VIGNAN'S
Foundation for Science, Technology & Research
(Deemed to be UNIVERSITY)
-Estd. u/s 3 of UGC Act 1956

R22 Academic Regulations

In Compliance with NEP 2020

Prof. P. NAGABHUSHAN
B.E., M.Tech., Ph.D., FIE, FIETE, FIAPS.
Vice Chancellor, VFSTR
Life time Professor, IIIT – Allahabad, Prayagraj
(Formerly: Director, IIIT-Allahabad 2017-22)

VIGNAN'S
Foundation for Science, Technology & Research
(Deemed to be UNIVERSITY)
-Estd. u/s 3 of UGC Act 1956

PREFACE

'You are born to Blossom' – What an inspiring title the book authored by APJ Abdul Kalam and Arun K Tiwari carries. The journey to blossom has got to be heralded by education. The purpose of education is to ensure that the 'Life Blossoms'. Earning a degree and getting a placement should be the just happening things, and should not become the only celebrated goals for education. In the book cited above, Honourable Kalam, Former President of India, underscores that "The scheme of civil society depends on Educating young people to become enlightened citizens and adults who are responsible, thoughtful and enterprising"

VIGNAN aims to seed these concepts in every learner who transits through this temple of learning. The doctrine of VIGNAN entitled R-22 contains the principles of policies laid down by the University, to realize the spirit of "Blossoming the lives" providing a foundation-strong professional education on the ethos of 'Creative learning for Critical thinking and Critically analysing for Creative decision making'. Certainly, our University is one of the earliest Universities, in fact the University is a trend setting one in completely internalising the concepts of the policies brought out in National Education Policy (New Educational Policy) NEP-2020, and inculcating the spirit in R-22. The R-22 document articulates the Academic Regulations of the University, which is being presented now and shall be inforce with immediate effect from the academic year 2022-23, not only for those who have joined in 2022, also the aspirants of 2021-22 are enabled into the navigation.

R-22 presents a novel design for the academic pursuit, making an exploratory cross disciplinary traversal for a learner who should find learning both holistic and experiential. The learner is ensured to enjoy the continuity in learning and the learner is supported to align and realign, enroute utilising the benefits of constructive feedbacks that s/he receives because of continuous assessment. S/he will be empowered to enjoy the opportunities to explore, experiment and experience.

R-22 eliminates the melancholy of examinations. The expected severity of breakdown due to the anxiety of examination system is replaced by an affectionate assessment system, increasing the effectiveness in accomplishing the outcomes.

In brief, NEP-2020 compliant revised academic regulation of the University – the R-22, is VIGNAN's commitment to alleviate the acuteness in the present educational practices. It intends to provide a strategic solution to the critical observation made by Bharat ratna awardee, Professor. CNR Rao – "India has exam system, not education system. When will young people stop taking exams and do something worthwhile?" (Thought for the Day, Times of India 13.08.2022)

Here is R-22, which assures that the learners at VIGNAN are bound to do something worthwhile – very much worthwhile.

***

R22 M.Tech.
2 YEAR
PG PROGRAMME

REGULATIONS - TABLE OF CONTENTS

* Programme will be offered based on satisfactory strength of students willing to register, after receiving the formal AICTE approval.

R22 M.Tech. 2 YEAR PG PROGRAMME

Academic Regulations, Curriculum and Course Contents

R22 M.Tech. 2 YEAR PG PROGRAMME

EXECUTIVE ABSTRACT

R22 - Academic regulations, Curriculum and course contents, is an articulation of the VFSTR deemed to be University's commitment towards NEP-2020, with a view that it enables student(s) to maintain the spirit of continuous learning and continuous assessment to replace the normal tendency of preparing just before a test or an examination. The proposed framework accomplishes multi-disciplinary holistic education, continuous assessment along with multiple honorable exit options if a student falls short to complete the requirements to earn the degree within the stipulated period including the permissible spill over period.

R22 is oriented towards holistic education at the postgraduate level that includes integrated and rigorous exposure to professional domains, as well as sufficient flexibility in curricular structures that allow students to choose electives from the wide choice of courses. Such holistic and diverse education will assist the candidate in transforming into all-rounded persons. Similarly, in line with NEP-2020, more weight is given to continuous/ formative assessment, in the frame work of an Integrated learning model comprising Learning – Thinking – Understanding – Skilling – Applying – Creating. Emphasis on continuous formative assessment with a creative summative assessment will facilitate the candidate to "Move away from high stake examinations – towards more continuous and comprehensive evaluation".

The M.Tech. degree offered will be for two years' (4 semesters) duration with lateral exit options within this period, with suitable certifications that will enable the candidate to have a professional career and as well as serves as a reminder to return and update his / her qualification in the future. In line with NEP-2020, following one year of study and the completion of the required credits, an Engineering PG Diploma degree will be conferred. However, the intention of the learners is not to join for the award of the PG diploma with lateral exit, but to acquire a M.Tech. degree.

Salient features of the regulation

- Continuous learning
- Continuous assessment
- Add-on certification
- Honorable exit option
- Onward Continuation to Ph.D. Program
- Sabbatical Semester Drop option to pursue innovation, incubation, entrepreneurial and advanced exploratory activities and subsequent re-entry

1 INTRODUCTION

This document contains the academic regulations, scheme of assessments, curriculum, detailed syllabi, course contents with text / reference books recommended, course outcomes, skills acquired and the projects / assignments that are to be performed for each course for the conduct of 2-year M.Tech. degree programmes. The various M.Tech. degree programmes under different schools in VFSTR are as listed below. The character codes indicated in paranthesis are their branch disciplinary code.

I. School of Agriculture & Food Technology

- Food Processing Technology (FT)
- Farm Machinery (FM)

R22 M.Tech. 2 YEAR PG PROGRAMME

II. **School of Biotechnology & Pharmaceutical Sciences**
- Biotechnology (BT)

III. **School of Computing & Informatics**
- Computer Science & Engineering (CSE)

IV. **School of Conventional Engineering**
- Structural Engineering(SE)
- Machine Design (MD)

V. **School of Electrical, Electronics & Communication Engineering**
- Embedded Systems (ES)
- VLSI (VLSI)
- Power Electronics and Drives (PED)

1.1 Definition

For the purpose of R22 regulation, definitions as follows shall apply:

- **"Degree"** shall refer to the M.Tech. Degree Program.
- **"Course"** shall refer to such Course(s) for which a student shall earn Credits after due assessment as per the laid provisions. Project is also treated as a Course.
- **"Academic activities"** shall refer to the activities like Lecture (Physical Lecture Session), Tutorial (Participatory discussion / Self-Study / Desk Work / Quiz / Seminar Presentation, *etc* activities that make the student absorb & assimilate, the delivered contents effectively) and Practical / Practice sessions (includes Hands on Experience / Lab experiments / Field Studies / Case Studies *etc* activities that enable the student to acquire the requisite skill).
- **"Continuous Assessment"** shall refer to the assessment of the student spread over the entire semester on the various constituent components of the prescribed course.
- **"Semester"** shall refer to a period covering the two assessment periods *viz* Formative and Summative Assessment period. A semester would generally be spread over twenty weeks.
- **"Course Drop"** shall refer to a student having to undertake a repeat of the Course(s) not being able to complete the Credit requirements of the Course(s), under the conditions stipulated in the regulation.
- **"Supplementary Examinations"** shall refer to the examination(s) conducted to allow the student to appear in the un-cleared Semester - End summative assessment component.
- **"Blank Semester"** shall refer to a Semester in which a student either does not register for any course at the beginning of the Semester OR chooses to DROP all courses OR is so compelled to DROP all the courses, as the case may be.
- **"Semester Drop"** shall refer to availing a blank semester. However, if drop is availed to pursue a creative extension activity, then it is defined as **semester sabbatical**.
- **"Spill Over Semester"** shall refer to the additional semester(s) beyond the completion of prescribed normal semesters.
- **"AAA Section"** shall refer to the Academics, Assessment and Awards Section of the Institute.
- **"Attendance"** refers to the Physical personal presence in an academic activity session.
- **"Summer Semester"** refers to a Semester that is scheduled to be held during the intervening period of Even and Odd Semester (*i.e*. Summer Vacation period).
- **"Themes"** refer to the courses offered in a particular stream other than offered by the regular departments, for example NCC, Entrepreneurship, Fitness and Living, *etc*.
- **"School"** refers to a division of institute dealing with two or more specific areas of discipline / study comprising of the departments related with exclusive emphasis on trans-disciplinary research.
- **"Department"** refers to a division of institute dealing with a specific area of discipline / study.

- **"HoD"** refers to the Head of the respective Department, where the student is enrolled for his / her Branch of Study.
- **"Center"** refers to a structured unit within the school / department established with the purpose to carry out advanced research.
- **"Grade Point"** refers to the quantification of the performance of a candidate in a particular course as defined herein.
- **"SGPA"** refers to the Semester Grade Point Average and is calculated as detailed in the regulations subsequently.
- **"CGPA"** refers to the Cumulative Grade Point Average and is calculated as detailed in the regulations subsequently.
- **"Division"** refers to the Division awarded to the student as per the mechanism detailed in the regulations subsequently.
- **"Internship"** refers to onsite Practical Training offered by reputed companies / Institutions, in India or abroad. To be undertaken with (or seeking) prior approval of the respective HoD.
- **"Project"** refers to a course executed by a candidate on a specific research problem at VFSTR / any organization of repute. To be undertaken with (or seeking) prior approval of the respective HoD.
- **"Credit equivalence and credit transfer committee"** refers to the committee designated to look into for credit equivalence and credit transfer.
- **"Honorable Exit Option"** refers to the Exit Options available to students, when they are unable to complete the prescribed two-year M.Tech. Degree program in four successive years.

1.2 Academic Administration

The academic programmes of VFSTR are governed by the rules and regulations approved by the Academic Council from time to time. The various academic activities are conducted following a fixed time schedule duly approved by the Academic Council in line with the AICTE / UGC regulations. The academic activities of VFSTR are followed meticulously as specified in the academic calendar as approved by the Academic Council. This academic calendar is shared with all the stake holders well before the beginning of the respective academic year. The curriculum and the course contents of all the programmes are discussed by the respective Board of Studies (BoS), analyzed and recommended for implementation. The Academic Council, being the highest statutory body, chaired by the Vice-Chancellor, meets at least twice or thrice a year and discusses, suggests and approves all the important academic matters related to curriculum and course contents in particular including the recommendations of BoS.

The intended revision in regulations (R22) was in principle accepted and recommended by the Academic Council in its 32nd meeting on 10-12-2022. Subsequently respective Board of Studies brought necessary recommendations accordingly, which were duly placed before the Academic Council in its 33rd meeting on 17-6-2023.

1.3 Program Duration

For the branch disciplines listed in section (1), the regular courses including theory and practical are offered over a period of two years in four semesters. The normal duration to complete the M.Tech. program is two years. However, a student can avail the benefit of spill over period for 2 years, that is the maximum duration of four years can be availed by a candidate to complete the M.Tech. programme in a slower pace if he / she desires. The candidate failing to complete the requirements will be considered for the honorable exit as applicable

1.4 Courses and Credits

The term course is used in a broader sense to refer to so called papers such as 'theory subject', 'laboratory', 'inter-departmental project', 'major-project' etc. A course can be of theoretical and / or of practical nature, and certain number of credits are allotted to it depending on the

number of hours of instruction per semester. For a course offered in a semester, one hour of lecture (L) instructions carried out in a week is considered equivalent to one credit, whereas two hours of practical (P) sessions done in a week are considered equivalent to one credit. Depending on the course two hours of tutorial (T) sessions may be considered equivalent to one credit. A student earns these credits when he / she successfully completes the course.

1.4.1 Content Delivery of a Course

Content delivery of a Course in the M.Tech. Degree Program shall be through, either or all, of the following methods:

i. **Lecture** - refers to Lecture Session(s) through classroom contact session wherein students will learn by listening. Denoted by "L".

ii. **Tutorial** - refers to transaction(s) consisting of Participatory discussion / Self-study / Desk work / Brief presentations by students along with such other novel methods that enable a student to efficiently & effectively absorb and assimilate the contents delivered in the lecture sessions. Denoted by "T".

iii. **Practice** - refers to Practice / Practical sessions and it consists of Hands-on- Experience / Laboratory Experiments / Field Studies / Case Studies / Minor / Major Project, that equip the students to acquire the much required skill component. Denoted by "P".

1.5 M.Tech. Degree

All students formally and conventionally enroll for M.Tech. degree programme. They have to earn **68** credits for the award of degree as specified in the Curriculum. However, additionally he/she can opt to earn up to 12 more credits as Add-on credits, to earn the academic benefits as specified below.

1.5.1 M.Tech. with Add-on Certification

If a candidate earns add-on 12 credits in the respective discipline, then he/ she will be eligible for the award of M.Tech. in YY Engineering with Add-on Certification.

Note: The consolidated transcript will contain the credits and grade details of all courses amounting to 68 + up to 12 credits.

1.6 Composition of an Academic year

An academic year is composed of an Odd semester (20 – 22 weeks), an Even semester (20 – 22 weeks) and a Summer semester (6 – 8 weeks). The regular semester that begins in July / August is known as odd / first semester and the one that begins in December / January is known as even / second semester (Figure 1). The instructional days for a regular semester shall be a minimum of 90 working days exclusive of days earmarked for summative assessment.

YEAR OF 12 MONTHS											
1	2	3	4	5	6	7	8	9	10	11	12
July/ Aug.	Aug./ Sept.	Sept./ Oct.	Oct./ Nov.	Nov./ Dec.	Dec./ Jan.	Jan./ Feb.	Feb./ Mar.	Mar./ Apr.	Apr./ May	May/ June	June/ July
ODD SEM/ FIRST SEM					EVEN SEM/ SECOND SEM					SUMMER SEM	

Figure 1: Distribution of semesters during an Academic Year.

1.6.1 Before the commencement of the semester, a candidate has to pay the stipulated tuition fee and submit an application detailing the courses he / she intended to register, valid for that respective Odd / Even semester. The maximum number of credits per semester will be 25 credits inclusive add-on credits. The intended semester wise coverage will be as presented in the curriculum.

1.6.2 **Summer semester** is a short duration semester program that will be generally conducted during the semester break between even semester and odd semester. The students having 'R' (Repeat grade) courses may register for the course work during this semester to get a chance for successfully completing the 'R' courses. In general, supplementary assessments are conducted in the later part of the summer semester. However, the courses offered in summer semester and the number of courses a student can register are subjected to academic and administrative convenience. A student may register up to a max. of 12 credits in a summer semester.

1.6.3 Exception to the routine practice of registering for 'R' courses in summer semester, a student can register in a course offered by a visiting expert during the summer vacation which may be equivalent to a department elective or an Add-on-course. The candidates can register for such courses within the scope of 12 credits. Candidate may also avail summer semester for summer internship opportunities, which may be considered as Add-on credits.

1.7 Semester wise provisions

A student may register for a max of 25 credits per semester as prescribed or otherwise he/she may include the Repeat courses in the event of having not successfully completed a course or courses in the earlier semester. However, a student may also opt to go in a slower pace to earn the credits less than the prescribed max of 25, including even 'Dropping' a semester for special reasons.

It should be clearly underscored that a candidate should on priority register for Repeat (R) credits if any, during a regular semester, within the said scope of 25 credits; in case he / she cannot be sure of completing or could not complete the 'R' credits in Summer semester.

1.7.1 During the first two years from the date of admission to M.Tech., a candidate has to pay the semester / annual fees as prescribed irrespective of the less number of credits that he / she would register or even opt to Drop a semester.

1.7.2 If a candidate gets into spillover semester beyond two years up to a maximum of four years he / she has to pay semester fee proportional to the credits that he/ she registered in that spill over semester as prescribed from time to time.

1.7.3 A candidate has to pay additional fee proportional to the number of credits for registering in a summer semester as prescribed from time to time.

2. CURRICULUM

Each School offers different M.Tech. degree programmes and the departments concerned prescribes semester-wise curriculum encompassing different courses. Every course offered will be designated in a L-T-P structure. The theory courses comprise of L (and / or T & P hours) whereas the practical courses include instructions (T) and practical sessions (P). Amalgamation of theory courses with practical sessions is predominantly seen in this curriculum.

2.1 Distribution of credits

The overall distribution of credits for various categories of courses in the curriculum of M.Tech. programmes is represented in Table (1) as given below.

Table 1 : Credits Distribution for Various categories of courses.

Category of Courses	Credits (%)	AICTE Recommendation (%)
Professional Core	29.4	29.4
Electives	17.6	22.1
Inter disciplinary courses	8.8	7.4
Projects	44.1	41.2

R22 M.Tech. 2 YEAR PG PROGRAMME

2.2 Organization of course contents

Courses offered in the program is composed of two modules covering all the course contents required for a candidate to obtain knowledge and skill. Content in each module is further distributed among two units; wherein Unit -1 contains 'Fundamentals and Broad perceptive' of the module. Unit-2 comprises of the extension / advanced topics of Unit-1 as well as necessary practice models for validation / applying the knowledge gained during L/T sessions. The modular period is about 8 weeks. The first unit in a module may be covered in 2 to 3 weeks and the second unit of the module maybe of 5 to 6 weeks (Figure 2). By the end of each module a candidate must be in a position to translate his/ her L-based knowledge into P-based skill as prescribed in the curriculum. Individual formative assessment shall be in place for each module and a single semester-end summative assessment for the course composed of both the modules.

YEAR OF 12 MONTHS											
1	**2**	**3**	**4**	**5**	6	7	8	9	**10**	**11**	**12**
July/ Aug.	Aug./ Sept.	Sept./ Oct.	Oct./ Nov.	Nov./ Dec.	Dec./ Jan.	Jan./ Feb.	Feb./ Mar.	Mar./ Apr.	Apr./ May	May/ June	June/ July
ODD SEM/ FIRST SEM					EVEN SEM/ SECOND SEM					SUMMER SEM	

Module- I		**Module- II**			**Module- I**		**Module- II**			
U1	**U2**	U1	U2		U1	U2	U1	U2		

Figure 2: Unit-wise distribution of course contents in a module and their mapping with Academic Calendar; U= Unit.

3. CHOICE BASED CREDIT SYSTEM

Each branch discipline of the M.Tech. programme comprises of a set of courses - professional core, electives, projects and audit courses. VFSTR offers flexibility for students to choose courses of their choice and obtain the credits satisfying the minimum credits criterion in each category as given in Table-1.

