satisfaction – Story Points and Velocity – Burndown Charts – Planning and Running a Sprint – GASP – Scrum Values Revisited – Practices Do Work Without the Values – Company Culture Compatible with Scrum Values.		
Unit - IV	**XP and Incremental Design:**	**9**
Primary Practices of XP – The XP values help the team change their mindset – An effective mindset starts with the XP values – Understanding the XP principles – Feedback Loops – Code and Design – Make Code and Design Decisions at the Last Responsible Moments – Incremental Design and the Holistic XP.		
Unit - V	**Lean, Kanban and Agile Coach:**	**9**
Lean Thinking – Commitment, Options Thinking and Set Based Development – Create Heroes and Magical Thinking – Eliminate Waste – Value Stream Map – Deliver As Fast As Possible – WIP Area Chart – Pull Systems – The Principles of Kanban – Improving Your Process with Kanban – Measure and Manage Flow – Little's Law – Emergent Behavior with Kanban – The Agile Coach – Shuhari - The Principles of Coaching. .		

Lecture:45; Total 45

TEXT BOOK:

1.	Andrew Stellman and Jennifer Greene, "Learning Agile: Understanding Scrum, XP, Lean and Kanban", First Edition, O'Reilly Media Inc, 2015. for Unit I, II, III, IV and V.

REFERENCES

1.	Eric Brechner, "Agile Project Management with Kanban", First Edition, Microsoft Press, 2015.
2.	Robert C. Martin, "Agile Software Development: Principles, Patterns, and Practices", Pearson Prentice Hall, 2011.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	outline the purpose of agile's core principles and apply for project development	Applying (K3)
CO2	utilize the scrum's emphasis on project management and self-organization	Applying (K3)
CO3	experiment with practices like user stories, story points, project velocity and visualization tools	Applying (K3)
CO4	model applications using XP practices and incremental design	Applying (K3)
CO5	make use of Lean thinking to empower a team, eliminate waste, and deliver software fast and learn how Kanban's practices help deliver great software by managing flow	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	3	2	1						1	1	1		3	2
CO2	3	2	1						1	1	1		3	2
CO3	3	2	1						1	1	1		3	2
CO4	3	2	1						1	1	1		2	2
CO5	3	2	1						1	1	1		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 %**
CAT 1-50 marks	30	40	30				100
CAT 2-50 marks	10	50	40				100
CAT 3-50 marks	25	45	30				100
ESE -100 marks	20	40	40				100

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

OPEN ELECTIVE

BUSINESS INTELLIGENCE

Programme& Branch	BE/BTech All branches except AI&ML and AI&DS	Sem.	Category	L	T	P	Credit
Prerequisites	NIL	4	OE	3	1	0	4

Preamble	This course focuses on learners to apply the business intelligence concepts and techniques to various applications for making better decisions	
Unit - I	**Business View of Information Technology Applications:**	**9+3**
Core Business Processes – Baldrige Business Excellence Framework – Purpose of using IT in Business – Characteristics of Internet-ready IT Applications – Enterprise Applications – Information users and their requirements. Case Study: GoodLife HealthCare Group, Good Food Restaurants Inc, Ten To Ten Retail Stores. Types of Digital Data: Introduction – Structured Data – Unstructured Data – Semi-Structured Data – Difference between semi-structured and structured data.		
Unit - II	**Business Intelligence and Data Integration:**	**9+3**
Business Intelligence: Definition – Evolution – Need for BI – BI Value Chain – Business Analytics –BI Framework – BI Users – BI Applications – BI Roles and Responsibilities – Data Integration : Need for Data Warehouse – Definition of Data Warehouse – Data mart – Ralph Kimbal's Approach vs. W.H.Inmon's Approach – Goals of Data Warehouse –ETL Process – Data Integration Technologies – Data Quality – Data Profiling.		
Unit - III	**OLTP, OLAP and Multidimensional Data Modeling:**	**9+3**
OLTP – OLAP – OLAP Architectures – Data Models – Role of OLAP Tools in BI –OLAP Operations –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.		
Unit - IV	**Performance Management and Enterprise Reporting:**	**9+3**
Understanding Measures and Performance – Measurement System – Role of metrics –KPIs – Enterprise Reporting: Reporting Perspectives – Report Standardization and Presentation Practices – Enterprise Reporting Characteristics – Balanced Scorecard – Dashboards –Creating Dashboards – Scorecards vs. Dashboards – Analysis.		
Unit - V	**Role of Statistics in Analytics and BI Applications:**	**9+3**
Role of Statistics in Analytics –Data Description and Summarization – Statistical Test – Application of Analysis in Industries. BI Applications: Understanding Business Intelligence and Mobility – Business Intelligence and Cloud Computing –Business Intelligence for ERP systems – Social CRM and Business Intelligence.		

Lecture: 45; Tutorial: 15; Total: 60

TEXT BOOK:

1. Prasad R.N. and Seema Acharya, "Fundamentals of Business Analytics", 2nd Edition, Wiley-India Publication, 2016. (Units I,II,III,IV,V)

REFERENCES

1. Ramesh Sharda, DursunDelen and Efraim Turban, "Business Intelligence, Analytics, and Data Science: A Managerial Perspective", 4th Edition, Pearson Education, 2017.

	COURSE OUTCOMES: On completion of the course, the students will be able to	**BT Mapped (Highest Level)**
CO1	demonstrate the enterprise view of IT applications and identify the different types of digital data	Applying (K3)
CO2	make use of BI concepts and techniques to experiment ETL process	Applying (K3)
CO3	compare OLTP with OLAP systems and design dimensional model	Applying (K3)
CO4	apply different software design techniques for a given problem	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	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1											
CO2	3	2	1											
CO3	3	2	1											
CO4	3	2	1											
CO5	3	2	1											

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

ASSESSMENT PATTERN - THEORY

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

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

DATA EXPLORATION AND VISUALIZATION TECHNIQUES

Programme& Branch	BE/BTech All branches except AI&ML and AI&DS	Sem.	Category	L	T	P	Credit
Prerequisites	Python Programming	**5**	**OE**	**3**	**0**	**2**	**4**

Preamble	To provide practical exposure to Python Programming frameworks required for visualizing various types of data	
Unit - I	**Data visualization in business intelligence**	**9**
Importance of data visualization – need for data visualization – visualization in business decision making – Data visualization techniques and libraries – data gathering and cleaning: cleaning data – reading data – merging and integrating – reading data from JSON, HTML, XML format.		
Unit - II	**Data Exploring and Analysis**	**9**
Data collection structures: series – data frames – panels - Series data structures – Data frame data structure – data analysis: Statistical Analysis – Data grouping – Iterating through groups – Aggregations – Transformations - Filtration		
Unit - III	**Data visualization techniques**	
Direct plotting: line plot – bar plot – pie chart – box plot – histogram plot – scatter plot – seaborn plotting system:strip plot – box plot – swarm plot – joint plot – Matplotlib plot: Line plot – bar chart - histogram plot – scatter plot – stack plot – pie chart.		
Unit - IV	**Time series analysis**	
Data and time data types and tools – time conversion - time series basics – data ranges, frequencies and shifting – time zone handling - periods and period arithmetic – Resampling and frequency conversion – Moving Window functions		
Unit - V	**Categorical Data Analysis and Modeling Libraries**	
Categorical data – advanced groupby – Techniques for method chaining – Interfacing between pandas and model code – Creating model descriptions with Patsy - statsmodel		

List of Exercises / Experiments:

1.	Load data in different formats and apply preprocessing
2.	Perform grouping aggregating and transforming operations on data
3.	Design different types of using direct plotting methods
4.	Create different types of plots using Matplolib
5.	Design different types of plot using Seaborn
6.	Demonstrate time series operations
7.	Visualize categorical data and perform operations on it
8.	Apply data transformations using Patsy

Lecture: 45; Practical: 30; Total: 75

TEXT BOOKS:

1.	Dr. Ossama Embarak, " Data Analysis and Visualization using Python ", APress, 2018 (Units : I, II and III)
2.	Wes McKinney, "Python for Data Analysis", 2nd Edition, Or'reilly, 2018 (Units IV and V)

REFERENCES:

1.	Daniel Nelson. Data Visualization in Python, 1st edition, StackAbuse, 2020.
2	Jake Vander Plas, "Python Data Science Handbook Essential Tools for Working with Data", 1stEdition, O'Reilly Media, 2016.

REFERENCES/MANUAL/SOFTWARE:

1.	Python, Matplotlib, Seaborn, Plotly
2.	Linux / Windows
3.	Lab manual

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	explore the concepts of data visualization and decision making using different formats	Applying (K3)
CO2:	make use of the features of data frames, panels and series data structure to analyze data	Applying (K3)
CO3:	apply the plotting techniques for efficient data visualization	Applying (K3)
CO4:	perform time series data analysis using appropriate methods	Applying (K3)
CO5:	apply suitable techniques to analyze categorical data and use libraries for modeling the data	Applying (K3)
CO6:	perform data preprocessing and transformation operations	Applying (K3) Precision (S3)
CO7:	explore various plotting to interpret various visualizations	Applying (K3) Precision (S3)
CO8:	demonstrate the use of Patsy for modeling and analyze categorical data.	Applying (K3) 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	2	1											
CO2	3	2	1											
CO3	3	2	1											
CO4	3	2	1											
CO5	3	2	1											
CO6	3	2	2	2	3									
CO7	3	2	2	2	3									
CO8	3	2	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 %
CAT 1	15	30	55				100
CAT 2	15	30	55				100
CAT 3	15	30	55				100
ESE	15	30	55				100

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

INDUSTRIAL MACHINE LEARNING

Programme & Branch	BE/BTech All branches except AI&ML and AI&DS	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	6	OE	3	0	0	3

Preamble	The course helps the students to understand and apply various machine learning algorithms in industrial applications.	
Unit - I	**Introduction:**	**9**
The Fourth Industrial Revolution: Introduction – Industry Smartization – Machine Learning Challenges and Opportunities within Smart Industries – Applications: Energy Sector – Basic Materials Sector – Industrials Sector – Customer Services Sector – Healthcare Sector – Customer Goods Sector – Telecommunications Sector – Utilities Sector – Financial services Sector – Information Technology Sector.		
Unit - II	**Component-Level Case Study:**	**9**
Introduction – Ball Bearing Prognostics: Data-Driven Techniques – PRONOSTIA Testbed – Feature Extraction from Vibration Signals – Hidden Markov Model-Based RUL Estimation: Hidden Markov Model Construction – RUL Results – Interpretation of the Degradation model.		
Unit - III	**Machine-Level Case Study:**	**9**
Introduction – Performance of Industrial Motors as a Fingerprint: Improving Reliability Models with Fingerprints – Industrial Internet Consortium Testbed – Testbed Dataset Description – Clustering Algorithms for Fingerprint Development: Agglomerative Hierarchical Clustering – K-means Clustering – Spectral Clustering – Affinity Propagation – Gaussian Mixture Model Clustering – Implementation Details.		
Unit - IV	**Production-Level Case Study:**	**9**
Introduction – Laser Surface Heat Treatment: Image Acquisition – Response Time Requirement – Anomaly Detection-Based AVI System: Anomaly Detection Algorithms in Image Processing – Proposed Methodology – Performance of the AVI System – Interpretation of the Normality Model.		
Unit - V	**Distribution-Level Case Study:**	**9**
Introduction – Air Freight Process: Data Preprocessing – Supervised Classification Algorithms for Forecasting: k-Nearest Neighbors – Classification Trees – Rule Induction – Artificial Neural Networks – Support Vector Machines – Logistic Regression – Bayesian Network Classifiers –.Metaclassifiers – Implementation.		

Lecture: 45; Total:45

TEXT BOOK:

1. Pedro Larranaga, David Atienza,Javier Diaz-Rozo, Alberto Ogbechie, Carlos Esteban Puerto-Santana, Concha Bielza, "Industrial Applications of Machine Learning", 1st Edition, CRC Press, 2019. (Units I,II,III,IV,V)

REFERENCE:

1. Andreas François Vermeulen," Industrial Machine Learning: Using Artificial Intelligence as a Transformational Disruptor", 1st Editrion, Apress, 2020.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand and apply machine learning concepts in various industry applications	Applying (K3)
CO2	use Hidden Markov models for handling industrial data	Applying (K3)
CO3	apply various clustering techniques in solving industry problems	Applying (K3)
CO4	make use of anomaly prediction algorithms in industrial image processing	Applying (K3)
CO5	apply classification algorithms for industrial forecasting	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	3	2	2											
CO2	3	2	2											
CO3	3	2	2											
CO4	3	2	2											
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	10	50	40				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)**

MACHINE LEARNING FOR SMART CITIES

Programme& Branch	BE/BTech All branches except AI&ML and AI&DS	Sem.	Category	L	T	P	Credit
Prerequisites	Nil	8	OE	3	0	0	3