3.1 Professional Core

Professional Core courses are individualized for each programme and they are mandatory for every student opting for that branch discipline. These are designed to offer the essential fundamental knowledge and skills required for that specific programme.

3.2 Electives

A candidate has a choice to choose the elective courses. A list of elective courses are pooled together, enabling a candidate to choose the electives from a pool. There may be more than one pool in certain disciplines aligned to a specific theme. Otherwise also he/ she can exercise the choice to choose electives from across the pools. There may be courses which may not be listed under any pool, which are called 'Free elective courses'.

Elective courses offered for each programme are categorized as 'program electives' that are aimed at offering the advanced/ additional knowledge in the chosen branch discipline.

Care should be exercised while opting for program elective courses and Add-on certification courses that is a course opted as program elective should not be registered as a course under Add-on certification courses and vice versa.

Apart from 68 credits, additionally candidate has to earn 12 credits for Add-on certification. Of these 8 credits may be earned through MOOCs offered via Swayam platform. A student may also be permitted to earn more elective credits through MOOCS. This will promote self-learning and drive students towards innovative learning approaches.

To facilitate the process of acquiring the elective credits through MOOCS, VFSTR has constituted "Online course committee" at Central level with 1-2 members represented from each of the department to guide students in selection of courses and to assist them with further steps if required until completion of the courses.

3.3 Inter disciplinary courses

Courses such as Cyber security, Research Methodology & IPR and employment Orientation/ Soft skills program are offered in the first and second semester of the programme. As per UGC guidelines cyber security course is introduced as compulsory course. The M.Tech. students are encouraged to participate in research activity of both academia and industry, hence research methodology & IPR could be an important course to offer.

The 50-hour Employment Orientation Program (EOP) for M.Tech degree students is conducted with the help of in-house and invited experts. It is aimed at improving presentation skills in general and pedagogical skills in particular.

3.4 Teaching Assistantship

Candidates after undergoing Employment Orientation Programme in the first semester of the program should enroll for the 'Teaching assistantship' course during their second semester to earn 2 credits. Each candidate will assist faculty in handling a 'P-based activities' for B.Tech. students, developing teaching abilities like handling the sessions, interaction with students for clarification of doubts and assessment capabilities. The candidate performance will be assessed in the same lines.

3.5 Inter Departmental Project

These projects are designed and executed by students during the first year second semester of their program. By doing these projects, students will get an idea of how technologies or processes, prototype or working model can be developed by culmination of technologies from courses of different programs. The minimum duration of inter-departmental project during each of the semester is 90 hours including writing of project report and submission for assessment. A batch of 2-3 students from same or across the departments can take part in each of the inter-departmental projects. Performance will also be assessed in the modular framework for formative and semester-end summative with a weightage of 2 credits

3.6 Project

Students may opt for Project work in lieu of internship for two complete semesters during second year. Such students may avail research-internship support from any institution well known for research and development (R&D). They may also take up project work in VFSTR itself. Each candidate has to submit interim reports and a final report which are mandatory requirements towards the partial fulfillment of project credits requirements. It bears a weightage of 13 credits for the work executed in the third and fourth semesters totalling up to 26 credits. During the project work the student under the guidance of a faculty member(s) will involve in an innovative design / research through the application of his / her knowledge gained in various courses studied. He / she is therefore expected to present a survey of literature on the topic, work out a project plan and carry it out through experimentation / modelling / simulation / computation. Through such a project work, the student is expected to demonstrate system analysis, design, presentation and execution skills. Performance in the project will also be assessed in the modular framework for formative and summative assessments.

3.7 Internship

A student can undertake internship in lieu of project work in industry for two complete semesters during second year in lieu of major project work. It bears a weightage of 13 credits for the work executed in the third and fourth semesters totalling up to 26 credits. This is aimed at training students in solving / understanding real-life problems through application of engineering analysis, design, evaluation and creation, particularly in association with practitioners and experts in the industry. The procedures for obtaining the internship placements and allocation of the same to the students are as per University. Even during internship, a student is preferably expected to carry out a focused study on one topic / problem in consultation with the interning institute. Internship progress report should be submitted periodically and finally a detailed internship report should be submitted duly certified by a mentor from the internship institute. Performance in the internship will also be assessed in the modular framework for formative and summative assessments.

R22 M.Tech. 2 YEAR PG PROGRAMME

4. ATTENDANCE

It is mandatory for the student to attend the course work in each semester as per the academic schedule of that semester. VFSTR expects 100% attendance. However, the attendance in each course shall not be less than 75 % of the aggregate of all L, T, P sessions conducted in that course.

a) The attendance calculations will be periodically reviewed at the end of every 4 weeks. The details of attendance status will be shared with the parents / guardian. The final status of attendance will be reported at end of 15th week granting the advantage of the attendance for the 16th week for the purpose of attendance shortage calculations.

b) The shortage of attendance may be condoned up to 10% on the ground of ill-health, social obligations, participating / representing in sports/cultural events, placement activities etc.

c) Documentary evidence like medical reports and certificates issued by concerned bodies is to be produced on time as support for the attendance shortage due to ill-health. These cases are subjected to the scrutiny of a committee constituted for this purpose by the Vice-Chancellor. The decision of the committee shall be final.

d) Prior approval has to be taken from the HoDs for the other types of leaves.

e) The courses where the student shortage of attendance was not condoned shall be considered as 'Repeat' category courses and will be under 'R' grade in the student's semester transcript. Student should re-register for these courses during the summer semester or whenever the course is offered next time during regular semesters. These re-registrations are subjected to the regulations at the time of re-registration. In case of core courses, the same core has got to be re-registered. However, in case of an elective a candidate may exercise a choice of choosing different elective in place of 'R' graded elective.

The students who are put into 'R' grade will not be allowed to take up the summative assessment in that semester. In case due to lack and/or delay in information, if he/she appears for the summative assessment in that course, office of AAA is empowered to cancel the attended exams. The scores obtained either in formative or summative assessment will not be considered for grading.

5. ASSESSMENT

Teaching-Learning and Assessment should go hand in hand and complement each other. Continuous assessment plays a vital role to enable the student to get synchronized with the teaching-learning process. Assessment mechanism adopted in the institute is aimed at testing the learning outcomes in tune with the outcome based model of education. The focus, is thus on assessing whether the outcomes are realized by the end of the course.

The performance of a student in each course is assessed on a continuous basis during the semester through various in-semester and end-semester assessment models. The marks awarded through continuous assessment are referred to as Formative assessment marks. The marks awarded through end-semester tests are referred to as Summative assessment marks (Figure 3). Both the formative and summative assessment marks are considered for awarding the final marks and the grade point in a particular course.

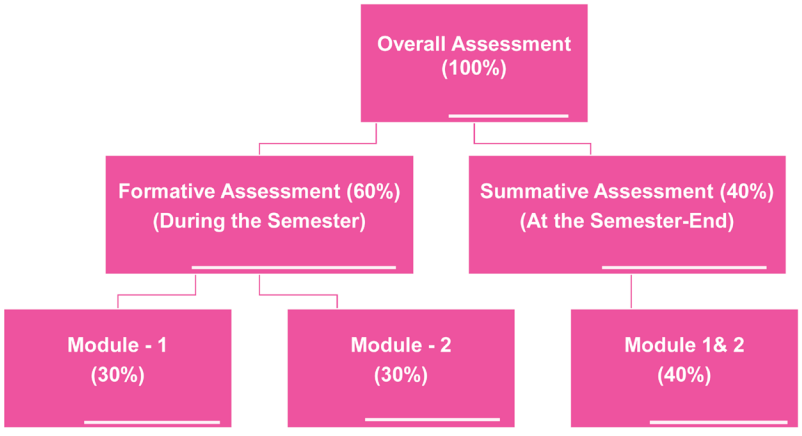


Figure 3: Categories of assessments in place for R22.

5.1 Marks distribution

For each course, the maximum sum of formative and summative assessment marks put together is 100, in the ratio of 60:40, respectively.

5.2 Qualifying criteria

To be declared successful in a course, a student must secure at least a grade 4.5 in a scale of 10 based on the total maximum marks which is inclusive of formative and summative assessment. The students should also get 40% from the maximum marks allotted for formative and summative assessments individually.

The hierarchy of qualifying criteria is as follows:

i. Attendance compliance should be 75% or within condonable range; else the candidate is put into 'R' grade.

ii. In formative assessment, a candidate should secure a minimum of 40% i.e. 24 marks out of 60; else the candidate is put into 'R' grade.

iii. In summative assessment, a candidate should secure a minimum of 40% i.e. 16 marks out of 40; else the candidate is put into 'I' (Incomplete) grade.

iv. Collectively the candidate should secure a min. grade of 4.5 in a scale of 10 after relative grading; else the candidate has to choose either 'R' or 'I' grade duly being counselled.

v. Every semester, candidate should score a min. of 5 Semester Grade Point Average (SGPA) in every semester individually with the successfully completed courses. In case a candidate fails to score the min. SGPA, then he / she shall voluntarily drop a few Courses to ensure a SGPA of 5. He / she after duly counselled has to choose either 'R' or 'I' grade for the dropped courses.

The candidates with 'R' grade should re-register for 'R' courses either in Summer semester or in a regular semester as and when the courses are offered. The candidates in 'I' grade are allowed to appear for supplementary summative assessment whenever the semester-end assessments are conducted.

To assess special projects / courses, not fitting into the categories described here, a suitable assessment procedure will be evolved in consultation with experts of that area and adjudicated by the committee constituted for that purpose. The decision given by the committee will be final. The appended assessment scheme shall be announced by the course coordinator during the commencement of course.

YEAR OF 12 MONTHS											
1	**2**	**3**	**4**	**5**	6	7	8	9	**10**	**11**	**12**
July/ Aug.	Aug./ Sept.	Sept./ Oct.	Oct./ Nov.	Nov./ Dec.	Dec./ Jan.	Jan./ Feb.	Feb./ Mar.	Mar./ Apr.	Apr./ May	May/ June	June/ July
ODD SEM/ FIRST SEM					EVEN SEM/ SECOND SEM					SUMMER SEM	

Module- I		**Module- II**			**Module- I**		**Module- II**			
U1	**U2**	**U1**	**U2**		**U1**	**U2**	**U1**	**U2**		
Formative Assessment				SA	Formative Assessment				SA	

Figure 4: Schedules of formative and summative assessments in line with Academic calendar. SA = Summative assessment.

5.3 L-based courses integrated with P/T

5.3.1 Formative Assessment

The scheme of formative assessment is designed to promote the continuous learning. Scheme consists of assessments planned at institute level and assessment that may be scheduled by

the course instructor (Figure 4). Institute level assessments shall be scheduled by the office of AAA. Respective Faculty Member(s) shall declare the schedule of Continuous Laboratory Assessments (CLA), Quiz, Tutorials, Assignments, Seminars, Discussions, etc. Some of the components may also however take place in an unscheduled manner like Surprise Tests. However, students shall be made aware of the assessment modalities that are going to be followed in a course by the faculty, under information to the HoD.

To monitor the progress of students, continuous assessment comprising of five targets (T1, T2, T3, T4 and T5) is advocated in each module for a maximum of 60 marks. For a class, formative assessment commences by the announcement of module bank containing 10 problems for each module in a course. Nature of problems in the module bank shall be at the level of creative / exploratory / design / thought provoking covering the complete syllabus of a module at advanced / challenging level.

The purpose of creating module bank of 10 problems is to assign one problem to each student or to a batches of 2 members. The batches are composed of randomly picked up candidates. These batches remain same for all courses and also for the P-sessions in the courses in that semester and are created in the beginning of that semester.

The purpose of assigning one problem to two batches is to create a healthy competitive spirit between the two batches.

The modality of evaluation of five targets is listed here under:

a) **T1**: During 5th or 6th week of each module a classroom test shall be conducted. T1 consists of two parts: A and B.

Part A consists of one random problem from the module bank and varies from batch to batch. All the questions in the module bank shall be distributed among students and students shall know the question to be answered only on the day of test in the examination hall.

Part B consists of one common problem at fairly application/ advanced level **(not at all prior notified)** from outside the module bank for all the students.

T1 shall be paper based and proctored test for a period of 60 min (maximum) which shall be assessed for 30 marks and downscaled to 10 marks.

For the students who for justifiable reasons could not attend the classroom test on the scheduled day, a re-test maybe conducted. However, Part-B will contain a new question and Part-B will have higher weightage than part-A or full weightage could even be allotted for Part-B in such an event

b) **T2**: Immediately follows T1. Students in a specified batch who now have received the same question during T1 will work further on that problem for T2.

T2 is primarily an extension of problem received in T1 for carrying out validation study: Case studies / Simulations / Experimentation. Each batch shall interact with the course instructor to finalize the nature of validation and expected to complete the exercise within 10 to 15 days after T1.

Course instructor should ensure assigning a different case study / a different scope for validation study for each batch in case the same problem is assigned to two batches.

Course instructor shall assess every student in a batch for a max. of 10 marks based on his observation, interaction and/or reviewing (based on at least two reviews).

c) **T3**: T3 shall be conducted during the last week of each module. Student batches are expected to submit a report, clearly documenting the work executed during T2. The report should be in IEEE / APA format and additionally a voice in-built PPT should be prepared and submitted.

The report and presentation shall be assessed by the course instructor for 10 marks for every student. In certain cases, a course instructor can call a batch for a physical presentation also.

d) **T4**: T4 is a comprehensive module test, conducted for 30 min. comprising of 20 multiple choice questions (MCQs) covering the holistic content of module. T4 shall be evaluated for a max. of 10 marks @ ½ mark for each question. T4 will be conducted in ON-LINE mode.

There shall be two tests in each course in a day and the best performance of the tests shall be considered for awarding the marks.

Two sets of question papers each containing 20 questions should be set. The theme of the questions could be similar across the sets. When the test is administered online, every student receives the questions in shuffled sequence and also the choices in shuffled sequence. Therefore, the choice like both 'a' & 'b' above, neither 'a' nor 'b', all the three a, b, c will not be set.

e) **T5:** T5 assessment is based on Practice or Tutorial assignments. Implementation, Report presentation and Discussion shall happen in a continuous mode throughout the module period.

At least 4 such continuous lab practice assessments (CLPA) / assignments per module shall be conducted by course instructor. The marks will be @ 5 marks per assignment totalling up to 20 per module.

f) The scores of the targets are to be normally announced within three working days on completion of the assessment and the performance is to be discussed in the class.

g) The total marks per module is 60 - T1 (out of 10), T2 (out of 10), T3 (out of 10), T4 (out of 10) and T5 (out of 20).

h) Total marks for both the modules from formative assessment will be added up to 120, which will be ***suitably mapped down*** to a max. of 60 marks. The mapping policy should be decided by the lead instructor / instructors in consultation with the HoD. The mapping policy should be shared with Dean AAA for the purpose of documentation.

i) The marks scored in Module-1 for a max. of 60 should be entered / submitted latest by 9th week and of Module-2 latest by 17th week of the semester. Consolidated score for a max. of 120 ***suitably mapped down*** to a max. of 60 marks should be submitted latest by 18th week of semester enabling the declaration of 'R'- grade before the commencement of summative assessment.

j) A candidate put under 'R'- grade will not be permitted to take up the summative assessment.

5.3.2 Summative Assessment

a) An instructor may choose one of the two formats for conducting summative assessment for L-based courses integrated with T/P.

i) 15 + 25 marks format or 20 + 20 marks format (following b, c, d below).
ii) 40 marks format (following c, d below).

b) **If summative assessment is in two parts format:**

i) Part-I will be the assessment of capstone project which is pre-assigned during the module-2 period or will be the exploratory review assessment of all lab practice assignments.

ii) Part-II will be based on a written examination for a max. marks of 80, as in c & d below, which is ***scaled down*** to 25 or 20 based on the selected pattern of format.

iii) A candidate should attend both the parts of summative assessments; else he will be put into 'I' grade.

c) For each L-based course integrated with T/P, the summative assessment shall be conducted by the Institute for a duration of 150 min. and for a maximum of 80 marks. Contents for summative assessment shall cover the breadth and depth of the complete syllabus that is mentioned in the two modules of a course.

R22 M.Tech. 2 YEAR PG PROGRAMME

d) The question paper for end-semester theory examination consists of two parts as given in Table (2).

Table 2: L-based Summative Assessment Question Paper Pattern.

Part No.	No. of Questions	Marks for each Question	Marks	Choice
A	4	10	40	No
B	2	20	40	No
Total Marks			80	

e) The questions will be comprehensive covering the entire course syllabus and any single question should not necessarily be limited to any particular unit / module.

f) These marks are ***suitably mapped down*** to a score of 40.

g) Total marks of summative assessment will be for a max. of 40 irrespective of format of evaluation.

h) The award of 'I' grade is solely based on marks scored in summative assessment out of 40, if he/she does not score a min. 16 out of 40 (40%).

5.4 P-based Courses

The detailed information consisting of experiments, batch formations, experiment schedules, etc., will be displayed / informed to the student in the first week of the semester so that the student comes prepared for the lab sessions. Copies of the manual will be made available to the students along with the schedule. The manual will consist of the list of equipments, detailed procedure to conduct the experiment, format for record writing, outcomes for each experiment and possible set of short questions to help students gain critical understanding. The courses like Cyber security, Research Methodology & IPR will also be treated as P-based courses.

5.4.1 Formative Assessment

During practice sessions, a brief viva-voce is conducted for each student on the experiment he/she is carrying out on that day. Some of the parameters that could be included in the Continuous Practice Assessment (CPA) are given in Table (3). The set of parameters may slightly differ from one laboratory to the other, and will be announced before the commencement of the practice session. These parameters are assessed for each laboratory session.

Table 3: Suggested parameters for Continuous Practice Assessment (CPA).

S. No	Component	Marks
1	Report of about 1 page on proposed experimental layout and background theory before the start of lab session	4
2	Viva and interaction to evaluate understanding of concepts	4
3	Experimentation and data collection	4
4	Analysis of experimental data and interpretation	4
5	Finalized report submitted in the next week	4
Total		**20**

This assessment is carried out for each practical session and the total marks of all practical sessions will be ***suitably mapped down*** to a max. of 60.