Preamble	This course provides working principles of Sensors, UAV's, Geriatric Design and IoT Enabled Homes and applying machine learning for Smart Cities.	
Unit - I	**Machine Learning for Sustainable and Resilient Buildings:**	**9**
Introduction – Sustainability and Resiliency Conditions – Paradigm and challenges of Sustainability and Resilience – Sustainability and Resilience of Engineered System – Structure Engineering Dilemmas and Resilient Epcot – Smart Building Appliances – Intelligent Tools (SRB) – Component of Smart Buildings – Machine Learning Tasks – ML Tools and Services – Big Data Application in SB.		
Unit - II	**Sensors and UAV's:**	**9**
Introduction – Sensors – Unmanned Aerial Vehicle – Bluetooth – Problem Description – Univariate Time series – Multivariate Time Series – Hidden Markov Model – Fuzzy Logic.		
Unit - III	**Data Fusion Approaches:**	**9**
Introduction to Data Fusion – Types of Data Fusion Architecture – Centralized Architecture – Decentralized Architecture – Distributed Architecture – Hierarchical Architecture – Case Study –Smart City Infrastructure – IoT Deployments – Smart City Control and Management Centers – Theory of Unified City Modeling – Smart City Operational Model.		
Unit - IV	**Geriatric Design and IoT Enabled Smart Homes:**	**9**
Introduction to Geriatric Design – Background – Development of Smart Homes – Development of Smart Homes for Elderly – Indian Scenario –Geriatric Smart Home Requirements – Design – Framework for Smart homes –Architectural Interventions – Case study : Schematic Design for a Nesting Home – IoT Based Real Time Automation – Technical Components of Smart Home.		
Unit - V	**Impact of IoT Enabled Smart Cities:**	**9**
Recent Development in IoT Application for Modern City – Classification of IoT based Smart Cities – Impact of 5G Technology – IoT Five Layer Architecture – IoT Computing Paradigm – Research Advancement and Drawbacks – Integration of Cloud Computing – Integration of Applications – System Security – Research Challenges and Guidelines.		

Lecture: 45, Total: 45

TEXT BOOK:

1. Adarsh Kumar, Anand Nayyar, Arun Solanki, "Digital Cities Road map IoT-Based Architecture and Sustainable Buildings", First Edition, Wiley, 2021.(Units - I,II,III,IV,V)

COURSE OUTCOMES: On completion of the course, the students will be able to		BT Mapped (Highest Level)
CO1	interpret the machine learning concepts for sustainable and resilient buildings	Applying(K3)
CO2	demonstrate the concept of sensors and time series data	Applying (K3)
CO3	explore data fusion approach	Applying (K3)
CO4	develop Geriatric design on IoT enabled homes	Applying (K3)
CO5	study the impact of IoT enabled smart cities	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	3	2	2											
CO2	3	2	2											
CO3	3	2	2											
CO4	3	2	2											
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	10	40	50				100

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

Honors in Internet of Things

INTRODUCTION TO IOT

Programme & Branch	BTech. & Artificial Intelligence and Data Science	Sem.	Category	L	T	P	Credit
Prerequisites	NIL			3	0	0	3

Preamble	This course provides insights about the basics of networking, network security, precursor technologies of IoT and the emergence of IoT. It gives an overview of various connectivity technologies prevalent in the field. It also focuses on various challenges of IoT and real-time IoT case studies.	
Unit - I	**Basics of Networking and Security**	**9**
Basics of Networking: Introduction - Network Types - Layered Network Models – Addressing - TCP/IP Transport layer. Basics of Network Security: Introduction – Security - Network Confidentiality – Cryptography - Message Integrity and Authenticity - Key Management - Internet Security – Firewall.		
Unit - II	**Predecessors and Emergence of IoT**	**9**
Predecessors of IoT: Introduction - Wireless Sensor Networks - Machine-to-Machine Communications - Cyber Physical Systems. Emergence of IoT: Introduction - Evolution of IoT - Enabling IoT and the Complex Interdependence of Technologies - IoT Networking Components - Addressing Strategies in IoT. IoT Sensing: Introduction – Sensors - Sensor Characteristics - Sensorial Deviations - Sensing Types - Sensing Considerations		
Unit - III	**IoT Actuators and Topologies:**	**9**
IoT Actuators: Actuator Types - Actuator Characteristics. IoT Processing Topologies and Types: Data Format - Importance of Processing in IoT - Processing Topologies - IoT Device Design and Selection Considerations - Processing Offloading. IoT Connectivity Technologies		
Unit - IV	**Cloud Computing and Fog Computing**	**9**
Cloud Computing: Introduction – Virtualization - Cloud Models - Service-Level Agreement in Cloud Computing - Cloud Implementation - Sensor-Cloud: Sensors-as-a-Service. Fog Computing and Its Applications: Introduction - View of a Fog Computing Architecture - Fog Computing in IoT - Selected Applications of Fog Computing.		
Unit - V	**IoT Paradigms and Case Studies**	**9**
Paradigms, Challenges, and the Future: Evolution of New IoT Paradigms - Challenges Associated with IoT - Emerging Pillars of IoT. IoT case studies: Agricultural IoT - Vehicular IoT - Healthcare IoT		

Lecture:45, Total: 45

TEXT BOOK:

1. Sudip Misra, Anandarup Mukherjee, Arijit Roy. “Introduction to IoT”. Cambridge University Press, 1st edition, United Kingdom, 2021.

REFERENCES:

1. Cuno Pfister. “Getting Started with the Internet of Things: Connecting Sensors and Microcontrollers to the Cloud”. Make Community, LLC, 1st edition, United States, 2011.
2. Vlasios Tsiatsis, Stamatis Karnouskos, Jan Holler, David Boyle, Catherine Mulligan. “The Internet of Things - Technologies and Applications for a New Age of Intelligence”. Academic Press, 2nd Edition, United States, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	recall the networking fundamentals and its security concepts	Understanding (K2)
CO2	emphasize the importance of IoT fundamentals and IoT sensors	Understanding (K2)
CO3	explain the IoT Actuators and IoT Processing Topologies	Understanding (K2)
CO4	investigate the Cloud computing and Fog computing technologies	Applying (K3)
CO5	examine the IoT Paradigms, Challenges and Case Studies	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	3	2	1	1									3	1
CO2	3	2	1	1									3	1
CO3	3	2	1	1									3	1
CO4	3	2	1	1									3	1
CO5	3	2	1	1									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	45	55					100
CAT2	35	65					100
CAT3	20	55	25				100
ESE	20	55	25				100

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

IOT ARCHITECTURE AND ITS PROTOCOLS

Programme & Branch	BTech. & Artificial Intelligence and Data Science	Sem.	Category	L	T	P	Credit
Prerequisites	Introduction to IOT			3	0	0	3

Preamble	This course provides a high-level overview of IoT, IoT architecture and IoT applications. Further it discusses about DNA of IoT, Protocols for IoT and IoT communication technologies	
Unit - I	**Introduction**	**9**
Introduction: Genesis of IoT - IoT and Digitization - IoT Impact - Convergence of IT and OT - IoT Challenges. IoT Network Architecture and Design: Drivers Behind New Network Architectures - Comparing IoT Architectures - A Simplified IoT Architecture - The Core IoT Functional Stack - IoT Data Management and Compute Stack.		
Unit - II	**IoT Applications and Four Pillars**	**9**
Ubiquitous IoT Applications: A Panoramic View of IoT Applications - Important Vertical IoT Applications. Four Pillars of IoT: The Horizontal, Verticals, and Four Pillars - M2M: The Internet of Devices - RFID: The Internet of Objects - WSN: The Internet of Transducers - SCADA: The Internet of Controllers.		
Unit - III	**DNA and Middleware of IoT**	**9**
The DNA of IoT: DCM: Device, Connect, and Manage - Device: Things That Talk - Connect: Via Pervasive Networks - Manage: To Create New Business Value. Middleware and IoT: An Overview of Middleware - Communication Middleware for IoT - LBS and Surveillance Middleware		
Unit - IV	**Protocol standards for IoT and WoT**	**9**
Protocol Standardization for IoT: Web of Things versus Internet of Things - IoT Protocol Standardization Efforts - Unified Data Standards. Architecture Standardization for WoT: Platform Middleware for WoT - Unified Multitier WoT Architecture - WoT Portals and Business Intelligence - Challenges of IoT Information Security		
Unit - V	**IoT Communication Technologies**	**9**
IoT Communication Technologies: Introduction - Infrastructure Protocols - Discovery Protocols - Data Protocols - Identification Protocols - Device Management - Semantic Protocols. IoT Interoperability: Introduction – Standards – Frameworks.		

Lecture:45, Total: 45

TEXT BOOKS:

1. David Hanes, Gonzalo Salgueiro,, Robert Barton, Jerome Henry. “IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things”. Cisco Press, 1st Edition, USA, 2017. (Unit-1)
2. Honbo Zhou, “The Internet of Things in the Cloud: A Middleware Perspective”, CRC Press, 1st edition, New York, 2013. (Unit-2,3,4)
3. Sudip Misra, Anandarup Mukherjee, Arijit Roy. “Introduction to IoT”. Cambridge University Press, 1st edition, United Kingdom, 2021.(Unit-5)

REFERENCES:

1. Cuno Pfister. “Getting Started with the Internet of Things: Connecting Sensors and Microcontrollers to the Cloud”. Make Community, LLC, 1st edition, United States, 2011.
2. Vlasios Tsiatsis, Stamatis Karnouskos, Jan Holler, David Boyle, Catherine Mulligan. “The Internet of Things - Technologies and Applications for a New Age of Intelligence”. Academic Press, 2nd Edition, United States, 2018.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explains the IoT Network Architecture and Design	Understanding (K2)
CO2	interpret the Pillars of IoT and IoT applications	Understanding (K2)
CO3	describe the technological aspects of the DCM layers of the IoT value chain and IoT middleware	Understanding (K2)
CO4	examine the possibility of creating a unified IoT middleware architecture based on existing protocol standard	Understanding (K2)
CO5	determine the requirements associated with IoT communication protocols in real-world solutions	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	3	2	1	1									3	1
CO2	3	2	1	1									3	1
CO3	3	2	1	1									3	1
CO4	3	2	1	1									3	1
CO5	3	2	1	1									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	45	55					100
CAT2	35	65					100
CAT3	20	55	25				100
ESE	20	55	25				100

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

COGNITIVE IOT

Programme & Branch	BTech. & Artificial Intelligence and Data Science	Sem.	Category	L	T	P	Credit
Prerequisites				3	0	0	3

Preamble	To impart the knowledge ofcognitive Internet of Things in various domains	
Unit – I	**Introduction**	**9**
Introduction to Cognitive Device - Cognitive Devices as Human Assistants - Cognitive Things in an Organization - Reuse and Monetization -Intelligent Observations – Organization of Knowledge and Problem-Solving		
Unit - II	**Architecture and Interfaces**	**9**
Installation, Training, Maintenance, Security and Infrastructure - Machine-to-Machine Interfaces - Man-to-Machine Interfaces - Assisting in Human Communications.		
Unit - III	Cognitive IoT Paradigm	**9**
Describing the Cognitive IoT Paradigm - Demystifying the Cognitive Computing Paradigm – Basics of Cloud computing - The Cognitive IoT: The Platforms, Technologies, and their Use cases - Delineating the Key Capabilities of Cognitive Cloud Environments.		
Unit - IV		**9**
Machine Learning (ML) Algorithms for enabling the Cognitive Internet of Things (CIoT) - Unsupervised and Semi-Supervised Machine Learning Algorithms for Cognitive IoT Systems - Deep Learning Algorithms for Cognitive IoTSolutions - Computer Vision (CV) Technologies and Tools for Vision-based Cognitive IoT Systems.		
Unit - V		**9**
Natural Language Processing (NLP) Methods for Cognitive IoT Systems - Design of a Secure Infrastructure for Cognitive IoT platforms and Applications - Revolutionizing Manufacturing using Cognitive IoT Technologies - Edge AI – Consumer, Social and Industry Use Cases		

Lecture:45, Total: 45

TEXT BOOKS:

1	Arvind Sathi. Cognitive (Internet of) Things. Palgrave Macmillan, 1st edition, 2016 (Units I, II)
2.	Pethuru Raj, Anupama C. Raman, Harihara Subramanian. Cognitive Internet of Things Enabling Technologies, Platforms, and Use Cases.Auerbach Publications, 1st edition, 2022 (Units III , IV, V)

REFERENCES:

1	ArshdeepBahga and Vijay Madisetti, Cloud Computing: A Hands-on Approach, 1st edition, CreateSpace Independent Publishing Platform, 2013.
2.	Alessandro Bassi, Martin Bauer, Martin Fiedler, Thorsten Kramp, Rob van Kranenburg, Sebastian Lange and Stefan Meissner, Enabling things to talk –Designing IoT solutions with the IoT Architecture Reference Model, 1st edition ,Springer Open, 2016.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	gain insights of cognitive devices and their applications	Understanding (K2)
CO2:	understand different types of interfaces and organizations in cognitive things	Understanding (K2)
CO3:	develop knowledge on significance of Cognitive IoT	Understanding (K2)
CO4:	implement different computational intelligent techniques for Cognitive IoT	Applying (K3)
CO5:	design cognitive IoT architectures using advanced methods	Understanding (K2)

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	2
CO2	3	3	2		2								3	2
CO3	3	2	3		3								3	3
CO4	3	2	3		3								3	3
CO5	3	2	2		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 %
CAT 1	40	45	15				100
CAT 2	40	45	15				100
CAT 3	40	45	15				100
ESE	40	45	15				100

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

INDUSTRIAL AND MEDICAL IOT

Programme & Branch	BTech. & Artificial Intelligence and Data Science	Sem.	Category	L	T	P	Credit
Prerequisites	Nil			3	0	0	3