5.4.2 Summative Assessment

End semester examination for each practical course is conducted jointly by two examiners. The examiners are appointed by Dean, AAA from the panel of examiners suggested by the respective Heads of the Department. In some cases, one of the examiner may be from outside the institution and will be identified as external examiner. The scheme of assessment may vary depending on the nature of laboratory, which shall be shared with student by the

laboratory in-charge. The summative assessment will be conducted for a max. marks of 40. The general scheme of assessment is given in Table (4).

Table 4: Suggested end-semester summative assessment pattern for P-based courses.

Component	Marks		
	Examiner 1	Examiner 2	Total
Objective & Procedure write up including outcomes	4	4	08
Experimentation and data collection	4	4	08
Computation of results	4	4	08
Analysis of results and Interpretation	4	4	08
Viva Voce	0	8	08
Total Marks	16	24	40

5.5 Assessment and Grading of MOOCs based elective

Whenever a candidate opts for a course through MOOCS offered via Swayam platform, he / she has to learn and undergo assessment as per norms set by VFSTR for such MOOCs Courses. Upon the declaration of the result, that the candidate has successfully completed the course, the candidate is said to have earned the credits under credit equivalence and credit transfer.

5.6 Inter Departmental Project

Inter departmental project work is undertaken in the 2nd semester for earning 2 credits by each candidate. It is expected that the inter- departmental Projects result in publication of a technical paper in a peer-reviewed journal. For this purpose, Dean R&D and Heads of Department will identify faculty mentors who will guide the students by conducting workshops on drafting of research article, communication, process of peer-review, publication, etc. The faculty will support the students by all means to get the technical findings published in peer-reviewed journals.

5.6.1 Formative Assessment

The assessment will be carried in two reviews in a systematic way. The detailed assessment guidelines and scheme are to be announced along with the assessment schedule as mentioned in the Table (5).

Table 5: Schedule and parameters followed for formative assessment.

No of Module	Schedule	No of reviews	Points to be considered	Formative assessment marks
Module -1	7th – 8th week	Review -1	• Identification of specific area out of broad areas under the supervisor • Identification of outcomes in line with programme objectives. • Feasibility of contributing to the attainment of outcomes • Identification of tools / equipment / surveys / training needs / etc..	30
Module – 2	15th–16th week	Review -2	• Presentation of results, analysis and conclusions • Meeting of objectives defined in first review • Preparation of report • Understanding by individual students on the overall project • Submission of technical article	30

R22 M.Tech. 2 YEAR PG PROGRAMME

5.6.2 Summative Assessment

Summative assessment will be done jointly by two examiners. The examiners are appointed by Dean, AAA from the panel of examiners suggested by the respective Head of the Departments. In some cases, one of the examiner may be from outside the institution and will be identified as external examiner. The scheme of assessment will be report (15 marks), presentation (10 marks) and demonstration (15 marks) respectively. Points to be considered during the review.

a) Presentation of results, analysis and conclusions
b) Meeting of objectives defined in first review
c) Preparation of report
d) Understanding by individual students on the overall project
e) Individual student contribution
f) Progress of project as per schedule
g) Submission of technical article/ prototype realization

5.7 Project

Those students who do not opt for the internship, carry out their major project at VFSTR and submit their report which is a mandatory requirement for the award of degree. These projects are usually done individually during third and fourth semesters, under the guidance of a faculty member. Every candidate, in consultation with the guide, should define the project and also the probable procedure of carrying it out and submit the same to a committee consisting of 2 to 3 faculty members appointed by Head of the Department. This is to avoid the repetition and also to come up with a roadmap for completion of the project within the time stipulated. The students are encouraged to select topics related to ongoing research and consultancy projects. The students are expected to carry out and present a survey of literature on the topic, work out a project plan and its implementation through experimentation / modelling / simulation / computation. They are also expected to exhibit system analysis, design, and presentation and evaluation skills.

5.7.1 Formative Assessment

The progress of project is reviewed twice in a semester by the Project Review Committee (PRC) and formative assessment marks are awarded based on these reviews. The Project review committee consists of

a) Head of Department or his/her nominee – Chairperson
b) A senior faculty member identified by the HoD – member
c) Project supervisor – member

Review schedules of PRC are to be announced by the department immediately after the commencement of semester. The review presentations are open to all the students of that section and attendance is compulsory. The first review should be of 15 minutes / student; second review should be around 30 minutes / student. Before every review every student should submit their PPT along with a brief report of not exceeding two pages. It is to be expected by the committee that student communicates / publishes research article based on the project work prior to graduation either in a peer-reviewed journal or top-notch conference. Based on the recommendations of the committee, he / she is expected to continue same research problem in the third and fourth semesters to derive possible solutions. The following aspects may be considered by the committee for assessment Table (6).

Table 6: Schedule and suggested parameters to be considered for formative assessment.

Semester	Module	Schedule	Review	Points to be considered	Max. Marks
Semester III	Module -1	7th – 8th Week	First review	• Identification of specific area out of broad areas. • Identification of outcomes in line with programme objectives • Feasibility of contributing to the attainment of outcomes	20
	Module -2	15th – 16th Week	Second review	• Identification of tools / equipment / training needs / etc. • Understanding by individual students on the overall aspect of the project • Completion of literature survey • Design of project set up	40
Semester IV	Module -1	7th – 8th Week	First review	• Acquisition / learning of the tool required • Readiness of the layout of the project report • Progress review as per mechanism / schedule identified • Preparation of draft manuscript for publication	20
	Module -2	15th – 16th Week	Second review	• Presentation of results and conclusions • Meeting of objectives defined in first review • Submission of draft report • Understanding by individual students on the overall project • Progress of project as per schedule • Progress of the publication	40

5.7.2 Summative Assessment

At the end of III & IV semesters, summative assessment of the project will be conducted in two phases.

Phase–I: This is an evaluation for a max of 20 marks. A committee of two members comprising of HoD's nominee and Guide will assess the project work which will involve going through the project report (6 marks), project presentation (7 marks) and demonstration of the project (7 marks).

Phase–II: A final presentation and defense assessment for a max. of 20 marks will be carried out by one-man committee composed of an external expert who is chosen by the Dean AAA from a panel of examiners suggested by the HoD. The format for evaluation will involve going through the project report's quality (6 marks), presentation (6 marks) and interaction and defense (8 marks).

The qualifying marks will be finalized considering the marks scored in both the phases (I & II) of summative assessment.

Publication in a top-notch conference / peer-reviewed journal is mandatory for evaluating the project for 100% weightage.

R22 M.Tech. 2 YEAR PG PROGRAMME

In case the candidate is placed in 'I' grade, he/she has to appear for both Phase-I and Phase-II assessments, which will be held within the 15 days after declaration of results. In the consecutive assessment also if the candidate fails to secure min. required score, then he / she will be placed in 'R' grade.

5.8 Internship

Internship work is undertaken by a student in an industry, under the joint supervision of industry personnel and an internal faculty member. Sixty percentage of the marks of Internship are allotted through continuous evaluation as formative assessment and the remaining 40% are based on summative assessment.

Table 7: Assessment scheme for Internship reviews.

Semester	Module	Schedule	Review	Formative assessment marks
Semester III	Module -1	7th – 8th Week	First review	20
	Module - 2	15th – 16th Week	Second review	40
Semester IV	Module - 1	7th – 8th Week	First review	20
	Module - 2	15th – 16th Week	Second review	40

a) The progress of internship work is reviewed twice in every semester by the "Internship Review- Committee (IRC)" and marks for formative assessment are awarded based on these reviews.

b) The IRC consists of Head of Department or his/her nominee (Chairperson), the internal and external (industry) supervisors.

c) The IRC may not be the same for all students; however, the same IRC should exist for entire duration of the internship program of any single student.

d) The schedule and the scheme of evaluation are to be announced with internship notification. The internship reviews may take place at the place of internship or at the university, as decided by the interning organization or may be conducted in the blended mode.

5.8.1 Formative assessment: Internal reviews at the place of internship

The internal supervisor will interact with the guide allotted at internship offering industry based on the schedule given to conduct the reviews. Scheduled reviews can be conducted by IRC on online mode for discussion/ presentation. The marks shall be distributed for each student in the scheduled reviews as given in Table (7).

a) Students should submit a report (not more than two pages) explaining about the progress of their work, mentioning clearly details like the machines or software handled / adopted, type of data collected and his/her understanding and contribution in the programme, and the same has to be presented before the supervisors.

b) The candidate should clearly present the completion of stipulated assignments set by the industry supervisor for that period.

c) The evaluation will be based on a & b above and also based on regularity and discipline maintained in the internship venue.

Table 8: Suggested scheme of assessment for every review

Component	First review	Second review
Regularity and interaction	5	10
Application of knowledge	3	6
Gaining of new knowledge /skills / literature survey	3	6
Internship progress	5	10
Report	4	8
Total marks	**20**	**40**

5.8.2 Summative assessment – Internship

At the end of III and IV semesters, the student shall submit a comprehensive report of internship covering the work done and make a final presentation in two phases as follows:

Phase–I: A committee of two members comprising of internal supervisor and HoD's nominee will assess the overall internship participation by the candidate and his final report through presentation made by the intern. The internship report (6 marks), presentation (7 marks) and overall impression (7 marks) during the internship will be evaluated respectively.

Phase–II: A final presentation and defense assessment for a max. of 20 marks will be carried out by one-man committee composed of an external expert who is chosen by the Dean AAA from a panel of examiners suggested by the HoD. The format for evaluation will involve going through the project report's quality (6 marks), presentation (6 marks) and interaction and defense (8 marks).

The qualifying marks will be finalized considering the marks scored in both the phases (I & II) of summative assessment.

Publication in a top-notch conference / peer-reviewed journal is mandatory for evaluating the Internship for 100% weightage.

In case the candidate is placed in 'I' grade, he / she has to appear for both Phase-I and Phase-II assessments, which will be held within the 15 days after declaration of results. In the consecutive assessment also if the candidate fails to secure min. required score, then he / she will be placed in 'R' grade.

6. SEMESTER-END ASSESSMENT ACTIVITIES

6.1 Setting of semester-end summative assessment question papers will be coordinated by the instructor assigned for a particular course. Two sets of question papers will be submitted latest by 12th week of the semester.

6.2 There shall be 'Summative Assessment Question Paper Scrutiny Committee' which would be constituted with external experts. Experts are empowered to modify / rephrase the questions to maintain a high standard of the semester-end assessment. The review should be completed by the 14th week of the semester. The review process will be coordinated by a committee of School Dean, HoDs and external experts.

6.3 The question wise marks scored in the summative assessment out of a total of 80 will be made available online within two weeks from the last date of examination and would be kept active for 24 hours. Latest by the end of 48 hours from the instant of notification any candidate can submit an appeal online providing question wise claim.

6.4 Claims for re-assessment on P-based courses are not allowed.

6.5 The appeals will be attended within next three working days. Fees for appeal, as decided from time to time, has to be remitted online along with the appeal.

6.6 Final results and grades will be computed as explained in the next section.

6.7 Final results and grades shall be announced within four weeks of completion of the last examination of the summative assessment (within two weeks from the last date of appeal). Grades are published on the University website, and also informed to the parents and students through SMS.

6.8 Provisional Grade cards will be issued within two weeks after the announcement of grades. Grade card will contain three parts. Part 1: Details of successfully completed courses. Part 2: Details of 'I' grade courses. Part 3: Details of 'R' grade courses.

7 COMPUTATION OF GRADING

7.1 Formative assessment decides the list of 'R'- candidates. Therefore, these candidates will not be considered for grading computation. Summative assessments decide the list of 'I' candidates. Therefore, these candidates will not be considered for grading computation.

R22 M.Tech. 2 YEAR PG PROGRAMME

7.2 The candidates who have successfully completed both formative and summative assessments will be considered for computation of relative grading.

7.3 Threshold value (**Th**) for relative grading in each course is arrived after studying the marks distribution in that course by a committee constituted by office of Dean AAA. The threshold value is decided by the upper bound marks of the major chunk of the class keeping the top outlier scores away from consideration (the least upper bound). The threshold value will be slightly greater than upper bound marks or may be equal to the upper bound marks.

7.4 The total marks (**m**) = marks scored in the formative assessment + marks scored in the summative assessment is transformed into relative grade expressed accurate to two decimal places as follows:

Relative grade point (P) = (m/Th) X 10 [and limited to 10]

7.5 If students require course wise percentage equivalence, then the calculation will be based on the following

Course wise percentage equivalence = (m/Th) X100
[truncated to two-digit integer and limited to 100]

7.6 After relative grading, a student is assigned a 'Letter Grade (G)' for each course as per Table (9). The grade and the corresponding letter grade represent the outcomes and assessments of a student's performance in a course.

Table 9: Grading information

Relative Grading Range (P)	Category	Grade (G)
≥ 9.50	Outstanding	O
≥ 8.50 to 9.49	Excellent	S
≥ 7.00 to 8.49	Very good	A
≥ 6.00 to 6.99	Good	B
≥ 5.00 to 5.99	Fair	C
≥ 4.50 to 4.99	Marginal	M
Transitional Grade	Repeat	R
Transitional Grade	Incomplete	I

8. SUPPLEMENTARY EXAMINATIONS

8.1 The supplementary examinations shall be conducted once in summer semester. Notifications will be released by the AAA section informing the students about registration procedures, details of fee and timetables. Apart from these examinations the students who have courses with 'I'-grade can also write the supplementary examinations along with regular semester-end examinations of that academic (Odd / Even) semester.

8.2 Whenever a candidate clears courses with 'I' grade in a supplementary examination that are conducted during a regular semester, the Threshold value for computing his / her grade will be obtained from the same batch in which he / she had completed his / her formative assessment.

8.3 Whenever a candidate clears courses with 'R' / 'I' grade in a summer semester, the Threshold value for computing his / her grade will be carry forwarded from the preceding Odd / Even semester for the respective courses.

8.4 Whenever a candidate clears courses with a 'R' grade in a regular semester along with his/ her junior batch then for this candidate the Threshold value will be corresponding to his/her junior batch for computing grade.

8.5 The results of summative assessment of Project / Internship will be announced only if the candidate successfully earn all the credits in courses registered during the program. If the candidate is with 'R' / 'I' graded courses the results will be kept under **'Announced Later (L)'** status and will be announced only after candidate clears these courses.

9. GRADE POINT AVERAGE

The Academic Performance of a student in every semester is indicated by the Semester Grade Point Average (SGPA) and finally by Cumulative Grade Point Average (CGPA).

9.1 SGPA

The Semester Grade Point Average (SGPA) shall be computed using the formula given below:

$$SGPA = \frac{\sum_{i=1}^{n} C_i P_i}{\sum_{i=1}^{n} C_i}$$

Where

n = number of courses a student successfully completed in the semester under consideration

Pi = Grade points secured for the i^{th} course registered in the semester under consideration.

Ci = the number of credits assigned to i^{th} course registered in the semester under consideration.

9.2 CGPA

The Cumulative Grade Point Average (CGPA) shall be computed after successful completion of the programme. The CGPA shall be expressed in different flavors to reflect M.Tech. of 68 credits, and Add-on certification up to 12 credits.

Accordingly, the computations will be as below:

$$\text{CGPA} = \frac{\sum_{j=1}^{m} C_j P_j}{\sum_{j=1}^{m} C_j}$$

Where

m = total number of courses prescribed for the completion of the programme

Pj = grade points secured for the j^{th} course.

Cj = the number of credits assigned to j^{th} course

and Σ Cj = 68

Σ Cj = 08 for CGPA calculations in case of M.Tech. with Add-on certification

Σ Cj = 12 for CGPA calculations of specialization part in case of M.Tech. with Add-on certification

Percentage equivalence of SGPA & CGPA = (SGPA or CGPA) X10

10. AWARD OF CLASS

The students who have become eligible for award of degree shall be classified based on their CGPA secured, as per the Table (10) given below:

Table 10 : Class/ Division information.

Sl. No.	CGPA	Class / Division
1	8.0 and above	First Class with Distinction
2	6.5 and above but less than 8.0	First Class
3	6.0 and above but less than 6.5	Second Class
4	Less than 6.0	Pass Class

a) For the purpose of rewarding the accomplishers with ranks and awards, toppers in each branch discipline are identified, based on their academic performance (CGPA) in the following categories:

i) Ranking in M.Tech.

ii) Ranking in M.Tech. with Add-on certification

b) In addition, the 'Chairman's gold medal' and other 'Endowment Awards' are awarded to

R22 M.Tech. 2 YEAR PG PROGRAMME

the 'outstanding students' based on the overall performance which includes academic, co-curricular and extra-curricular activities, campus placements and competitive examinations. A committee appointed by the Vice-Chancellor will recommend the eligible student for the award, selected from the nominations received from the departments.

c) In addition, the institution may recognize exceptional performance such as music, dance, sports etc. and display of exceptional bravery from time to time.

d) Only such candidates who complete 68 credits (+12 credits) in the first 4 successive semesters shall be eligible to receive awards/ ranks.

e) The candidates availing spill over semesters will not be eligible for the award of merit scholarships.

11. AWARD OF DEGREE

On successful completion of prescribed requirements of the programme, the degree shall be conferred during the convocation of the VFSTR.

For the conferment of degree, the student has to fulfill the following requirements:

a) a bonafide student and undergone the course work of not less than two academic years and not more than four academic years from the date of joining.

b) successfully completed all the courses as prescribed in the respective curriculum.

c) acquired a minimum eligible credits i.e. 68 credits for the award of M.Tech. degree.

d) obtained no due certificates as prescribed by VFSTR.

e) no in-disciplinary proceedings pending against him / her.

Consequent upon being convinced, following an enquiry, the Academic council may resolve to withdraw the degree / diploma / any other certification provided by the institute. The aggrieved may however prefer for a review of such decision by the Academic Council, citing cogent reasons for review or go in for an appeal to the, BoM of the institute.

12. Honorable exit with Engineering PG Diploma

In line with NEP-2020, an optional exit is provided for a candidate who has earned a min. of 40 credits and has completed all the requirements up to the end of two semesters.

Engineering PG Diploma will be awarded in respective branches of specialization. In case the candidate fails to earn 40 credits, a suitable certification will be awarded during his / her exit from M.Tech. degree.

Semester-wise transcript and a consolidated transcript will be given to the candidates during their exit from the registered program.