Preamble	This course deals with introduction to Industrial and medical IoT and how IoMT is used to for remote healthcare	
Unit - I	**Industrial IoT**	**9**
Introduction to IoT- key technologies- I-IoT- IoT Analytics and AI- Industrial process – CIM pyramid architecture -devices and networks- I-IoT data Flow		
Unit - II	**Industrial Data Flow**	**9**
I-IoT dataflow-Industrial protocols-Supervisory control and Data Acquisition-Discovering OPC-Understanding I-IoT Edge-Implementing I-IoT dataflow-OPC UA Simulation server-		
Unit - III	**Implementing I-IoT**	**9**
Developing Industrial I-IoT and Architecture-Implementing custom Industrial IoT Platform -Implementing a cloud Industrial IoT solution with AWS		
Unit - IV	**Internet of Medical things**	**9**
Introduction-IoMT- IoMT Medical Devices- Remote Patient monitoring- privacy of IoT -based health records - remote Health Care: wearable smart devices - Communication technologies		
Unit - V	**IoMT Applications**	**9**
Smart Assistance for Elderly Individuals -Parkinson's Disease handling using IoMT- Machine Learning with IoMT		

Lecture:45, Total: 45

TEXT BOOK:

1.	Giacomo Veneri,Antonio Capsso, "Hands-On Industrial Internet of Things: Create a powerful Industrial IoT infrastructure using Industry 4.0,Packt Publishing Ltd, 1st edition,2018
2.	D.Jude Hemanth,J.Anitha,George A. Tsihrintzis "Internet of Medical things- remote healthcare systems and applications", Springer, 1st edition, 2021.

REFERENCES:

1.	Ismail Butun,"Industrial IoT Challenges, Design Principles, Applications, and Security", Springer Publications,1st edition, 2020.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand the basic concepts of Industrial IoT	Understanding (K2)
CO2	explain the principles of Industrial Data Flow	Understanding (K2)
CO3	explore different aspects of implementing I-IoT	Understanding (K2)
CO4	implement the concepts of Internet of Medical things	Applying(K3)
CO5	demonstrate various IoMT Applications	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	3	2	2		2								3	2
CO2	3	2	2		2								3	2
CO3	3	2	2		2								3	2
CO4	3	2	2		3								3	2
CO5	3	2	2		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	50	50					100
CAT2	20	50	30				100
CAT3	20	50	30				100
ESE	20	50	30				100

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

IOT AND MACHINE LEARNING

Programme & Branch	BTech. & Artificial Intelligence and Data Science	Sem.	Category	L	T	P	Credit
Prerequisites	Nil			3	0	0	3

Preamble	To impart knowledge on various mechanisms of integrating IoT devices and Machine Learning algorithms	
Unit – I	**Introduction**	**9**
Infusion of AI and data science in IoT - Data Access and Distributed Processing for IoT :txt, csv,xlsx,json,HDF5,SQL, NoSQL, HDFS. Edge Computing on IoT Devices - Distributed Machine Learning - Machine Learning Accelerator - Machine Learning Model Optimization.		
Unit - II	**Machine Learning for IoT**	**9**
Prediction using linear regression - Logistic regression for classification - Ensemble learning - Improving machine learning model		
Unit - III	**Deep Learning for IoT**	**9**
Introduction to Deep learning - Multilayered perceptrons for regression and classification - Convolutional neural networks - Recurrent neural networks – Autoencoders		
Unit - IV	**Genetic Algorithms for IoT Optimization**	**9**
Deterministic and analytic methods - Natural optimization methods- Introduction to genetic algorithms - Coding genetic algorithms using Distributed Evolutionary Algorithms in Python - Reinforcement Learning for IoT		
Unit - V	**Advanced models for IoT**	**9**
Generative Models for IoT - Distributed AI for IoT - AI for the Industrial IoT - Processing different types of data - Computing in the cloud		

Lecture:45, Total: 45

TEXT BOOKS:

1. Hantao Huang, Hao Yu. Compact and Fast Machine Learning Accelerator for IoT Devices. Springer, 1st edition, 2019.
2. Amita Kapoor. Hands-On Artificial Intelligence for IoT. Packt Publishing, 1st edition, 2019.

REFERENCES:

1 Shrirang Ambaji Kulkarni, Varadaraj P.Gurupur, Steven L.Fernandes. Introduction to IoT with machine learning and image processing using Raspberry pi. CRC Press, 1st edition, 2020.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1:	describe the basic concepts of IoT and Machine learning	Understanding (K2)
CO2:	implement machine learning algorithms for IoT applications	Applying (K3)
CO3:	describe various Deep Learning algorithms for IoT	Understanding (K2)
CO4:	apply Genetic Algorithms for IoT Optimization	Applying (K3)
CO5:	understand advanced models for IoT	Understanding (K2)

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	2
CO2	3	3	2		2								3	2
CO3	3	2	3		3								3	3
CO4	3	2	3		3								3	3
CO5	3	2	2		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 %
CAT 1	40	50	10				100
CAT 2	40	45	15				100
CAT 3	40	50	10				100
ESE	40	45	15				100

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

PRIVACY AND SECURITY IN IOT

Programme & Branch	BTech. & Artificial Intelligence and Data Science	Sem.	Category	L	T	P	Credit
Prerequisites	Nil			3	0	0	3

Preamble	This syllabus explores issues of privacy and security with regard to the IoT environments, as well as technical solutions to help address them.	
Unit - I	**Attacks and Protection Mechanisms in IoT Devices**	**9**
Introduction-physical attacks in IoT Devices-Profiling Attacks-Real World Attacks-count measures- Remote Attestation- Types of Remote Attestation-remote Attestation-Human Aspects of IoT Security and privacy		
Unit - II	**Defence Mechanisms Against Attacks**	**9**
Introduction - Data Exfiltration- Types-Attack Mechanisms, and Defence Technique- Types of Data Exfiltration-Data Exfiltration Attack Techniques-Data Exfiltration Threats-Counter Data Exfiltration-Mechanisms to Defend Against Physical Data Exfiltration-Threat Scenario-Scenario Execution and Analysis-Discussion		
Unit - III	**Protocol for UAV Remote Identification**	**9**
Introduction- Drone Security - Drone Security in UTM-Security Attacks on Drones -Security Attacks from Drones-Drone Safety-Drone Detection and Classification-Interdiction Technologies-UAV Remote Identification-Authentication Protocol for Remote Identification-Secure Communication Protocol-Security Analysis- Formal Verification		
Unit - IV	**Cyber-Security IoT Infrastructure**	**9**
Cyber-Attacks on IoT Infrastructure – Eavesdropping - Solutions-Network Activity Analysis Solutions-Active Reconnaissance-Solutions-Volumetric Attack -Solutions - Masquerading Attack -Solutions- Access Attack – Solutions-Active Crypto Attack - Solutions - Data Exfiltration- Solutions-Blocking Attack- Solutions-Sleep Deprivation Attack - Solutions Trigger Action Attack-Solutions- Network Behavioral Model of IoTs -Enforcing MUD Profile to Network		
Unit - V	**Security and privacy - Case studies**	**9**
Securing Contemporary eHealth Architectures- Techniques and Methods: Introduction - eHealth- Fog or Edge Computing for eHealth- Cloud Computing for eHealth -Applications of IoT in eHealth- eHealth Threat Landscape-eHealth Threat Model- eHealth IoT Vulnerabilities and Threats-Real-world Attacks-Counter measures. Security and Privacy of Smart Homes- Issues and Solutions :Smart Homes' Security and Privacy-Smart Home Technologies-Privacy Techniques and Mechanisms		

Lecture:45, Total: 45

TEXT BOOK:

1. Ali Ismail Awad, Jemal Abawajy, "Security and Privacy in the Internet of Things -Architectures, Techniques, and Applications", Wiley-IEEE Press, 1st edition ,2018.
2. Fei Hu ,Security and Privacy in Internet of Things (IoTs): Models, Algorithms, and Implementations, CRC Press; 1st edition,2016.