Such a candidate who has exited can seek re-entry to complete M.Tech. by surrendering the Engineering PG Diploma. A committee constituted by Vice-Chancellor will scrutiny all such re-entry requests and recommend the plan of action. However, the max. duration of programme should be limited to four years and further extension beyond the stipulated max. duration of study has to be approved by Academic Council, if the candidate appeals for an extension.

13. Onward Continuation to Ph.D. Program

As per the section 6.2 of R-22 Ph.D. regulations, candidates pursuing M.Tech. at VFSTR, who have completed all the courses prescribed for the first 2 semesters with a minimum of 60% or equivalent CGPA may be considered for onward continuation to Ph.D. program with a provisional admission to Ph.D.

For such candidates, a faculty mentor is allocated after the provisional admission. Mentor could become a Research Supervisor for the Ph.D program after confirmation of Ph.D admission at VFSTR, which is after formally completing M.Tech degree requirements.

Candidate in consultation with the faculty mentor shall identify the broad area of research topic and can utilize the M.Tech Project as a preliminary work before commencing the intensive research work during Ph.D programme. The M.Tech project work under the guidance of faculty mentor should satisfy all the mandates prescribed in the regulations of M.Tech. However, candidate is required to hold a Master's degree in Engineering / Technology with a minimum of 60% or equivalent CGPA before being formally admitted into the Ph.D program

14. Volunteer 'Drop' with Sabbatical Semester option

A candidate may exercise his option to voluntarily exit from M.Tech. programme temporarily for a semester during the M.Tech. programme, by registering for a 'DROP option' in the beginning of the semester after completion of first two semesters. The DROP can be exercised to take up special Internship / Innovation / Exploratory / Entrepreneurship / Advanced research / Start-up and such related activities. Under such circumstances a candidate can normally avail DROP over two successive semesters. Such 'Drop' semester will be identified as Sabbatical semesters.

Such a candidate has to pay the regular semester fee if such a Drop option is utilized during the first 4 semesters of M.Tech., and has to pay a nominal semester maintenance fee during the spillover period, if a candidate has not yet completed the credit requirements.

Upon returning from such a temporary exit, a candidate may continue his M.Tech. studies utilizing the provision of spillover period. A candidate may also submit a claim for Credit equivalence for the activities undertaken during the sabbatical period. The equivalence committee would evaluate and assess the academic equivalence of the work carried out and would recommend the credit equivalence and credit transfer to be granted together with the grades that could be attributed, if applicable. However, the max. duration of programme should be limited to four years and further extension beyond the stipulated max. duration of study has to be approved by Academic Council, if the candidate appeals for an extension.

14.1 Volunteer 'Drop' with Semester Drop option

A candidate may exercise his option to voluntarily exit from M.Tech. programme temporarily for a semester during the M.Tech. programme, by registering for a 'DROP option' in the beginning of the semester to meet the family / personal exigencies. All the norms as mentioned in the section (14) shall be applicable for the candidates utilizing semester drop option.

15. INTERPRETATION OF RULES

a. The academic rules and regulations should be read as a whole for the purpose of any interpretation.

b. For the matter(s) NOT covered herein above or for unforeseen circumstances, but arising during the course of the implementation of the above regulations. The Vice-Chancellor shall be authorized to remove the difficulties and decide upon the matters. The same shall be reported in the next meeting of Academic Council for ratification and subsequently informed to BoM.

c. The Institution may change or amend the academic rules and regulations or curriculum at any time, and the changes or amendments made shall be applicable to all the students with effect from the dates, notified by the Institution.

d. Procedure and explanation to any section can be floated by the office of Dean AAA as applicable from time to time with due approval by the chairman of Academic Council.

R22 M.Tech.
2 YEAR
PG PROGRAMME

R22 - M.Tech. - Course structure

I Year I Semester

Course Code	Course Title	L	T	P	C
	Professional Core - 1	2	2	2	4
	Professional Core – 2	2	2	2	4
	Professional Core – 3	2	2	2	4
	Department Elective – 1	2	-	2	3
	Department Elective – 2	2	-	2	3
	Cyber security	1	2	-	2
	Employment Orientation Program	-	2	2	2
Total		**11**	**10**	**12**	**22**
		33 Hrs			

I Year II Semester

Course Code	Course Title	L	T	P	C
	Professional Core – 4	2	2	2	4
	Professional Core – 5	2	2	2	4
	Department Elective – 3	2	-	2	3
	Department Elective – 4	2	-	2	3
	Research Methodology & IPR	1	2		2
	Inter Departmental project	-	1	3	2
	Teaching assistantship	-	-	4	2
Total					20
	Add-on certification course -1	3	-	2	4
Total		11	7	17	24
		35 Hrs			

II Year I Semester

Course Code	Course Title	L	T	P	C
	Project / Internship	-	2	24	13
	Add-on certification course -2 (MOOCs / Self-Study Course)	4	-	-	4
Grand Total		**4**	**2**	**24**	**17**

II Year II Semester

Course Code	Course Title	L	T	P	C
	Project / Internship	-	2	24	13
	Add-on certification course -3 (MOOCs/ Self-Study Course)	4	-	-	4
Grand Total		**4**	**2**	**24**	**17**

VIGNAN'S
Foundation for Science, Technology & Research
(Deemed to be University)
-Estd. u/s 3 of UGC Act 1956

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Annexure I

Program: M. Tech **Regulation: R22**

COURSE STRUCTURE

I Year I Semester

S. No.	Course Title	L	T	P	C
1	Data Structures and Algorithms	2	2	2	4
2	Machine Learning	2	2	2	4
3	Internet of Things	2	2	2	4
4	Department Elective – 1	2	0	2	3
5	Department Elective – 2	2	0	2	3
6	Cyber Security	1	2	0	2
7	Employment Orientation Program	0	2	2	2
		11	10	12	22
	Grand Total	**33**			**22**

I Year II Semester

S. No.	Course Title	L	T	P	C
1	Cloud Computing	2	2	2	4
2	Big Data and Analytics	2	2	2	4
3	Department Elective – 3	2	0	2	3
4	Department Elective – 4	2	0	2	3
5	Research Methodology & IPR	1	2	0	2
6	Inter-Departmental Project	0	1	3	2
7	Teaching Activity	0	0	4	2
	Total	9	7	15	**20**
8	Add-on certification course - 1	3	0	2	4
		12	7	17	24
	Grand Total	**36**			**24**

II Year I Semester

S. No.	Course Title	L	T	P	C
1	Project / Internship	0	2	24	13
2	Add-on certification course – 2 (MOOCs / Self-Study Course)	4	0	0	4
	Grand Total	4	2	24	17

II Year II Semester

S. No.	Course Title	L	T	P	C
1	Project / Internship	0	2	24	13
2	Add-on certification course – 3 (MOOCs / Self-Study Course)	4	0	0	4
	Grand Total	4	2	24	**17**

Department Electives – Stream-wise

Artificial Intelligence and Machine Learning

S. No.	Course Title	L	T	P	C
1	Artificial Intelligence	2	0	2	3
2	Artificial Neural Networks	2	2	0	3
3	Deep Learning	2	0	2	3
4	Computer Vision	2	0	2	3
5	Pattern Recognition	2	2	0	3
6	Digital Image Processing	2	0	2	3

Data Science

S. No.	Course Title	L	T	P	C
1	Data Handling and Visualization	2	0	2	3
2	Statistical Foundations of Data Science	2	0	2	3
3	Natural Language Processing	2	2	0	3
4	Deep Learning	2	0	2	3
5	Time Series Analysis and Forecasting	2	0	2	3
6	Kernel Methods for Pattern Analysis	2	0	2	3

Cyber Security

S. No.	Course Title	L	T	P	C
1	Wireless Sensor Networks	2	0	2	3
2	Mobile Adhoc Networks	2	0	2	3
3	Blockchain Technologies	2	0	2	3
4	Mobile and Wireless Security	2	0	2	3
5	Advanced Cryptography	2	0	2	3
6	Digital Forensics	2	0	2	3

22CSB101 - DATA STRUCTURES AND ALGORITHMS

Hours per week:

L	T	P	C
2	2	2	4

PREREQUISITE KNOWLEDGE: Programming in C

COURSE DESCRIPTION AND OBJECTIVES:

This course introduces students to the analysis and design of computer algorithms. The course is intended to provide the foundations of the practical implementation and usage of Algorithms and Data Structures. One objective is to ensure that the student evolves into a competent programmer capable of designing and analysing implementations of algorithms and data structures for different kinds of problems. The second objective is to expose the student to the algorithm analysis techniques, to the theory of reductions, and to the classification of problems into complexity classes like NP.

MODULE-1

UNIT-1 **8L+8T+8P=24 Hours**

Elementary Data Structures: Trees, binary heaps, Hashing, Balanced Search Trees - Properties and Abstract Data Types (ADT) of AVL, Red-Black and Splay Trees, Disjoint set data structure: Union-find

Introduction to Algorithm Analysis: Algorithm, Asymptotic Notation Recurrences: Substitution, Iteration, and Master method.

UNIT-2 **8L+8T+8P=24 Hours**

Divide and Conquer: General method, Applications - Binary search, Merge sort, Quick sort, Strassen's Matrix multiplication.

Greedy Method: General method, Applications - Fractional knapsack problem, Minimum cost spanning trees, Single source shortest path problem

PRACTICES:

- Implementation of a Red-Black tree operation.
- Implementation of a Splay tree operation.
- Implement a program to find the closest pair of points using a divide-and-conquer strategy. Use the random number generator to generate a large number of points in a unit square as input to the algorithm. Test the correctness of the algorithm by using a brute force method.
- Sort a given set of elements using the following methods and determine the time required to sort the elements. Repeat the experiment for different values of n, the number of elements in the list to be sorted and plot a graph of the time taken versus n inputs. The elements can be read from a file or can be generated using the random number generator.
    a) a. Quick sort b. Merge sort
- Search for a given set of elements using the Binary Search and determine the time required to search the given element. Repeat the experiment for different values of n, the number of elements in the list to be sorted and plot a graph of the time taken versus no. of elements. The elements can be read from a file or can be generated using the random number generator.
- Implement the following using divide and conquer approach.
    a) To multiply two given square matrices.
    b) To multiply two given square matrices using Strassen's matrix multiplication.

MODULE-2

UNIT-1 **8L+8T+8P=24 Hours**

Greedy Method: General method, Applications - Fractional knapsack problem, Minimum cost spanning trees, Single source shortest path problem

Graph Algorithms: BFS, Applications of BFS, bipartite graphs, Depth First Search (DFS), Application

Of DFS: Topological Sort, Cycle Detection, Checking Whether a Digraph is Strongly connected or not.

UNIT-2 **8L+8T+8P=24 Hours**

Dynamic Programming: General method, Applications - Matrix chain multiplication, Optimal binary search trees, 0/1 knapsack problem, All pairs shortest path problem, Travelling salesperson problem and design, Longest Common Subsequence.

Backtracking: General method, Applications - N-queen problem, Sum of subsets problem

Intractability and NP-Completeness: The class NP, Satisfiability, NP-hard and NP-complete problems, proving a problem is NP-complete. Approximation algorithms for NP-hard problems

PRACTICES:

- Design the Algorithm to solve Job sequencing with deadlines problem and Analyze its time complexity. Implement the above algorithm using Greedy method.
- Design the Algorithm to solve fractional Knapsack problem using Greedy method. Analyze the time complexity and implement the above algorithm.
- Design the Algorithm to find minimum spanning tree and its cost for an undirected graph. Analyze the time complexity and implement the above algorithm.
- Design the Algorithm to find all pairs shortest path problem by using dynamic programming approach. Analyze its time complexity and implement the above algorithm.
- Design the Algorithm to find optimal binary search tree and its cost by using dynamic programming approach. Analyze its time complexity and implement the above algorithm.
- Design the Algorithm to find optimal order of matrix chain multiplication and its cost using dynamic programming approach. Analyze its time complexity and implement the above algorithm.
- Design the Algorithm to find optimal route for travelling sales person problem and its cost by using dynamic Programming approach. Analyze its time complexity and implement the above algorithm.
- Design the Algorithm to solve N-queens problem by using backtracking approach and Analyze its time complexity. Implement the above algorithm.
- Design the Algorithm to solve sum of subsets problem using backtracking approach and Analyze its time complexity. Implement the above algorithm.
- Design the Algorithm to solve 0/1 Knapsack problem using Branch and Bound method. Analyze the time complexity and Implement the above algorithm.

SKILLS:

- Be able to Design and Analyse programming problem statements
- Choose appropriate data structures and algorithms, understand the ADT/libraries, and use it to design algorithms for a specific problem.
- Be able to understand the necessary mathematical abstraction to solve problems
- Be able to come up with analysis of efficiency and proofs of correctness
- To be able to comprehend and select algorithm design approaches in a problem specific manner

COURSE OUTCOMES:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1.	Analyze the asymptotic performance of algorithms.	Analyze	1	1,2,12
2.	Demonstrate a familiarity with major algorithms and data structures	Apply	1	1, 2,3, 5, 12
3.	Apply important algorithmic design paradigms and methods of analysis.	Apply	2	1, 2, 3, 5, 12
4.	Synthesize efficient algorithms in common engineering design situations	Analyze	2	1, 2,3,5, 12
5.	Investigate computational complexity of different class of problems	Evaluate	2	1, 2,4,12

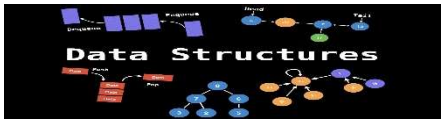
TEXT BOOKS:

1. Ellis Horowitz, Sartaj Sahni and Rajasekaaran "Fundamentals of Computer Algorithms", second edition, University press.
2. Sartaj Sahni, "Data Structures, Algorithms and Applications in java", University Press

REFERENCE BOOKS:

1. T.H.Cormen, C.E.Leiserson, R.L.Rivest,and C.Stein, "Introduction to Algorithms", second edition ,PHI Pvt. Ltd.
2. Aho, Ullman and Hopcroft, "Design and Analysis of algorithms", Pearson education.
3. Richard Johnson baugh and Marcus Schaefer , "Algorithm Design: Foundations, Analysis and Internet examples, Algorithms", Pearson Education.
4. Anany Levitin, "Introduction to the Design and Analysis of Algorithms", 3rd Edition by, AddisonWesley.
5. Jon Kleinberg and Eva Tardos , "Algorithm Design", Pearson.

https://www.youtube.com/watch?v=Qmt0QwzEmh0



22CSB102 - MACHINE LEARNING

Hours per week:

L	T	P	C
2	2	2	4

PREREQUISITE KNOWLEDGE: Statistics, Probability and Linear algebra, Python programming.

COURSE DESCRIPTION AND OBJECTIVES:

This course provides a broad introduction to machine learning, datamining, and statistical pattern recognition. Topics include (i) Supervised learning (parametric/non-parametric algorithms, support vector machines, kernels, neural networks). (ii) Unsupervised learning (clustering, dimensionality reduction, recommender systems, deep learning). (iii) Best practices in machine learning (bias/variance theory; innovation process in machine learning and AI). The course will also draw from numerous case studies and applications, so that students' can also learn how to apply learning algorithms to build smart robots (perception, control), text understanding (web search, anti-spam), computer vision, medical informatics, audio, database mining, and other areas.)

MODULE-1

UNIT-1 **8L+8T+8P=24 Hours**

INTRODUCTION

What is machine learning? Machine learning applications; Types of Learning: Supervised learning; Un-supervised learning; Reinforcement learning**.** Learning Associations

Understanding Data: Descriptive Statistics, Outlier, Handling Missing Values, Encode the Categorical data.

Model Training Essentials: Data Preprocessing, Data Visualization Tools; Bias–Variance Trade-off. Hypothesis Testing and Variable Selection, Class Imbalance, SMOTE; Training, validation and Testiong; Cross Validation (validation set, Leave-One-Cut (LOO), k-fold strategies) and bootstrap; Evaluation measures-Error functions, Confusion Matrix, Accuracy, Precision and Recall, F1 Score; Overfitting and Underfitting.

Regression Analysis: Linear Regression, Simple and Multiple Linear Regression, Polynomial Regression, Logistic Regression, Multi nominal Regression. Ordinary Least Squares Method, Model Shrinkage-Ridge, and LASSO regression.

UNIT-2 **8L+8T+8P=24 Hours**

FEATURE SELECTION

Feature Selection Strategies: Problem statement and Uses, Filter methods, Wrapper methods, Embedded methods. Branch and bound algorithm, Sequential forward/backward selection algorithms.

Dimensionality Reduction: Singular value decomposition, matrix factorization, Linear discriminant Analysis, Principal components analysis.

MODULE-2

UNIT-1 **8L+8T+8P=24 Hours**

CLASSIFICATION

Classification: Binary, Multi-class and Multi-label Classification; K-Nearest Neighbours, Support Vector Machines, Decision Trees, The Naïve Bayes' Classifier, Perceptron ANN model.

Ensemble Methods: Ensemble Learning Model Combination Schemes, Voting, Error-Correcting Output Codes, Bagging: Random Forest Trees, Boosting: Adaboost, Stacking.

UNIT-2 **8L+8T+8P=24 Hours**

CLUSTERING

Clustering: Different distance functions and similarity measures, K-means clustering, Medoids, Hierarchical Clustering-Single linkage and Complete linkage clustering, Graph based Clustering -MST, DBSCAN, Spectral clustering, k-medoids clustering.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1.	Apply a wide variety of learning algorithms such as Probabilistic, Discriminative and Generative algorithms for a given application.	Apply	1,2	1
2.	Design an end-to-end Machine-learning model to realize solutions for real-world problems.	Apply	1	(1,2,3,5,12)
3.	Learn different techniques employed for the dimension reduction techniques.	Create	1,2	(1,2,3,5,12)
4.	Analyze and evaluate the performance of various machine learning models approaches on different kinds of data.	Analyze	2	(1,2,3,5,12)

TEXT BOOKS:

1. Ethem Alpaydin, “Introduction to Machine Learning”, 3rd Edition, The MIT Press, 2014.

2. Flach, Peter. “Machine learning: the art and science of algorithms that make sense of data”.

Cambridge University Press, 2012.

REFERENCE BOOKS:

1. Murphy, Kevin P. Machine learning: a probabilistic perspective. MIT press, 2012.
2. Aurélien Géron, “Hands-on Machine Learning with Scikit Learn and Tensor Flow”, O’reilly, 2017.
3. Gareth James, Daniela Witten, Trevor Hastie, and Robert Tibshirani, “An Introduction to Statistical Learning with Applications in R”, Springer, 2013. (ISLR).