REFERENCES:

1. Zaigham Mahmood, Security, Privacy and Trust in the IoT Environment", Springer ,1st edition2019.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	describe Attacks and Protection Mechanisms in IoT Devices	Understanding (K2)
CO2	explain Defence Mechanisms Against Attacks	Understanding (K2)
CO3	summarize Protocol for UAV Remote Identification	Understanding (K2)
CO4	design Cyber-Security IoT Infrastructure	Understanding (K2)
CO5	implement Security and privacy mechanisms	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	3	2	2										3	2
CO2	3	2	2										3	2
CO3	3	2	2										3	2
CO4	3	2	2										3	2
CO5	3	2	2										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	50	50					100
CAT2	50	50					100
CAT3	20	50	30				100
ESE	20	50	30				100

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

Honors in Block Chain Technology

INTRODUCTION TO BLOCK CHAIN

Programme & Branch	BTech. & Artificial Intelligence and Data Science	Sem.	Category	L	T	P	Credit
Prerequisites	Nil			3	0	0	3

Preamble	This course provides technical fundamentals of Blockchain, and hands on development aspects of Blockchain applications	
Unit - I	**Introduction**	9
Overviw of blockchain – Centralized vs Decentralized Systems – Layers of Blockchain – Importance – Blockchain Uses and Use Cases – Laying the Blockchain Foundation .		
Unit - II	**Working of Blockchain**	**9**
Game Theory – Prisoner"s Dilemma – Byzantine Generals" Problem – The Blockchain – Merkle Trees – Properties of Blockchain Solutions – Blockchain Transactions – Distributed consensus mechanisms – Blockchain applications – Scaling blockchain.		
Unit - III	**Bitcoin and Altcoins**	**9**
History of Bitcoin – bitcoin is volatile – key and address- transactions – blocks – bitcoin network : types of nodes – Network discovery wallets – Altcoins: Introducing Altcoins – alternative currency – acquiring cryptocurrency.		
Unit - IV	**Ethereum and Introduction to Hyperledger**	**9**
Bitcoin to Ethereum – Ethereum Blockchain – Ethereum Smart Contracts – Ethereum Virtual Machine and Code Execution – Ethereum Ecosystem – Swarm – Whisper – DApp – Development components – Hyperledger: Introduction – Projects. Fabric – Sawtooth lake – Iroha – Blockchain explorer – Fabric chaintool – Fabric SDK Py-Corda		
Unit - V	**Blockchain Application Development**	**9**
Decentralized Applications – Blockchain Application Development – Interacting with Bitcoin Blockchain – Sending Transactions – Creating a Smart Contract – Executing Smart Contract Functions – Public vs. Private Blockchains – Decentralized Application Architecture – Building an Ethereum DApp.		

Lecture:45, Total:45

TEXT BOOK:

1. Bikramaditya Singhal, Gautam Dhameja, Priyansu Sekhar Panda, “Beginning Blockchain: A Beginner"s Guide to Building Blockchain Solutions”, APress, 1st Edition, 2018. (Units 1,2,4,5)
2. Brenn Hill, Samanyu Chopra, Paul Valencourt, “Blockchain Quick Reference: A guide to exploring decentralized blockchain application development”, Packt publishing, 1st Edition, 2018.(Unit – 3)

REFERENCES:

1. Elad Elrom,”The Blockchain Developer: A Practical Guide for Designing, Implementing, Publishing, Testing, and Securing Distributed Blockchain-based Projects”, Apress, 2019

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explore the history, background, and theoretical aspects of blockchain and apply in real case scenarios	Applying (K3)
CO2	demonstrate core components and working of blockchain	Applying (K3)
CO3	outline Bitcoin"s technical concepts and apply it for real case scenarios	Applying (K3)
CO4	adapt Ethereum blockchain for different use cases	Applying (K3)
CO5	demonstrate the end-to-end development of a decentralized application	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	3	2	1										2	3
CO2	3	2	1										2	3
CO3	3	2	1										2	3
CO4	3	2	1										2	3
CO5	3	2	1										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	20	30	50				100
CAT2	20	30	50				100
CAT3	20	30	50				100
ESE	10	40	50				100

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

CRYPTOGRAPY

Programme & Branch	BTech. & Artificial Intelligence and Data Science	Sem.	Category	L	T	P	Credit
Prerequisites	**Nil**			**3**	**0**	**0**	**3**

Preamble	This course describes cryptographic algorithms deployed for offering confidentiality, integrity, authentication and non repudiation.	
Unit - I	**Introduction**	9
Computer Security Concepts – The OSI Security Architecture – Security Attacks – services and mechanisms – Model for Network Security – Classical encryption techniques: symmetric cipher model – substitution techniques – transportation techniques - steganography		
Unit - II	**Block ciphers and Data Encryption standard**	**9**
Block cipher Structure – data encryption standard – the strength of DES - DES Example – block cipher design principles – Finite fields: Groups – rings – fields - Advanced encryption standard – Block cipher operation.		
Unit - III	**Asymmetric cipher**	**9**
Public key cryptography and RSA – Other Public key cryptosystems – Diffie-Hellman Key Exchange – Elgamal Cryptographic System – Elliptic Curve Arithmetic – Elliptic Curve Cryptography		
Unit - IV	**Cryptographic Data Integrity Algorithms**	**9**
Cryptographic hash functions – Message authentication codes: Message Authentication Requirements – Message Authentication Functions – Requirements for Message Authentication Codes – Security of MACs – MACs Based on Hash Functions: HMAC – Digital signatures: Elgamal Digital Signature Scheme – Schnorr Digital Signature Scheme – NIST Digital Signature Algorithm – Elliptic Curve Digital Signature Algorithm.		
Unit - V	**Network and Internet Security**	**9**
Network access control and cloud security –Transport level security – Wireless network security – Electronic mail security – IP security – Intruder – Firewalls		

Lecture:45, Total:45

TEXT BOOK:

1. William Stallings, "Cryptography and Network Security", 7th Edition, Pearson Education, 2017. (Unit 1-5)

REFERENCES:

1. Christof Paar and Jan Pelzl, “Understanding Cryptography: A Textbook for Students and Practitioners”, Springer, 2009

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	interpret the basic security architecture and classical symmetric key techniques in cryptography	Applying (K3)
CO2	apply various block ciphers and data encryption standars to solve the problems	Applying (K3)
CO3	make use of various public key cryptography techniques for solving real time problems	Applying (K3)
CO4	explore hashing and digital signature techniques	Applying (K3)
CO5	determine the appropriate security protocols and standards for the given application	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	3	2	1										2	3
CO2	3	2	1										2	3
CO3	3	2	1										2	3
CO4	3	2	1										2	3
CO5	3	2	1										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	20	30	50				100
CAT2	20	30	50				100
CAT3	20	30	50				100
ESE	10	40	50				100

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

BITCOIN TECHNOLOGY

Programme & Branch	BTech. & Artificial Intelligence and Data Science	Sem.	Category	L	T	P	Credit
Prerequisites	Nil			3	0	0	3

Preamble	The course focuses on the basics of Bitcoin technology and various technologies involved.	
Unit - I	**Introduction:**	**9**
Introduction to Bitcoin and How Bitcoin works: Transactions, Blocks, Mining and the Blockchain – Bitcoin Transactions – Constructing a Transaction – Bitcoin Mining – Mining transactions in Blocks – Bitcoin Core: The Reference Implementation – Bitcoin Development Environment – Compiling Bitcoin Core from the Source Code – Running a Bitcoin Core Node – Bitcoin Core API.		
Unit - II	**Keys, Addresses, Wallets and Transactions:**	**9**
Keys, Addresses: Introduction – Bitcoin Addresses – Implementing Keys and Addresses in Python – Advanced Keys and Addresses - Wallets: Wallet Technology Overview – Wallet Technology Details - Transactions: Transactions in Detail – Transaction Outputs and Inputs – Transaction Scripts and Script Language – Digital Signatures (ECDSA) – Bitcoin Addresses, Balances and other Abstractions.		
Unit - III	**Advanced Transactions and Bitcoin Network:**	**9**
Advanced Transactions and Scripting: Multisignature – Pay-to-Script-Hash(P2SH) – Data Recording Output (RETURN) – Timelocks –Scripts with Flow Control - The Bitcoin Network: Peer-to-Peer Network Architecture – Nodes Types and Roles – The Extended Bitcoin and Relay Networks – Network Discovery – Full Nodes – Exchanging “Inventory” – SPV Nodes – Bloom Filters – How SPV Nodes Use Bloom Filters – SPV Nodes and Privacy.		
Unit - IV	**Blockchain and Consensus:**	**9**
The Blockchain: Structure of a Block – Block Header and Identifiers – The Genesis Block – Linking Blocks in the Blockchain – Merkle Trees - Merkle Trees and SPV – Bitcoin’s Test Blockchains - Mining and Consensus: Decentralized Consensus – Independent Verification of Transactions – Mining Nodes – Aggregating Transactions into Blocks – Constructing the Block Header and validating the Block - Assembling and Selecting Chains of Blocks – Mining and the Hashing Race – Consensus Attacks – Changing the Rules.		
Unit - V	**Applications:**	**9**
Bitcoin Security: Security principles – User Security Best Practices – Blockchain Applications: Building Blocks(Primitives) – Applications from Building Blocks – Colored Coins – Counterparty – Payment Channels and State Channels – Routed Payment Channels (Lightning Network).		

Lecture:45, Total: 45

TEXT BOOK:

1. Andreas M. Antonopoulos, “Mastering Bitcoin Programming the Open Blockchain”, Second Edition, O’Reilly Media, Inc., 2017. (Units I to V)

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	understand the Bitcoin basics and use it for creating transactions.	Applying (K3)
CO2	apply the concepts of Keys, Addresses and Wallet for security applications.	Applying (K3)
CO3	develop scripts to provide security in a Bitcoin network.	Applying (K3)
CO4	explore and apply Blockchain technology and Consensus .	Applying (K3)
CO5	apply Blockchain to provide security for real time applications.	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	3	2	1										3	1
CO2	3	2	1										3	1
CO3	3	2	1										3	1
CO4	3	2	1										3	1
CO5	3	2	1										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	15	35	50				100
CAT2	15	35	50				100
CAT3	15	35	50				100
ESE	10	40	50				100

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

BLOCKCHAIN AND CRYPTOCURRENCY TECHNOLOGIES

Programme & Branch	BTech. & Artificial Intelligence and Data Science	Sem.	Category	L	T	P	Credit
Prerequisites	Nil			3	0	0	3

Preamble	To understand blockchain concepts, working functionality and its main application cryptocurrency. which is new global money for the Internet age.	
Unit - I	**Introduction**	**9**
Distributed Database - Two General Problem - Byzantine General problem and Fault Tolerance - Hadoop Distributed File System - Distributed Hash Table - ASIC resistance - Turing Complete - Hash function - Digital Signature - ECDSA, Memory Hard Algorithm - Zero Knowledge Proof		
Unit - II	**Blockchain**	**9**
Blockchain Network - Mining Mechanism - Distributed Consensus - Merkle Patricia Tree - Gas Limit - Transactions and Fee - Anonymity – Reward - Chain Policy - Life of Blockchain application - Soft & Hard Fork - Private and Public blockchain		
Unit - III	**Distributed Consensus**	**9**
Nakamoto consensus - Proof of Work - Proof of Stake - Proof of Burn - Difficulty Level - Sybil Attack - Energy utilization and alternate–Real time Case Study - Play with Go-ethereum		
Unit - IV	**Cryptocurrency**	**9**
History - Distributed Ledger - Bitcoin protocols - Mining strategy and rewards - Ethereum – Construction – DAO - Smart Contract – GHOST – Vulnerability – Attacks – Sidechain–Namecoin – Real time Case Study - Smart Contract Construction		
Unit - V	**Cryptocurrency Regulation**	**9**
Stakeholders - Roots of Bitcoin - Legal Aspects - Cryptocurrency Exchange - Black Market and Global Economy - Hashcash implementation - Toy application using Blockchain - Mining puzzles		

Lecture:45, Total: 45

TEXT BOOK:

1. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, Princeton University Press (July 19, 2016)

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	To know about distributed database	Applying (K3)
CO2	To explore blockchain concept	Applying (K3)
CO3	To understand the concepts of consensus	Applying (K3)
CO4	To learn the basics of cryptocurrency	Applying (K3)
CO5	To utilize cryptocurrency technologies in real time scenarios	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	3	2	1										3	1
CO2	3	2	1										3	1
CO3	3	2	1										3	1
CO4	3	2	1										3	1
CO5	3	2	1										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	15	35	50				100
CAT2	15	35	50				100
CAT3	15	35	50				100
ESE	10	40	50				100