22CSB103 - INTERNET OF THINGS

Hours per week:

L	T	P	C
2	2	2	4

PREREQUISITE KNOWLEDGE: Computer networks

COURSE DESCRIPTION AND OBJECTIVES:

This course gives a foundation in the Internet of Things, including the components, tools, and analysis by teaching the concepts behind the IoT and a look at real-world solutions. Familiarize with networking and application program interfaces for IoT. IoT cuts across different application domain verticals ranging from civilian to defense sectors. These domains include agriculture, space, healthcare, manufacturing, construction, water, and mining, which are presently transitioning their legacy infrastructure to support a IoT. Enable to create various use cases of IoT

MODULE-1

UNIT-1 **8L+8T+8P=24 Hours**

INTERNET OF THINGS FUNDAMENTALS

Introduction to Internet of Things; Physical design & Functional Block of IoT, Device architectures, CoreIoT Functional Stack; Resource constrained devices; Sensors and Components; IoT Enabling Technologies. Societal Benefits of IoT (Domain Specific), Risks, Privacy, and Security.

Network And Communication Protocols: Network Layer Model (OSI or TCP/IP), Network Topologies, Clouding computing, fog computing and big data technology, data handling and analytics, Introduction of Software define networking, Introduction of API and how to define new API.

UNIT-2 **8L+8T+8P=24 Hours**

IOT AND M2M

Software defined networks, Network function virtualization, difference between SDN and NFV for IoT Basics of IoT System Management with NETCONF-YANG: SDN; NFV; Need for IOT Systems Management; SNMP-NETCONF, YANG; IOT Systems management with NETCONF-YANG.

PRACTICES:

- Identify different Sensors and IoT devices
- Identify the Components in Raspberry pi, Arduino, and UNO boards
- Examine IoT levels with any one domain specific application like home automation, weather monitoring system etc.
- Connecting Arduino with Mobile Device Using the Bluetooth Module.
- Integrating Ethernet Shield. Read data from sensor and send it to a requesting client using socket communication. Note: The client and server should be connected to same local area network.
- Interfacing Cloud and Push sensor data to cloud - Use Arduino to Upload data from Environmental Sensors to Cloud Server.
- Data analysis and Visualization Access the data pushed from sensor to cloud and apply any data analytics or visualization services
- Design the Network Configuration and System Management with IoT devices using NETCONFYANG.
- Design the Network Configuration and System Management with IoT devices using SNMPNETCONF.

MODULE-2

UNIT-1 **8L+8T+8P=24 Hours**

INTRODUCTION TO SYSTEMS DESIGN & DEVELOPMENT

IoT system building blocks, Arduino, Node MCU– Board details, IDE programming; Raspberry Pi-Model and Interfaces, Platform: Axonize, Blynk IoT platform, Fogwing.

UNIT-2 **8L+8T+8P=24 Hours**

PROGRAMMING AND CASE STUDY

Embedded C vs Python; Operating systems for constrained devices; Domain Specific IoT Application, Task Support IoT, Industrial internet of things, connected vehicles, Agriculture and IOT. Heath care and IOT, Smart grid system, Smart cities IoT Wearables, The Refrigerator, Weather Monitoring System – Case study- Design, Programming and Execution.

PRACTICES:

- Demonstration and study of Raspberry Pi board, GPIO Pins and familiarity of various sensors.
- Demonstration and study of other Hardware board of IoT such as Arduino Uno and NodeMCU.
- Design and Implementation of controlling LED-using Python in Raspberry Pi board.

- Design and Implementation of sensing light through LDR using Python in Raspberry Pi board.
- Design and Implementation to find obstacles through sensor using Python in Raspberry Pi board.
- Design and Implementation of sensing and display temperature using Python in Raspberry Pi board.
- Design and Implementation of detecting noise through microphone sensor using Python in Raspberry Pi board.
- Design and Implementation of output devices through relay using Python in Raspberry Pi board.
- Design and Implementation of vibration sensor using Python in Raspberry Pi board.
- Design and Implementation of uploading sensor data into cloud using Python.
- Identify a problem in your local area or college which can be solved by integrating the things you learned so far and create a prototype to solve it

SKILLS:

- Sensor Identification and IoT system design.
- Sensor data analysis.
- Tool usage for developing IoT applications

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1.	Illustrate the impact and challenges posed by IoT networks leading to new architectural models.	Analyze	1	1,2,4
2	Develop the Internet communication protocols for IoT applications	Design	1	1,3,5
3.	Design an end-to-end Machine-learning model to realize solutions for real-world problems	Design	1	1,3,5
4.	Apply various machine-learning models to develop IoT applications.	Apply	2	1,2,3,5
5.	Compare and contrast the deployment of smart objects and the technologies to connect them to network	Evaluate	2	1,3,4,5
6.	Design and develop a solution for a new applications with cloud and TCP/IP Model.	Create	2	1,2,3,4,5

TEXT BOOKS:

1. Arshdeep Bahga and Vijay Madisetti “Internet of Things: A Hands-on Approach”, Universities Press, 2015.
2. Rajkumar Buyya and Amir Vahid Dastjerdi “Internet of Things: Principles and Paradigms”, Morgan Kaufmann; 1st Edition, May 25, 2016,
3. Bahga, Arshdeep, and Vijay Madisetti. Internet of Things: A hands-on approach. Vpt, 2014.

REFERENCE BOOKS:

1. NPTEL Course on: Introduction of Internet of Things. By Prof. Sudip Misra | IIT Kharagpur.
2. Matt Richardson & Shawn Wallace “Getting Started with Raspberry Pi”, O’Reilly (SPD), 2014, ISBN: 9789350239759.
3. Waltenegus Dargie, Christian Poellabauer, “Fundamentals of Wireless Sensor Networks: Theory and Practice”.
4. Beginning Sensor networks with Arduino and Raspberry Pi – Charles Bell, A press, and 2013.

22CSB104 - CLOUD COMPUTING

L	T	P	C
3	0	2	4

PREREQUISITE KNOWLEDGE: Operating systems and Computer Networks.

COURSE DESCRIPTION AND OBJECTIVES:
This course deals with the computing model, which enables information, software, and shared resources to be provisioned over the network as services in an on-demand manner. The main objective of this course is to enable the student to understand the evolution of cloud computing through its supporting technologies virtualization and the architectures of top cloud platforms.

MODULE-I

UNIT– I **[12L+0T+8 P = 20Hours]**

INTRODUCTION: Definition, Historical developments, Computing platforms, and technologies.
PRINCIPLES OF PARALLEL AND DISTRIBUTED COMPUTING: Parallel versus distributed computing, Elements of parallel computing, Elements of distributed computing, Technologies for distributed computing.

UNIT – II **[12L+0T+8 P = 20Hours]**

VIRTUALIZATION: Introduction, Characteristics, Virtualization techniques, Virtualization and cloud computing, Pros. and cons. of virtualization, Technology examples.
CLOUD COMPUTING ARCHITECTURE: Introduction, Cloud reference model, Types of clouds, Economics of clouds, Open challenges.
CLOUD PLATFORMS IN INDUSTRY: Amazon web Services, Google app engine, Microsoft Azure.

PRACTICE ASSIGNMENTS:

1. Probability and statistical analysis of performing hardware virtualization using VMware workstation.
2. Launch Amazon Linux EC2 Instance and connect the windows client to it.
3. Launch Windows EC2 instance in AWS and connect windows client to it.
4. Configure Web Server on Amazon Linux instance with Elastic IP.
5. Manage Elastic Block Storage (EBS).
6. Configure Amazon Simple Storage Service (Amazon s3).
7. Configure Amazon S3 Glacier.
8. Configure Amazon EFS.

MODULE-II

UNIT – I **[12L+0T+8 P=20Hours]**

ANEKA: Cloud application platform, Framework overview, Anatomy of the Aneka container, Building Aneka clouds, Cloud programming, and management.
HIGH THROUGHPUT COMPUTING- TASK PROGRAMMING: Task computing, Task-based application models, Aneka task-based programming.

UNIT - II **[12L+0T+8 P=20Hours]**

CLOUD APPLICATIONS & GLOBAL AND LOCAL IMPACT OF CLOUD COMPUTING ON SOCIETY:

Scientific applications in healthcare, biology, geo science; Business applications in– CRM and ERP, productivity, social networking, media applications, multiplayer online gaming.

ETHICAL CONSIDERATION FOR CLOUD COMPUTING: Cloud Security Risks, Security: The Top Concern for Cloud Users, Privacy and Privacy Impact Assessment, Trust, Operating System Security, Virtual Machine Security,

PRACTICE ASSIGNMENTS:

1. Configure Amazon Virtual Private Cloud (VPC).
    a) Create your own VPC.
    b) Create a public subnet.
    c) Create a private subnet.
    d) Create an Internet gateway and attach to your VPC.
    e) Create Pubic Routing Table, associate subnet and add routing rules.
    f) Create Private Routing Table, associate subnet and add routing Rules.
    g) To launch Windows instance in Public subnet.
2. Configure Amazon Elastic Load Balancer.
3. Configure Relational Database Service (RDS).

SKILLS:

- Gain knowledge of different types of Cloud Service Providers.
- Explore basic design issues of Cloud Applications.
- Compare & evaluate the optimum costs in the data transmissions.

ACTIVITIES:

- ✓ *Create a Virtual environment using VMware. Tool.*
- ✓ *Implementing EC2 Instance with services like Storage, databases, and networking.*

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	**Deploying** a VM Image to understand the evolution of cloud computing in contrast to the traditional approach.	Apply	1	1,5
2	**Evaluate** the concepts of various virtualization technologies.	Evaluate	1	2,5
3	**Analyze** the trade-offs, security, and privacy issues among application deployment in the various cloud and the local infrastructure.	Analyze	2	2,5
4	**Deploy** applications over commercial cloud computing infrastructures.	Apply	2	1,5

TEXT BOOKS:

1.Raj Kumar Buyya, C Vecchiola and S TSelvi , “Mastering Cloud Computing”, 1st edition, Tata McGraw Hill Education (India), 2013.
2. RajKumarBuyya, Broberg J and GoscinskiA, “Cloud Computing - Principles and Paradigms”, 1st edition, Wiley, 2011.

REFERENCE BOOKS:

1. David S. Linthicum , Cloud Computing and SOA Convergence in Your Enterprise A Step-by-Step Guide, Pearson 2010.
2. Dr. Kumar Saurabh, Cloud Computing, 2nd Edition, Wiley India 2012.
3. Rittinghouse J W, and Ransome J F, “Cloud Computing - Implementation, Management, and Security”, 1st edition, CRC Press, 2009.
4. Michael Wittig and Andreas Wittig, “Amazon Web Services in Action”, 2nd edition, Manning Publications, 2015.
5. Tim Mather, Subra Kumaraswamy, Shahed Latif, “Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance”, O’ReillyMediaInc, 2009

Image source:

https://www.bing.com/images/search?view=detailV2&ccid=vN86lZCA&id=5D96871BF0046552849C5EF7C5D20920877D50CF&thid=OIP.vN86lZCAdr3RDSXc0cuHcAHaE8&mediaurl=https%3a%2f%2fwww.novacom.gr%2fwp-content%2fuploads%2f2013%2f10%2fLaw-Firm-Cloud-Technology-1.jpg&exph=1200&expw=1800&q=+Cloud+Computing&simid=608014455797203951&FORM=IRPRST&ck=D59E9D70089F50C971D55B07D21E4C0E&selectedIndex=7&ajaxhist=0&ajaxserp=0

Image file name: Cloud Computing

22CSB105 - BIG DATA AND ANALYTICS

Hours Per Week:

L	T	P	C
3	0	2	4

PREREQUISITE KNOWLEDGE: Basics of databases, Data mining.

COURSE DESCRIPTION AND OBJECTIVES:

This course serves as an introductory course to gain knowledge on analyzing Big Data. Expecting to face Big Data storage, processing, analysis, visualization, and application issues on both workplaces and research environments. Get insight on what tools, algorithms, and platforms to use on which types of real-world use cases.

MODULE-1

UNIT-1 **12L+0T+8P=20 Hours**

INTRODUCTION TO BIG DATA

Data, Characteristics of data and Types of digital data, Sources of data, working with unstructured data, Evolution and Definition of big data, Characteristics and Need of big data, Challenges of big data**.**

Big data analytics: Overview of business intelligence, Data science and Analytics, Meaning and Characteristics of big data analytics, Need of big data analytics, Classification of analytics, Challenges to big data analytics, Importance of big data analytics, Basic terminologies in big data environment.

UNIT-2 **12L+0T+8P=20 Hours**

INTRODUCTION TO HADOOP

Introducing Hadoop, need of Hadoop, limitations of RDBMS, RDBMS versus Hadoop, Distributed Computing Challenges, History of Hadoop, Hadoop Overview, Use Case of Hadoop, Hadoop Distributors, HDFS (Hadoop Distributed File System)

PROCESSING DATA WITH HADOOP:

Introduction, Mapper, Reducer, Combiner, Partitioner, Searching, Sorting, Compression, Real time applications using Map Reduce, combiner, Partitioner, matrix multiplication using Map Reduce and page rank algorithm using Map Reduce, Managing Resources and Applications with Hadoop YARN (Yet another Resource Negotiator), Interacting with Hadoop Ecosystem.

PRACTICES:

- Hadoop installation in standalone machine.
- Pig installation.
- Setup of Hadoop cluster.
- HDFS basic command-line file operations.
- HDFS monitoring User Interface.

MODULE-2

UNIT-1 **12L+0T+8P=20 Hours**

APPLICATIONS ON BIG DATA USING PIG AND HIVE

Introduction to Pig, The Anatomy of Pig, Pig on Hadoop, Pig Philosophy, Use Case for Pig: ETL Processing, Pig Latin Overview, Data Types in Pig, Running Pig, Execution Modes of Pig, HDFS Commands, Relational Operators, Piggy Bank, Word Count Example using Pig, Pig at Yahoo!
Hive: Introduction to Hive, Hive Architecture, Hive Data Types, Hive File Format, Hive Query Language (HQL), Partitions and bucketing, working with XML files, User-Defined Function (UDF) in Hive, Pig versus Hive, fundamentals of HBase and Zookeeper.

UNIT-2 **12L+0T+8P=20 Hours**

Spark Programming: Introduction, features of Spark, components of Spark, Programming with Resilient Distributed datasets (RDDS).
Predictive Analytics- Simple linear regression- Multiple linear regression- Interpretation of regression coefficients. Visualizations - Visual data analysis techniques- interaction techniques - Systems and applications

PRACTICES:

- Word Count Map Reduce program using Hadoop.
- Implementation of word count with combiner Map Reduce program.
- Practice on Map Reduce Monitoring User Interface.
- Implementation of Sort operation using Map Reduce.
- Map Reduce program to count the occurrence of similar words in a file by using partitioner.
- Design Map Reduce solution to find the years whose average sales is greater than 30.
- Input file format has year, sales of all months and average sales.
- Year Jan Feb Mar April May Jun July Aug Sep Oct Nov Dec Average.
- Map Reduce program to find Dept wise salary.
- Empno Emp Name Dept Salary.
- Designing of Pig Latin scripts to sort, group, join, project and filter the data.
- Implementation of Word count using Pig.
- Creation of Database and tables using Hive query language.
- Implementation of partitions and buckets using Hive query language.
- Implementation of word count using spark RDD.
- The data set Vehicle is available in kaggle. Load it and explore its help page to grab a minimal understanding of the data and then

Answer the following questions:

1. Obtain a random split of the data into two sub-sets using the proportion 80%-20%. Solution.
2. Obtain a linear discriminant using the larger set. Solution
3. Obtain the predictions of the obtained model on the smaller set. Solution
4. Obtain a confusion matrix of the predictions and calculate the respective accuracy

- Write a Map Reduce program that mines weather data. Weather sensors collecting data every hour at many locations across the globe gather large volume of log data, which is a good candidate for analysis with MapReduce, since it is semi structured and record-oriented. Data available at:
  https://github.com/tomwhite/hadoopbook/tree/master/input/ncdc/all.
  Find average, max and min temperature for each year in NCDC data set?
  Filter the readings of a set based on value of the measurement, Output the line of input files associate.
- Write a single Spark application that:
- Transposes the original Amazon food dataset, obtaining a PairRDD of the type: <user_id> → <list of the product_ids reviewed by user_id>
- Counts the frequencies of all the pairs of products reviewed together;
- Writes on the output folder all the pairs of products that appear more than once and their frequencies. The pairs of products must be sorted by frequency.

SKILLS:

- Build and maintain reliable, scalable, distributed systems with Apache Hadoop
- Develop Map Reduce based applications for Big data.
- Design and build applications using Hive and pig based Big data applications
- Learn tips and tricks for big data use cases and solutions.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Use of Big data frameworks like Hadoop and NOSQL to efficiently store and process Big data to generate analytics.	Apply	1	1, 2, 5,9,10,12
2	Design a solution for data intensive problems usingMap Reduce paradigm.	Apply	1	1, 2, 5, 9,10,12
3	Design and analyze the solutions of Big data using Pig and Hive to solve data intensive and togenerate analytics.	Apply	2	1, 2, 3, 5, 9,10,12
4	Analyze Big data using Spark programming.	Analyze	2	1, 2, 3, 5, 9,10,12

TEXT BOOKS:

1. Seema Acharya, Subhashini Chellappan, “Big Data Analytics”, Wiley, 2015.
2. Holden Karau, Andy Konwinski, Patrick Wendell, MateiZaharia, “Learning Spark: Lightning-Fast Data Analysis”, O’Reilly Media, Inc., 2015.