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

BLOCKCHAIN APPLICATION DEVELOPMENT THROUGH SMART CONTRACTS

Programme & Branch	BTech. & Artificial Intelligence and Data Science	Sem.	Category	L	T	P	Credit
Prerequisites	Introduction to Blockchain			3	0	0	3

Preamble	This course enables the students to develop the applications through smart contracts	
Unit - I	**Introduction to Ethereum Blockchain**	**9**
History of Blockchain-Characteristic of a Blockchain: Decentralized Networks-Consensus Protocols-Transaction Processing-Transaction Finality. **Ethereum Fundamentals**: Ether and Gas-Accounts-Contracts-Blocks and Transactions. **Decentralized Applications:** Tokens- Supply Chain -Permanent Records -Evaluating Blockchain for Application		
Unit - II	**Smart contract development**	**9**
Ethereum Clients-Installing MetaMask-Installing Node.js-Installing the Truffle Suite- First Smart Contract Development. **Deploying and Interacting with Contracts:** Contract Compilation and Deployment-Setting Up the UI-Deploying to Ganache-Deploying to Goerli with Parity-Deploying to Rinkeby with Infura.		
Unit – III	**Application Development**	**9**
The Fundraiser Application-Application Overview - Initializing Fundraisers - Editing the Beneficiary-Making Donations-Withdrawing Funds- Fallback Functions. **FundraiserFactory :** Migrating FundraiserFactory -Creating Fundraisers - Viewing Available Fundraisers-Setting Up the UI		
Unit – IV	**Interacting Smart Contracts through Web**	**9**
Web3: Frontend-Web3-Blockchain- Web3 Methods. Connecting the UI to Our Contracts: React -Truffle. **Larger DApp :** Starting with React Truffle Box-React and Material UI-Fundraiser UI		
Unit – V	**Securing Smart Contracts**	**9**
Smart Contract Security- Types of Smart Contract Vulnerabilities: Unprotected Function - Transaction Ordering Dependence - Integer Overflow and Underflow – Reentrancy- Block Gas Limit - Timestamp Dependence. **Contract for an External Audit preparation:** External Auditing - Auditing Companies -Solidified		

Lecture:45, Total:45

TEXT BOOK

1.	Solorio, K., Kanna, R., & Hoover, D. H. Hands-on Smart Contract Development with Solidity and Ethereum: From Fundamentals to Deployment. O'Reilly Media, 2019. Unit -1,2,3,4,5

REFERENCE BOOK

1.	Zand, M., Wu, X. B., & Morris, M. A. Hands-On Smart Contract Development with Hyperledger Fabric V2. O'Reilly Media, 2021.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	explore smart contract fundamentals, ethereum protocol, solidity programming language, ethereum virtual machine.	Applying (K3)
CO2	develop smart contract using solidity and Interacting with Contracts	Applying (K3)
CO3	deploy and test the smart contracts using Truffle framework tools	Applying (K3)
CO4	make use of web3 to connect the smart contract to an application	Applying (K3)
CO5	demonstrate smart contract security with free online resourse for smart contract security auditing	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	3	2	1										2	3
CO2	3	2	1										2	3
CO3	3	2	1										2	3
CO4	3	2	1										2	3
CO5	3	2	1										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	20	30	50				100
CAT2	20	30	50				100
CAT3	20	30	50				100
ESE	10	40	50				100

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

PRACTICAL ASPECTS OF BLOCKCHAIN

Programme & Branch	BTech. & Artificial Intelligence and Data Science	Sem.	Category	L	T	P	Credit
Prerequisites	Introduction to Blockchain			3	0	0	3

Preamble	This course intended the students to study the basics of Blockchain technology. During this course learner will explore various aspects of Blockchain technology like application in various domains.	
Unit - I	**Blockchain Basics and Nodes**	**9**
Introduction to Cryptoeconomics and blockchain- Overloading Cryptocurrencies- Blockchain P2P Network. **Blockchain Node:** Running a Blockchain Node- Bitcoin Core API		
Unit - II	**Creating Blockchain, Bitcoin Wallets and Transactions**	**9**
Basic P2P Network creation- Genesis Block and Sharing Blocks creation -Registering Miners and Creating New Blocks-Storing Blocks in LevelDB-Creating a Blockchain Wallet-Creating an API-Creating a Command-Line Interface. **Bitcoin Wallets and Transactions:** Bitcoin Core RPC Resources -Bitcoin Wallet-Transactions- Bitcoin Colored Coins		
Unit – III	**Ethereum Wallets, NEO Blockchain and Smart Contracts**	**9**
Ganache Simulated Full-Node Client- IntelliJ IDEA Plugin for Solidity- Truffle Suite- Compile with Remix- Private Ethereum Blockchain with Geth- Connect the Mist Ethereum Wallet to Private Network- MetaMask. **NEO Blockchain and Smart Contracts :** NEO's High-Level Blockchain Architecture- Setting Up Local Environment- Create a Local NEO Private Testnet- Publish a Smart Contract on a Private Testnet		
Unit – IV	**Hyperledger**	**9**
Hyperledger Overview- Hyperledger Fabric- Installing Hyperledger Fabric and Composer- Hyperledger Composer- "Hello, World" with Playground- Deploying on a Local Hyperledger Fabric Network- Running "hello-network" Network- Error Troubleshooting		
Unit – V	**Build Dapps with Angular**	**9**
Dapp-Angular- Smart Contract transfer -Link with the Ethereum Network- MetaMask connection-Test Dapp Functionality		

Lecture:45, Total: 45

TEXT BOOK

1. Elrom, E. (2019). The Blockchain Developer: A Practical Guide for Designing. Implementing, Publishing, Testing, and Securing Distributed Blockchain-based Projects. Unit -1,2,3,4,5

REFERENCE BOOK

1. Krishnan, S., Balas, V. E., Golden, J., Robinson, Y. H., Balaji, S., & Kumar, R. (Eds.). (2020). Handbook of research on blockchain technology. Academic Press.

COURSE OUTCOMES: On completion of the course, the students will be able to		**BT Mapped (Highest Level)**
CO1	make use of the structure and mechanism of blockchain to address the basic security.	Applying (K3)
CO2	deploy Blockchain and create a Bitcoin Wallets and Transactions.	Applying (K3)
CO3	create Ethereum Wallets, NEO Blockchain and publish a Smart Contract on a Private Testnet	Applying (K3)
CO4	solve the business network issues using Hyperledger Composer.	Applying (K3)
CO5	build Dapps with Angular and link with the Ethereum Network	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	3	2	1	2	2								2	3
CO2	3	2	1	2	2								2	3
CO3	3	2	1	2	2								2	3
CO4	3	2	1	2	2								2	3
CO5	3	2	1	2	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	20	30	50				100
CAT2	20	30	50				100
CAT3	20	30	50				100
ESE	10	40	50				100

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