REFERENCE BOOKS:

1. Boris Lublinsky, KevinT. Smith, Alexey Yakubovich, “Professional Hadoop Solutions”, Wiley, 2015.
2. Chris Eaton,Dirk deRooset al. , “Understanding Big data ”, McGraw Hill, 2012.
3. Tom White, “HADOOP: The definitive Guide”, O Reilly 2012.
4. Jiawei Han, Micheline Kamber “Data Mining Concepts and Techniques”, 2nd Edition, Elsevier, Reprinted 2008.
5. Da Ruan, Guoquing Chen, Etienne E.Kerre, Geert Wets, “Intelligent Data Mining”, Springer, 2007.
6. Paul Zikopoulos, Dirkde Roos, Krishnan Parasuraman, Thomas Deutsch, James Giles , David Corrigan, “Harness the Power of Big Data The IBM Big Data Platform”, Tata McGraw Hill Publications, 2012.
7. Arshdeep Bahga, Vijay Madisetti, “Big Data Science & Analytics: A Hands-on Approach", VPT, 2016.
8. Bart Baesens “Analytics in a Big Data World: The Essential Guide to Data Science and its Applications (WILEY Big Data Series)”, John Wiley & Sons,2011.

https://miro.medium.com/max/844/0*ARAg3FnAzy2e02Wy.png

22CSB801 - ARTIFICIAL INTELLIGENCE

Hours per week:

L	T	P	C
2	0	2	3

PREREQUISITE KNOWLEDGE: Probability and statistics.

COURSE DESCRIPTION AND OBJECTIVES: The primary objective of this course is to introduce the basic principles, techniques, and applications of Artificial Intelligence. In addition to this, student will understand the building blocks of AI such as search, knowledge representation, inference, logic and learning. This course enables the students to develop a small AI system for real time problems.

MODULE-1

UNIT – I **8L+0T+8P=16 Hours**

INTRODUCTION, OVERVIEW OF ARTIFICIAL INTELLIGENCE: Problems of AI, AI technique, Tic - Tac - Toe problem.

INTELLIGENT AGENTS: Agents & environment, nature of environment, structure of agents, goal based agents, utility based agents, learning agents.

Problem Solving, Problems, Problem Space & search: Defining the problem as state space search, production system, problem characteristics, and issues in the design of search programs.

UNIT – II **8L+0T+8P=16 Hours**

SEARCH TECHNIQUES: Problem solving agents, searching for solutions, uninformed search strategies: breadth first search, depth first search, depth limited search, bidirectional search, comparing uninformed search strategies.

HEURISTIC SEARCH STRATEGIES: Greedy best-first search, A* search, AO* search, memory bounded heuristic search. local search algorithms & optimization problems: Hill climbing search, simulated annealing search, local beam search, Constraint satisfaction problems: Local search for constraint satisfaction problems.

ADVERSARIAL SEARCH: Games, optimal decisions & strategies in games, the minimax search procedure, alpha-beta pruning.

PRACTICES:

- In the classical vacuum cleaner problem, we have two rooms and one vacuum cleaner. There is dirt in both the rooms and it is to be cleaned. The vacuum cleaner is present in any one of these rooms. Find the solution, how we can reach to reach a state in which both the rooms are clean and are dust free.
- In this problem, three missionaries and three cannibals must cross a river using a boat which can carry at most two people, under the constraint that, for both banks, that the missionaries present on the bank cannot be outnumbered by cannibals. The boat cannot cross the river by itself with no people on board. Find the solution, how to solve the given problem.
- You are given two jugs, a 4-gallon one and a 3-gallon one, a pump which has unlimited water which you can use to fill the jug, and the ground on which water may be poured.

Neither jug has any measuring markings on it. Find the solution, how can you get exactly 2 gallons of water in the 4-gallon jug?

- There is a farmer who wishes to cross a river but he is not alone. He also has a goat, a wolf, and a cabbage along with him. There is only one boat available which can support the farmer and either of the goat, wolf or the cabbage. So at a time, the boat can have only two objects (farmer and one other). But the problem is, if the goat and wolf are left alone (either in the boat or onshore), the wolf will eat the goat. Similarly, if the Goat and cabbage are left alone, then goat will eat the cabbage. The farmer wants to cross the river with all three of his belongings: goat, wolf, and cabbage. What strategy he should use to do so?
- Either place a block that doesn't have other blocks stacked on top of it on another block with the same behaviour, or on the table. The initial and the goal state are described by the exact position of each block. Find the solution, how to solve the given problem.
- Given a 3×3 board with 8 tiles (every tile has one number from 1 to 8) and one empty space. The objective is to place the numbers on tiles to match the final configuration using the empty space. We can slide four adjacent (left, right, above, and below) tiles into the empty space. Find the solution, how to solve the given problem by using using A* search algorithm.
- The rules of tic-tac-toe on the 3×3 field are as follows. Before the first turn all the field cells are empty. The two players take turns placing their signs into empty cells (the first player places Xs, the second player places Os). The player who places Xs goes first, the another one goes second. Find the solution, how to solve the given problem where the winner is the player who first gets three of his signs in a row next to each other (horizontal, vertical or diagonal).
- In crypt arithmetic problem, the digits (0-9) get substituted by some possible alphabets or symbols. The task in crypt arithmetic problem is to substitute each digit with an alphabet to get the result arithmetically correct. Find the solution, how to solve the given problem, where we can perform all the arithmetic operations on a given crypt arithmetic problem.

MODULE-2

UNIT-I **8L+0T+8P=16 Hours**

KNOWLEDGE & REASONING: Knowledge representation issues: Representation & mapping, approaches to knowledge representation. Using predicate logic: representing simple fact in logic, representing instant & ISA relationship, computable functions & predicates, resolution, natural deduction.

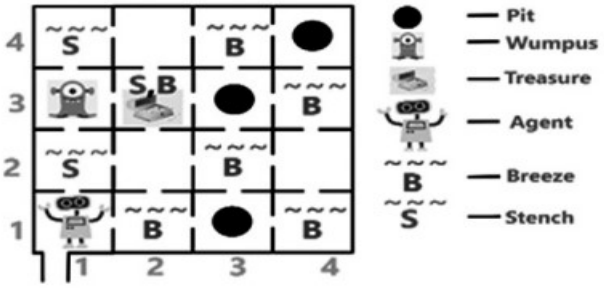
REPRESENTING KNOWLEDGE USING RULES: Procedural verses declarative knowledge, logic programming, forward verses backward reasoning, matching, control knowledge.
Probabilistic reasoning: Representing knowledge in an uncertain domain, the semantics of Bayesian networks.

UNIT - II **8L+0T+8P=16 Hours**

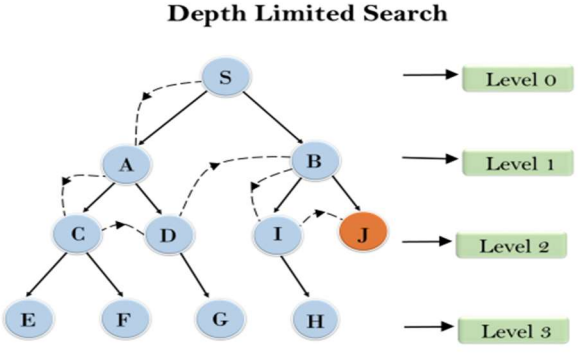
PLANNING: Overview, components of a planning system, Goal stack planning, Hierarchical planning, other planning techniques.
EXPERT SYSTEMS: Representing and using domain knowledge, expert system shells, and knowledge acquisition.

PRACTICES:

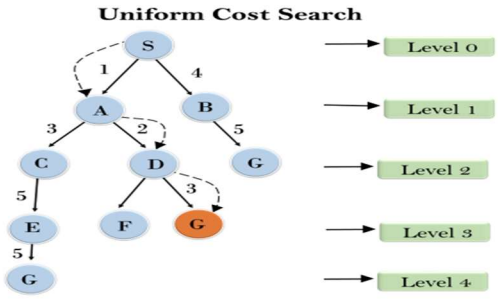
- The Wumpus world is a cave with 16 rooms (4×4). Each room is connected to others through walkways (no rooms are connected diagonally). The knowledge-based agent starts from Room
  [1, 1]. The cave has – some pits, a treasure and a beast named Wumpus. The Wumpus cannot move but eats the one who enters its room. If the agent enters the pit, it gets stuck there. The goal of the agent is to take the treasure and come out of the cave. The agent is rewarded, when the goal conditions are met. The agent is penalized, when it falls into a pit or being eaten by the Wumpus. Some elements support the agent to explore the cave, like -The Wumpus's adjacent rooms are stench. -The agent is given one arrow which it can use to kill the Wumpus when facing it (Wumpus screams when it is killed). – The adjacent rooms of the room with pits are filled with breeze. -The treasure room is always glittery. Find the Wumpus presented room.



- You are on one side of a river with a wolf, a goat, and a cabbage. You want to transport all three to the other side of the river, but you can only transport one object at a time. You cannot leave the wolf and the goat alone, or the cabbage and the goat alone; you are the only thing keeping them from eating each other. How can you transport everything from one side of the river to the other? Formulate it in terms of a Planning Domain Definition Language (PDDL).
- Implement Depth-Limited Search Algorithm for the following graph. Find the shortest path to reach to the goal node.



- Write a program and implement Uniform-cost Search Algorithm for the following weighted tree/graph. Find a path to the goal node which has the lowest cumulative cost.



- Implement the working of the decision tree based ID3 algorithm. Use an appropriate data set
  for building the decision tree and apply this knowledge to classify a new sample.
- Build an Artificial Neural Network by implementing the Back propagation algorithm and test the same using appropriate data sets.
- Implement the naïve Bayesian classifier for a sample training dataset. Compute the accuracy
  of the classifier, considering few test data sets.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Identify Artificial Intelligence (AI) problems in various domains and define the problems using state space search.	Analyze	1,2	1, 3
2	Apply search algorithms for solving various AI problems.	Apply	1,2	1, 2
3	Demonstrate knowledge representation and reasoning for solving real-world Problems.	Apply Create	1,2	1,6
4	Illustrate and implement planning to construct basic AI models and expert systems	Apply Create	1,2	1, 4

TEXT BOOKS:

1. Russell, S. and Norvig, P. Artificial Intelligence - A Modern Approach, 3rd edition, Prentice Hall., 2015.
2. Rich, E., Knight, K and Shankar, B. Artificial Intelligence, 3rd edition, Tata McGraw Hill.

REFERENCE BOOKS:

1. Introduction to Artificial Intelligence & Expert Systems, Patterson, PHI
2. Logic & Prolog Programming, Saroj Kaushik, New Age International
3. Expert Systems, Giarranto, VIKAS
4. Poole, D. and Mackworth, A. Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press, 2010
5. Luger, G.F. , Artificial Intelligence -Structures and Strategies for Complex Problem Solving, 6th edition, Pearson, 2008.

22CSB802 - ARTIFICIAL NEURAL NETWORKS

Hours per week:

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE: Engineering Mathematics

COURSE DESCRIPTION AND OBJECTIVES:

The course introduces the principles of neuro-computing with artificial neural networks, which are widely used for addressing real-world problems such as classification, regression, pattern recognition, data mining, time-series modelling, etc. This course majorly covers two kinds of learning such as supervised and unsupervised.

MODULE-1

UNIT-1 **08L+08T+0P=16 Hours**

INTRODUCTION TO ARTIFICAL NEURAL NETWORKS: Introduction; Artificial neural networks; Historical development of neural networks; Biological Neural Networks; Comparison between them and the computer; Comparison between artificial and biological neural network; Basic building blocks; Terminologies.

FUNDAMENTAL MODELS OF ARTIFICIAL NEURAL NETWORKS: Introduction, McCulloch-Pitts Neuron model; Learning rules - Hebbian learning rule, perceptron learning rule, Delta learning rule, Widrow-Hoff rule or least mean square (LMS) rule, Competitive learning rule; Out star learning; Boltzmann based learning; Hebb net.

UNIT-2 **08L+08T+0P=16 Hours**

PERCEPTRON NETWORKS: Introduction; Single layer perceptron; Brief introduction to multilayer perceptron networks.

ADALINE AND MADALINE NETWORKS: Introduction, Adaline, Madaline.

ASSOCIATIVE MEMORY NETWORKS: Introduction, Algorithms for pattern association, Hetero associative memory neural networks, auto associative memory network, Bi-directional associative memory.

MODULE-2

UNIT-1 **08L+08T+0P=16 Hours**

FEEDBACK NETWORKS: Introduction, Discrete Hopfiled Net, Continuous Hopfiled Net, Relation between BAM and Hopfiled Nets.

FEED FORWARD NETWORKS: Introduction, Back Propagation Network (BPN), Radial Basis Function Network (RBFN).

UNIT-2 **08L+08T+0P=16 Hours**

SELF ORGANIZING FEATURE MAP: Introduction; Methods used for determining the winner; Kohonen self-organizing feature maps; Learning vector quantization (LVQ); MaxNet, Maxican Hat, Hamming Net.

ADAPTIVE RESONANCE THEORY: Introduction, ART Fundamentals, ART1, ART2.

SKILLS:

- Learn to design and build different neural network models.
- Learn to develop learning algorithms for both supervised/ unsupervised learning.
- Gain the knowledge of network tuning, generalization and address over-fitting problems.

COURSE OUTCOMES:

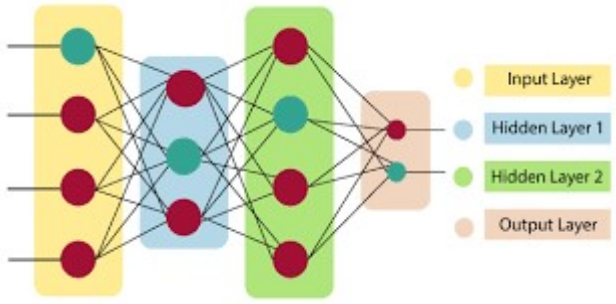
CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1.	Understand the differences between networks for supervised and unsupervised learning.	Understand	1	1
2.	Apply the linear and nonlinear models for learning the data.	Apply	1	1
3.	Analyse the performance of various neural networks on different kinds of data.	Analyze	1	3
4.	Evaluate the neural networks for classify/ cluster the data to achieve higher performance.	Evaluate	2	4
5.	Design/ Develop different neural networks such as MLP, SOM, Hopfiled net and ART etc.	Create	2	5

TEXT BOOK:

1. Sivanandam, S.Sumathi and S.N.Deepa; “Introduction toNeural Networks”, 2nd edition., TATA McGraw HILL: 2005.

REFERENCE BOOKS:

1. Simon. Hhaykin, “Neural networks A comprehensive foundations”, 2nd edition, Pearson Education, 2004.
2. B. Yegnanarayana, “Artificial neural networks”, 1st edition., Prentice Hall of India Pvt. Ltd, 2005.
3. Li Min Fu, “Neural networks in Computer intelligence”,1st edition., TMH, 2003.



https://static.javatpoint.com/tutorial/artificial-neural-network/images/artificial-neural-network4.png

22CSB803-DEEP LEARNING

Hours per week:

L	T	P	C
2	0	2	3

PREREQUISITE KNOWLEDGE: Machine Learning, Python Programming.

COURSE DESCRIPTION AND OBJECTIVES:

This course offers sufficient details required to understand the basic building blocks of various deep learning-based models. Especially, focuses on different types of neural network models like feed forward neural networks, convolutional neural networks, recurrent neural networks, and deep auto encoders. During this course the students build, train, and evaluate deep neural network models for various applications in image, text, and speech domains. In addition, throughout this course students will be able to understand hyper parameter tuning and other best practices to be followed while training deep neural network models.

MODULE-1

UNIT-1 **8L + 0T + 8P = 16 Hours**

EVOLUTION OF DEEP NEURAL NETWORKS

Deep Learning Intuition: History of Deep Learning, what is Deep Learning? Applications of Deep Learning.

Neural Network Basics: McCulloch–Pitts neuron, Perceptron learning rule, Perceptron convergence theorem, Sigmoidal neuron, Multi-layer feed forward neural network, back propagation algorithm, Gradient descent method, Stochastic gradient descent method. Shallow Neural Networks and Deep Neural Networks.

REGULARIZATION and OPTIMIZATION for training Deep Models: Optimization methods - Adagrad, Adadelta, RMSProp, Adam; Regularization Methods-Dropout, Drop connect, Batch normalization; Activation functions - Linear, sigmoid, sigmoid, ReLU and variations of ReLU; Losss Function, Improving the training process – Dataset Augmentation, Noise Robustness, Weight Initialization methods, Early stopping, Parameter sharing and tying, bagging and other ensemble methods;

UNIT-2 **8L + 0T + 8P = 16 hours**

CONVOLUTIONAL NEURAL NETWORKS

Convolutional Neural Networks (CNNs): Foundations of Convolutional Neural Network, Popular Deep CNN Models: LeNet, AlexNet, VGGNet, ResNet, Google Net and other architectures.

Instructions for Practices:

- Practice Assignments can be implemented using the Keras / Tensorflow APIs of Python
- Relevant data sets can be downloaded from standard repositories such as Kaggle/UCI or can be developed by the students.

PRACTICES:

- Implement Logistic regression With Neural Network Mindset.
  - logistic regression classifier for classification.
  - Plot the loss over each epoch.
  - Plot the accuracy over each epoch.
  - Report final Accuracy.
- Implement Shallow Neural Network model:
  - Implement a binary classification neural network with a single and multiple hidden layers.
  - Implement a Multi-class classification neural network with a single and multiple hidden layers.
  - Vary the number of neurons at suitable layers.
- Hyper parameter Tuning of a Neural Network model implemented for hand-written digit classification:
  - Vary the type of activation functions.
  - Choose suitable Loss functions.
  - Vary the number of neurons at suitable layers.
  - Vary Weight Initialization methods.
  - Save the Best Model and load the saved model.
- Building a Deep Neural Network:
  - Implement a multi-class classification neural network with number of layers of your choice.
  - Include Batch Normalization layers.
  - Vary Optimization methods.
  - Add drop out layers.
- Convolutional Neural Network Models.
  - Design a Convolutional neural network with the layers of your choice
  - Compare the performance by changing the
    - Kernel size
    - Number of feature maps at each convolutional layer
    - Stride.
    - Padding.
    - Number of fully connected layers.
- Visualization of CNN Models.
  - Design a Convolutional Neural Network Model for image classification.
  - Plot Model Architecture.
  - Visualize feature maps after training of CNN.
  - Visualize class activation maps.

MODULE-2

UNIT-1 **8L + 0T + 8P = 16 hours**

DEEP UNSUPERVISED LEARNING

Transfer learning Approaches: Deep Pre-trained architectures- AlexNet, VGG16, VGG19, ResNEt. Use deep Convolutional architectures for feature extraction and fine-tuning tasks.

Deep Unsupervised Learning: Autoencoders- Under complete Autoencoders, regularized auto encoders, Representation power, layer size and depth, stochastic encoders and decoders, Denoising auto-encoders, Sparse auto encoder, Contractive auto-encoders

UNIT-2 **8L + 0T + 8P = 16 hours**

RECURRENT NEURAL NETWORKS

Architecture of an RNN, unfolding of an RNN, Backpropagation through time, Long short term memory (LSTM), Gated recurrent units, Applications- Text Classification, Sentiment Analysis.

PRACTICES:

- **Using Deep pre-trained CNN model for feature extraction:**
  - Extract features from the FC1 of VGG network.
  - Train any traditional ML model like SVM for classification.
  - Repeat the above by considering FC2 of VGG for feature extraction.
- **Fine-tuning Deep pre-trained CNN for Classification:**
  - Fine-tune VGG network for the task under consideration.
  - Check the performance by making.
- all the layers trainable.
- freezing the initial layers.
- freezing the entire network except the final layer.
- Design MLFFNN with 3-level stacked autoencoder based pre-training for Black and white image data, Display features extracted by different levels of stacked autoencoder at the end of pre-training.
- **Sentiment Analysis**
  - Pre-process the text.
  - Convert the text into word embeddings.
  - Implement the classification network using LSTMs/ GRUs.
  - Pre-process the text
  - Convert the text into word embeddings.
  - Implement the classification network using LSTMs/ GRUs.

SKILLS:

- Developing Vision and text based applications
- Hyperparameter Tuning of a deep Neural network model.
- Tensor Flow/ Keras tool usage for neural network implementation

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

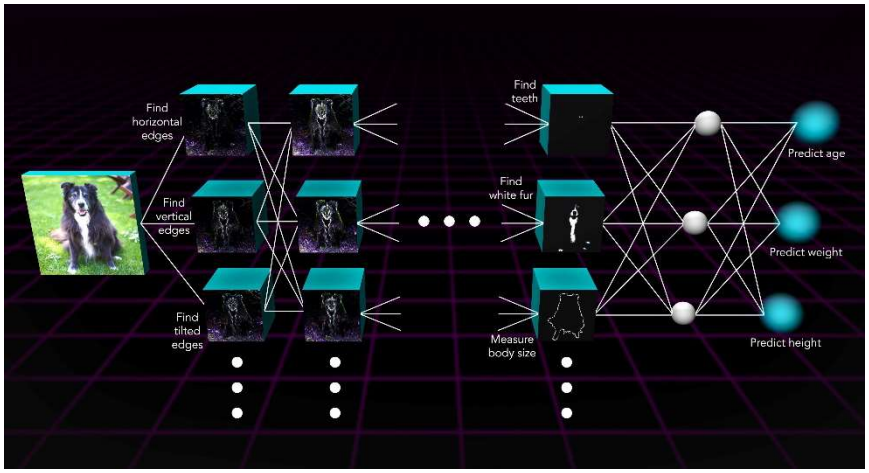
CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Implementation of Deep learning models to solve various real-time problems	Apply	1,2	1, 3
2	Analyse performance of a deep network and tune its capacity and hyper parameters	Analyse	1	2
3	Leveraging tools to Build deep networks and apply them for real word tasks	Apply	1,2	1,5
4	Developing core components for deep learning algorithms	Design	1,2	3

TEXT BOOKS:

1. Ian Good fellow and Yoshua Bengio and Aaron, **"**Deep Learning**",** 1st Edition, An MIT Press Book, 2016.
2. Charu C. Aggarwal "Neural Networks and Deep learning" Springer International Publishing, 2018

REFERENCE BOOKS:

1. Francois Chollet, "Deep learning with python", 1st edition, Manning Publications, 2017.
2. S. Haykin, "Neural Networks and Learning Machines", 3rd edition, Prentice Hall of India, 2011.
3. Josh Patterson and Adam Gibson, "Deep Learning: A Practitioner's Approach", 1st Edition, O'Reilly, 2017.
4. Satish Kumar, "Neural Networks, A Classroom Approach", Tata McGraw-Hill, 2007



https://www.symmetrymagazine.org/sites/default/files/images/standard/neural_network_visual_final.jpg

22CSB804 - COMPUTER VISION

Hours per week:

L	T	P	C
2	0	2	3

PREREQUISITE KNOWLEDGE: Basic Image Processing, Linear Algebra, Vector Calculus, Python Programming with Open CV and Neuroscience.

COURSE DESCRIPTION AND OBJECTIVES:

This course will cover the fundamentals of Computer Vision. This course provides an understanding of the basic mathematical elements of the image processing and computer vision. It explains and illustrates how the objects are located and identified by the computer in real time environment.

MODULE - 1

UNIT-1 **8L+0T+8P = 16 Hours**

INTRODUCTION TO COMPUTER VISION

Basic Concepts Of Image Formation: Introduction and Goals of Computer Vision and Image Processing, Bio-Vision Vs Computer-Vision, Brief history of Image Formation Concepts.

Fundamental Concepts Of Image Formation And It's Transformation: Radiometry, Geometric Transformations, Geometric Camera Models, Camera Calibration, 2D and 3D transformations, 2D and 3D rotations and projections, Image Formation in a Stereo Vision Setup, Image Reconstruction from a Series of Projection

UNIT-2 **8L+0T+8P = 16 Hours**

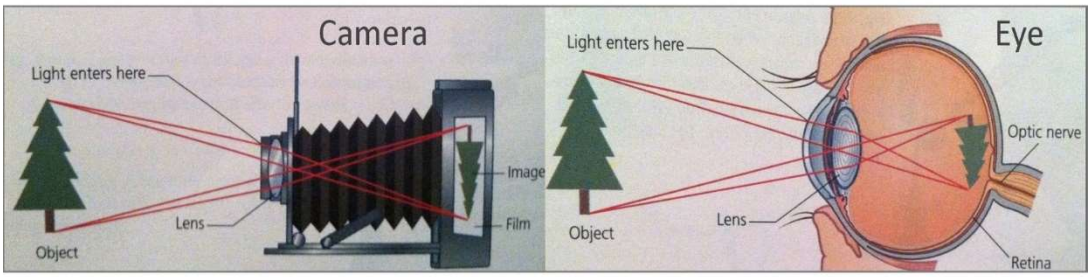
IMAGE AND VISION PROCESSING

Basic Image Processing: Image generation, Image Enhancement, Image Filtering, Colour Image Processing, Basic Image Segmentation techniques.

Image Descriptors and Features: Texture Descriptors, Colour Features, Edges/Boundaries, Object Boundary and Shape Representations, Interest or Corner Point Detectors, Histogram of Oriented Gradients, Scale Invariant Feature Transform, HoG, LBP, Blobs; Scale Space and Scale Selection; Speeded up Robust Features

PRACTICES:

- Explore and show the practical implementation of the analogy between eye and camera and explain about the vital parts for providing the vision in the human eyes and computers?



- Explore and discuss what are the basic image formation techniques and describe with an example how image formation technique got evolved into the present form in terms of the time and space complexities (show the implementations of different algorithms).
- Implement an intelligent and optimized technique using image arithmetic and logical operations to enhance the given input image. Discuss how to choose the best method depending on the input image.
- Explore an intelligent row wise and column wise algorithm for pixel operations to enhance (highlight the horizontal and vertical edge operations) the given input image.
- Compute the Harris matrix for 3x3 window highlighted below and compare it with 2x2 and 4x4 windows in terms of complexity?

0	0	1	4	9
1	0	5	7	11
1	4	9	12	16
3	8	11	14	16
8	10	15	16	20

d/dx

-1	0	1

d/dy

-1
0
1

- Discuss and implement a robust technique forperforming gray level slicing on medical imageswith and without background noise.
- Investigate how to revise the technique of histogram equalization to enhance the given input image with salt and pepper noise.
- Write a function to compute the Euclidean distance between the original RGB pixel values and the quantized values. Your function should be called *compute Quantization Error*, should take in inputs *origImg*, *quantizedImg*, and should return an output *error*, where *origImg* and *quantizedImg* are both RGB images, and *error* is a real number.

MODULE - 2

UNIT-1 **8L+0T+8P = 16 Hours**

VISUAL MATCHING

Feature: Bag-of-words, VLAD, RANSAC, Hough transform, Pyramid Matching, Stereo vision, Correspondence problem, Motion and Optical Flow.

UNIT-2 **8L+0T+8P = 16 Hours**

REAL TIME APPLICATIONS OF COMPUTER VISION

Artificial Neural Network for Pattern Classification, Gesture Recognition, Motion Estimation, Object detection and Tracking, Face Recognition, Instance recognition, Category recognition, and context and scope understanding.

PRACTICES:

- Discuss and compare different image compression techniques in terms of complexity, and propose an intelligent and fast compression technique appropriate to the input image type.
- Given an input image with noise and degradation write an intelligent algorithm to restore the image.
- Your headlights have a radiant intensity of 60 Wsr−1. Determine the irradiance on a sign 2 meters away.
- Investigate different existing image (Indoor and outdoor images) segmentation algorithms. Design your own segmentation algorithm on Vadlamudi region (extract image form google map) and compare with the state of the are methods.
- Explore different existing image (Indoor and outdoor images) segmentation algorithms. Design your own segmentation algorithm and compare with the state of the are methods.
- Given an RGB image, perform clustering in the 3-dimensional RGB space, and map each pixel in the input image to its nearest center. That is, replace the RGB value at each pixel with its nearest cluster's average RGB value. Show the output image for different value of *K*. Since these average RGB values may not be integers, you should round them to the nearest integer (1 through 255). Your function should be called quantizeRGB, should take in inputs *origImg* and *k*, and return outputs *outputImg, meanColors, clusterIds*. The variables *origImg* and outputImg are RGB images, k specifies the number of colors to quantize to, and *meanColors*is a Kx3 array of the K centers (one value for each cluster and each color channel). *clusterIds*is a *numpixelsx1* matrix *(with numpixels = numrows * numcolumns)* that says which cluster each pixel belongs to.
- A function called *detectEdges* which takes in as input *im*, *threshold* and returns output *edges*. This function computes edges in an image. *im* is the input color image, and *threshold* is a user-set threshold for detecting edges. edges is an *Nx4* matrix containing 4 numbers for each of N detected edge points: the x location of the point, the y location of the point, the gradient magnitude at the point, and the gradient orientation (non-quantized) at the point.
    - In this function, first convert the image to grayscale. Then simply compute the gradient magnitude and orientation at each pixel, and only return those (x, y) locations with magnitude that is higher than the threshold. You can reuse code from HW2.
    - At the end, display, save, and include in your submission the *thresholded* edge image for an image of your choice.
    - Remember that the x direction corresponds to columns and the y direction corresponds to rows.

SKILLS:

- Acquire the basic image formation knowledge and fundamental image processing techniques.
- Analyse the various Segmentation techniques for specific applications.
- Know more advanced topics and current research literature of Image Processing and Computer Vision.

- Ability to work in industry or in academic research in the field of Computer Vision and Image Processing.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Explorethe fundamental understanding of computer vision and its techniques with its advanced libraries.	Apply	1	1, 2, 12
2	Implement the techniques to have hands on experience with all the techniques.	Apply	1	1, 2, 5, 12
3	Able to design new changes in methods, and make use of different existing techniques to enhance the vision better.	Apply	1	1, 2, 3, 5, 12
4	Capable to analyse and comparereal time models for computer vision problems.	Analyze	2	1, 2, 3, 12
5	Going in depth to find out research outcomes.	Analyze	2	1, 3, 5, 2

TEXT BOOKS:

1. M.K. Bhuyan, “Computer Vision and Image Processing: Fundamentals and Applications”, CRC Press, 2020.
2. Forsyth & Ponce, “Computer Vision-A Modern Approach”, 2nd edition, Pearson Education, 2012.

REFERENCE BOOKS:

1. R. Hartley and A. Zisserman, “Multiple View Geometry in Computer Vision”, 2nd edition, Cambridge University Press, 2004.
2. Simon Prince, “Computer Vision: Models, Learning, and Inference”, Cambridge University Press, 2012
3. Richard Szeliski, “Computer Vision- Algorithms & Applications”, Springer, 2010.

https://www.kdnuggets.com/2020/06/6-easy-steps-implement-computer-vision-application-tensorflow-js.html

22CSB805 - PATTERN RECOGNITION

Hours per week:

L	T	P	C
2	2	0	3

PREREQUISITE KNOWLEDGE:

- Basic knowledge of linear algebra and calculus.
- Familiarity with programming (Python preferred).

COURSE DESCRIPTION AND OBJECTIVES:

Pattern recognition is a field of study that deals with the identification of patterns in data and the extraction of meaningful information from it. This course introduces students to various techniques used in pattern recognition and their applications in diverse domains like computer vision, natural language processing, speech recognition, and more.

MODULE-1

UNIT-1 **6L+6T+0P=12 Hours**

INTRODUCTION TO PATTERN RECOGNITION

Definition and scope of pattern recognition, Applications of pattern recognition in various domains. The pattern recognition pipeline: data acquisition, preprocessing, feature extraction, classification, and evaluation.

FEATURE EXTRACTION

Feature representation and selection, Feature extraction techniques: statistical, transform-based, and deep learning-based, Dimensionality reduction methods: PCA, LDA, t-SNE.

UNIT-2 **10L+10T+0P=20 Hours**

CLASSIFICATION ALGORITHMS

Introduction to supervised and unsupervised learning, Bayes decision theory and Bayes classifier, k-Nearest Neighbors (k-NN) algorithm, Support Vector Machines (SVM), Decision Trees and Random Forests, Neural Networks for pattern recognition.

MODULE-2

UNIT-1 **8L+8T+0P=16 Hours**

EVALUATION AND PERFORMANCE METRICS

Confusion matrix, precision, recall, F_1-score, Receiver Operating Characteristic (ROC) curves and Area Under the Curve (AUC), Cross-validation and hyper parameter tuning, Overfitting and regularization.

UNSUPERVISED LEARNING FOR CLUSTERING

- K-Means clustering, Hierarchical clustering, Density-based clustering: DBSCAN.

UNIT-2 **8L+8T+0P=16 Hours**

DEEP LEARNING FOR PATTERN RECOGNITION

Introduction to deep learning and neural networks, Convolutional Neural Networks (CNNs) for computer

vision, Recurrent Neural Networks (RNNs) for sequence data, Transfer learning for pattern recognition.

PRACTICES:

Problem 1: Feature Extraction

Given a dataset of handwritten digits (MNIST dataset), implement and compare three different feature extraction techniques:

a) Histogram of Oriented Gradients (HOG),

b) Scale-Invariant Feature Transform (SIFT), and

c) Local Binary Patterns (LBP).

Evaluate the performance of each technique using a classifier of your choice (e.g., SVM or k-NN).

Problem 2: Classification Algorithms

Using the famous Iris dataset, apply three different classification algorithms:

a) Decision Trees,

b) Random Forests, and

c) Multilayer Perceptron (MLP).

Compare and analyze the accuracy and decision boundaries of these models.

Problem 3: Dimensionality Reduction

Take a high-dimensional dataset (e.g., the Wine dataset) and apply Principal Component Analysis (PCA) and t-distributed Stochastic Neighbor Embedding (t-SNE) for dimensionality reduction. Visualize the reduced data and interpret the results.

Problem 4: Clustering

Implement the k-means clustering algorithm on a synthetic dataset with known cluster centers. Evaluate the clustering performance using metrics like silhouette score and adjusted Rand index.

Problem 5: CNN for Image Recognition

Design a Convolutional Neural Network (CNN) architecture to classify images of dogs and cats from the CIFAR-10 dataset. Train the model and evaluate its performance on a test set. Experiment with different hyperparameters to optimize the model's accuracy.

Problem 6: Real-world Application

Choose a real-world application of pattern recognition (e.g., face recognition, speech recognition, or anomaly detection). Research the state-of-the-art techniques in that domain and propose a novel method or an improvement to an existing approach. Implement and evaluate your solution on an appropriate dataset.

SKILLS:

- ✓ Labelling the data objects by using different classification techniques.
- ✓ Combining the data objects by applying various clustering algorithms.
- ✓ Identify the data objects by using different feature selection approaches.
- ✓ Reduce the data objects by applying dimensionality reduction techniques.
- ✓ Implement pattern recognition solutions for real-world problems through hands-on projects.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1.	Understanding of Pattern Recognition Concepts	Understanding	1	1, 9, 10
2.	Apply feature extraction techniques to preprocess and represent data for pattern recognition tasks.	Apply	1	1, 2, 9, 10, 12
3.	Analyze the results of clustering algorithms and interpret the grouping patterns in data	Analyze	1	1, 2, 4, 9, 10
4.	Design and implement a pattern recognition system for a specific application using appropriate feature extraction and classification techniques.	Create	2	1, 2, 9, 10
5.	Assess the performance of pattern recognition models and propose methods for their improvement	Evaluate	2	1, 2, 3, 5, 9, 10, 12

TEXT BOOKS:

1. "Pattern Recognition and Machine Learning" by Christopher Bishop.
2. "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville.

REFERENCE BOOKS:

1. S Theodoridis and K Koutroumbas, “Pattern Recognition”, 4th edition, AcademicPress,2009.
2. K Fukunaga, “Statistical pattern Recognition”, 1st edition, Academic Press, 2000.
3. R O Duda, P E Hart and D G Stork, “Pattern Classification”, 2nd edition, John Wiley,Reprint 2010.
4. Christopher M.Bishop, “Pattern Recognition and Machine Learning”, Springer, 2007.
5. M.NarasimhaMurty and Der V Susheela Devi, “Introduction to Pattern Recognition and Machine Learning” IISC Press.

22CSB806 - DIGITAL IMAGE PROCESSING

Hours per week:

L	T	P	C
2	0	2	3

PREREQUISITE KNOWLEDGE: Probability & Statistics.

COURSE DESCRIPTION AND OBJECTIVES:

This course focuses on imparting knowledge about the aspects of Image Processing and its applications. The main objective of the course is to learn digital image fundamentals, image transforms, image enhancement, restoration and compression, morphological image processing, representation and description.

MODULE-1

UNIT–1 **8L+0T+8P=16 hours**

FUNDAMENTALS OF IMAGE PROCESSING

Fundamental steps in digital image processing, Components of image processing system, A simple image formation model, Image sampling and quantization, Basic relationships between pixels, Introduction to Fourier Transform and DFT – properties of 2D Fourier Transform, FFT.

UNIT–2 **8L+0T+8P=16 hours**

IMAGE ENHANCEMENT IN THE SPATIAL AND FREQUENCY DOMAINS

Basic gray - level transformations, Histogram processing, Basics of spatial filtering, Smoothing spatial filters, Sharpening spatial filters, The basics of filtering in the frequency domain, Image smoothing in frequency domainfilters, Image sharpening in frequency domain filters.

Image Segmentation: Fundamentals, Point, Line and edge detection, Thresholding, Region-based segmentation, Segmentation using morphological watersheds, The use of motion in segmentation.

PRACTICES:

- Develop a module to enhance the image by using image arithmetic and logical operations.
- Develop a module for an image enhancement using kernel operations.
- Develop a module for gray level slicing with and without background.
- Develop a module for image enhancement using histogram equalization.
- Develop a module to filter an image using low pass & high pass filter in spatial domain. Compare the performance of both filters.
- Develop a module for smooth an image using low pass & high pass filters in frequency domain. Compare the performance of both filters.
- Develop a module for detecting lines & edges in an image.
- Develop a module for segmenting region of interest.

MODULE-2

UNIT–1 8L+0T+8P=16 hours

IIMAGE RESTORATION

A model of image degradation/restoration, Noise models, inverse filtering, wiener filtering, Constrained Least Squares Filtering, Geometric Mean Filter.

Image Compression: Fundamentals, Huffman coding, Golomb coding, LZW coding, Run-length coding

UNIT–2 8L+0T+8P=16 hours

MORPHOLOGICAL IMAGE PROCESSING

Erosion, Dilation, Opening, Closing, The hit-or-miss transformation; Basic morphological algorithms - boundary extraction, hole filling, extraction of connected components, thinning, thickening, skeletons, pruning.

Feature Extraction: Background, Boundary preprocessing, Boundary Feature Descriptors, Region Feature Descriptors, Principle Components as feature descriptors, Whole-image features.

PRACTICES:

- Develop a module to perform add & removal of salt and pepper noise. Compute PSNR & MSE and check the impact before and after removal of noise.
- Develop a module to remove noise using average filter and median filter. Compute PSNR & MSE before and after removal of noise.
- Develop a module for image compression and decompression.
- Develop a module for morphological image operations -erosion, dilation, opening & closing.
- Develop a module for morphological image operations - hit-or-miss transformation.
- Develop a module for morphological image operations - thinning, thickening
- Develop a module for extracting boundary features of an image.
- Develop a module for extracting features of an image using GLCM.

SKILLS:

- Apply knowledge of science and engineering principles to image related problems.
- Undertake image problem identification and formulate solutions.
- Implement algorithms for enhancement, restoration, compression etc.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

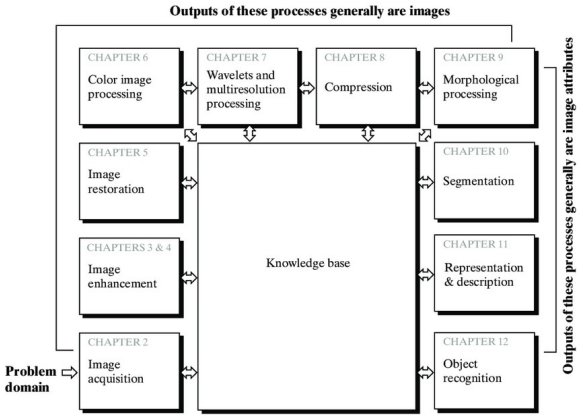
CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	understand the fundamental concepts of a digital image processing system	Understand	1	1,2
2	learn different techniques employed for the enhancement of images.	Analyse	1	1,2,3,5,12
3	employ image segmentation and representation techniques to extract region of interest	Apply	1	1,2,3,5,12
4	learn different causes for image degradation and overview of image restoration techniques.	Evaluate	2	1,2,3,5,12
5	apply various compression techniques to reduce image size and morphological operations to extract features.	Apply	2	1,2,3,5,12
6	learn different feature extraction techniques for image analysis and recognition	Apply	2	1,2,3,5,12

TEXT BOOKS:

1. Rafeal C Gonzalez and Richard E.Woods, "Digital Image Processing", 4th edition, Pearson Education/ PHI, 2018.
2. Rafeal C Gonzalez and Richard E.Woods, "Digital Image Processing using MATLAB", 4th edition, PearsonEducation/ PHI, 2020.

REFERENCE BOOKS:

1. Milan Sonka, Vaclav Hlavac and Roger Boyle, "Image Processing, Analysis and Machine Vision", 4th Edition, Cengage, 2015.
2. Alasdair McAndrew, "Introduction to Digital Image Processing with Matlab", Thomson Course Technology, 2004 Course Technology Press, Boston, MA, United States, 2004.
3. William K. Prat, "Digital Image Processing", 4th Edition, Wiley-Interscience, A John Wiley &Sons, Inc., Publication, 2007.



https://www.researchgate.net/figure/Fundamental-steps-in-digital-image-processing_fig10_333856607

22CSB807 - DATA HANDLING AND VISUALIZATION

Hours per week:

L	T	P	C
2	0	2	3

PREREQUISITE KNOWLEDGE: Python programming

COURSE DESCRIPTION AND OBJECTIVES:

This course covers the basics of how large data sets are managed to extract meaningful information. This course imparts knowledge required to understand subtle patterns, trends and correlations necessary to understand the data. In addition, this course covers skills required to leverage data and to reveal valuable insights using real example data sets drawn from a variety of different disciplines. Effective data visualization is an important tool as it allows us to quickly examine large amounts of data, expose trends efficiently, exchange ideas with key players, and influence decisions. This course allows the students to work with various tools for visualization of data from a variety of fields.

MODULE-1

UNIT-1 **10L + 0T + 10P = 20 Hours**

DATA STRUCTURES

NumPy: Creating Arrays, Arrays Operations, Multidimensional Arrays, Arrays transformation, Array Concatenation, Array Math Operations, Multidimensional Array and its Operations, Vector and Matrix operations.

Pandas Data structures- Series and data fames, working with 1D and 2D data- Creation, accessing, manipulation, various operations

UNIT-2 **6L + 0T + 6P = 12 Hours**

SUB SETTING, FILTERING, AND GROUPING

Sub setting the Data Frame, The unique Function, Conditional Selection and Boolean Filtering, Setting and Resetting the Index, The Group By Method, Aggregating

Detecting Outliers and Handling Missing Values: Outlier detection, Missing Values in Pandas, Filling and dropping missing Values in Pandas, Outlier Detection and removing duplicates

PRACTICES:

- **Write code to perform the following operations on Numpy arrays:**

i. Create a 2D Numpy array with 24 elements of size 4x6 and retrieve the last three rows, retrieve the first two column values, retrieve the sum of the second row, retrieve the sum of first column, and display the max value index in the array

ii. Create a 2D Numpy array with 42 elements of size 7x6, add a new row, Delete an existing column, replace a specific value, and identify how many values are less than given x

iii. Create a 1D-array with 64 elements, Reshape the array into 4, 2x8 arrays, also reshape the array into other possible shapes, Convert the data type into float, Split the array into three sub-arrays of same size

iv. Create a 2D Numpy array with 35 elements of size 7x5, identify unique values in the array, identify the existence of duplicates, perform conditional replace operations, insert NaNs, replace NaNs,

- Create the following 2D array using Numpy and perform below operations:

2	**3**	**4**	**5**	**6**
10	**11**	**12**	**13**	**14**
18	**19**	**20**	**21**	**22**
26	**27**	**28**	**29**	**30**
31	**33**	**34**	**35**	**36**
37	**38**	**39**	**40**	**41**

i. Write the code routine to print the masked (gray) colored sub-array

ii. Print the maximum of the fifth row.

iii. Reshape the array (change columns to rows, rows to columns)

iv. Extract all the odd number using conditional logic

v. Find the column wise mean, std and variance

- **Apply the following operations on the given csv file**
  - i. Load data from CSV files
  - ii. Retrieve first 10, last 10 rows, 3rd Column and a subgroup
  - iii. Query and index operations on the above data frame
  - iv. Insert, delete and update your data
  - v. Apply aggregate operations
  - vi. Apply various filters on the data
  - vii. Group, merge, and aggregate data in the data frames

- Apply the following operations on the given csv file

i. Load the csv and convert to data Frame
ii. Identify the total number of missing values
iii. Replace the missing values with a constant, with the Mean of that column, with the mode of that column
iv. Remove missing values on the original csv file
v. Apply fill options and replace

MODULE-2

UNIT – 1 **8L + 0T + 8P = 16 Hours**

DATA VISUALIZATION

Elements of data visualization, Exploration plots: Scatter plots, Line plots, bar plots, box plots, Error-plots, histograms, Kernel-density-estimation plots, Cumulative frequencies, Error-bars, box-plots, bubble-plot, grouped bar charts, pie charts, Advanced plots: correlation, regression, waffle charts, word clouds, Bi-variate, and multivariate plots

UNIT-2 **8L + 0T + 8P = 16 Hours**

DATA VISUALIZATION WITH TABLEAU

Intro to Tableau, Getting started with Tableau Desktop, connecting to the tutorial dataset, Creating the first charts, Filtering and sorting data, creating common visualizations (bar charts, line charts etc.); Advanced visualizations- Creating more advanced chart types, using multiple source tables; Data Storytelling-Intro to data storytelling, Creating a data story in Tableau.

PRACTICES:

- **Plotting with matplotlib and Seaborn-**Load the given csv file and visualize the data with the help of the following graphical representations:

a. Line plots	b. Bar plots	c. Error Plots	d. Scatter plots
e. KDE Plots	f. Heat Maps	g. Box Plots	h. Pie graph
i. Histogram	j. multiple graphs in single figure		k. saving figures

- **TABLEAU for visualization**
  - Analyze the given patients data and, based on their information, predict and infer the risk of their health. Then integrate all this analysis into Tableau for easy consumption of the end-users.
  - Analyze the data of sales of a company and infer the past sales numbers of a company and then forecast their sales for the coming quarters and years.
  - Analyze the dataset of marketing campaigns and visualize the performance of various marketing campaigns.
  - Analyze a dataset of product-related information, analyze the trends and showcase the availability of any product at any given point in time.

- Analyze a dataset of flight-related information, consider different factors of a flight and infer accurate trends for flight prices and visualize.

SKILLS:

- Exploratory Data Analysis
- Data Visualization
- Matplotlib, Seaborn, and Tableau tools usage

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Application of data pre-process techniques	Apply	1, 2	1
2	Analyze the given data using exploratory and visualization techniques	Analyze	1,2	2
3	Transforming and developing data suitable for Machine learning applications	Design	2	3
4	Tool usage for data handling and visualization	Apply	1,2	1, 5

TEXT BOOKS:

1. Thomas Haslwanter, “An introduction to statistics with python-with applications in the life sciences”, spinger publisher, 2015.

2. Joshua N. Milligan, “Learning Tableau 2020: Create effective data visualizations, build interactive visual analytics, and transform your organization”, 4th Edition, 2020

REFERENCE BOOKS:

1.Wes McKinney, “Python for data analysis”, 1st Edition, O’Reilly Media, 2012

2. Joel Grus,”Data Science from Scratch”, O’Reilly Media Inc., 2015.

3. Edward Tufte, "Tableau style guide"

https://www.analyticsvidhya.com/blog/2021/06/must-known-data-visualization-techniques-for-data-science/

22CSB8088 - STATISTICAL FOUNDATIONS OF DATA SCIENCE

Hours per week:

L	T	P	C
2	0	2	3

PREREQUISITE KNOWLEDGE: Engineering Mathematics

COURSE DESCRIPTION AND OBJECTIVES:

Statistics is critical for data science and this course imparts sufficient knowledge required for data science. Students in this course receive an overview of statistical methods from an experimental design perspective. Students will review statistical sampling, hypothesis, Linear Regression and other related skills. Rather than calculations, the course focuses on interpretation, analysis and communication of the results of statistical analysis. This course makes students familiar with various python libraries that are useful for statistical analysis.

MODULE-1

UNIT-1 **8L + 0T + 8P = 16 Hours**

EXPLORATORY DATA ANALYSIS

Introduction: Need of statistics in data science. Python packages for statistics. Population and samples: Introduction, Sampling techniques, random sampling, clusters sampling, systematic sampling, stratified sampling techniques

Statistical Analysis: Types of Statistical Inference, Descriptive Statistics, Inferential Statistics, Importance of Statistical Inference for data science; Descriptive Statistics- Measures of Central Tendency: Mean, Median, Mode, Mid-range; Measures of Dispersion- Range, Variance, Mean Deviation, Standard Deviation, quartiles and percentiles, Inter Quartile Range; Moments- Skewness and Kurtosis.

UNIT-2 **8L + 0T + 8P = 16 Hours**

STATISTICAL DATA ANALYSIS

Probability Distributions: Review of discrete and continuous distributions, Central limit theorem, Continuous distributions derived from the normal distribution: t-distribution, chi-sqaure distribution, F-distribution

Hypothesis Tests: Typical analysis procedure- Data screening and outliers, Normality check, Hypothesis concept, p-value, Interpretation of p-value, types of Errors, sensitivity and specificity. Hypothesis Tests for statistical analysis: z-test, student t-test, one-way chi-square test, chi-square contingency test, Analysis of variance (ANOVA)- One-way ANOVA and Two-way ANOVA.

PRACTICES:

- **Sampling and Resampling:**
  - Generate a population of random numbers.
  - Generate multiple samples using Random sampling with and without random sampling.
  - Load a balanced dataset and visualize the class distribution.
  - Load an imbalanced dataset and visualize the class distribution.
- **Interpreting Data Using Descriptive Statistics:** Compute Mean, Median, Mode, Standard Deviation, Variance, Co-variance, Interquartile Range and Skewness for two different datasets and write your interpretations about these statistical measures. Which measure is best suitable? Justify.
- **Generating Samples from Probability Distributions:**
  - Generate a set of random numbers (which corresponds to a uniform distribution) using the function rand and plot its histogram. What is the shape of this histogram and why?
  - Investigate how the shape of the histogram is affected by the number of random numbers you have generated.
  - Similarly generate numbers using Bernoulli, Binomial distributions and plot a histo gram and check the shape.
  - Generate numbers using exponential and poisson distributions and plot a histo gram and check the shape
- **Hypothesis tests:** Implement the following three popular statistical techniques for hypothesis testing: Chisquare test, T-test and ANOVA test (Calculate the Test Statistic and P-value by running a Hypothesis test that well suits your data and Make Conclusions).

MODULE-2

UNIT-1 **8L + 0T + 8P = 16 Hours**

CORRELATION AND REGRESSION ANALYSIS

Linear correlation- Correlation coefficient, rank correlation, Pearson Correlation, Correlation Coefficient for Bivariate Frequency Distribution; Regression-General linear regression model, univariate regression, Bi-variate regression, Multi-variate regression, regression coefficients, Co-efficient of Determination, Linear regression analysis with python

UNIT-2 **8L + 0T + 8P = 16 Hours**

ESTIMATION

Introduction, Statistical Inference, Classical Methods of Estimation. Estimating the Mean, Standard Error of a Point Estimate, Prediction Intervals, Tolerance Limits, Estimating the Variance, Estimating a Proportion for single mean, Difference between Two Means, between Two Proportions for Two Samples and Maximum Likelihood Estimation.

PRACTICES:

- Identify Coefficient of correlation between every pair of features in the given dataset and report your inferences
- Using the Gapminder database, We would like to see if an increasing Internet usage results in an increasing suicide rate. A study shows that other factors like unemployment could have a great impact. Accept or reject the hypothesis? Justify your answer
- Linear Regression Analysis: Download house prediction dataset and explore the data, Prepare the dataset for training, Train a linear regression model, and Make predictions and evaluate the model.
- Under the assumption of binomial distribution, use Maximum likelihood approach and estimate the parameters.
- Under the assumption of Bernoulli distribution, use Maximum likelihood approach and estimate the parameters.

SKILLS:

- Exploratory data analysis.
- Statistical data analysis.
- Scikit learn tool usage.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Application of exploratory and statistical analysis on data	Apply	1,2	1
2	Analyze data by evaluating various statistical measures	Analyze	1, 2	2
3	Installation and usage of python tools for statistical analysis	Apply	1, 2	1, 5

TEXT BOOKS:

1. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers, Keying Ye, Probability & Statistics for Engineers & Scientists, 9th Ed. Pearson Publishers, 2012.

2. Thomas Haslwanter, “An introduction to statistics with python-with applications in the life sciences”, spinger publisher, (2015).

REFERENCE BOOKS:

1. T.T. Soong, Fundamentals of Probability And Statistics For Engineers, John Wiley & Sons Ltd, 2004.
2. Sheldon M Ross, Probability and statistics for Engineers and scientists, Academic Press

https://towardsdatascience.com/basic-statistics-you-need-to-know-for-data-science-1fdd290f59b5

22CSB810 - TIME SERIES ANALYSIS AND FORECASTING

Hours per week:

L	T	P	C
2	0	2	3

PREREQUISITE KNOWLEDGE: Introduction to probability theory and statistics, calculus, Linear algebra and Python Programming.

COURSE DESCRIPTION AND OBJECTIVES:

This course will cover the fundamental techniques in analysing time series data. This course provides an understanding of the different forecasting techniques. It discusses different explorative and decomposition models, Box-Jenkins analysis and ARIMA models for deep understanding of the time series analysis and forecasting.

MODULE–1

UNIT–1 **8L+0T+8P = 16 Hours**

INTRODUCTION TO TIME SERIES AND FORCASTING

Fundamentals Concepts: Purpose, Time Series, the nature and uses of forecasts, some examples of time series, the forecasting process, data for forecasting, Resources for forecasting,

Statistics Background for Forecasting: Introduction, Graphical displays, Numerical description of time series data, use of data transformation and adjustments, general approach to time series modelling and forecasting, Evaluating and monitoring forecasting model performance.

UNIT – 2 **8L+0T+8P = 16 Hours**

REGRESSION ANALYSIS AND FORECASTING

Fundamentals Concepts of Regression: Introduction, least square estimation in linear regression models, statistical inference in linear regression, prediction of new observations, model adequacy checking, variable selection methods in regression, estimating the parameters in time series regression models.

Exponential Smoothing Methods: Introduction, first-order exponential smoothing, modelling time series data, forecasting.

PRACTICES:

- Suppose that you are in charge of capacity planning for a large electric utility. A major part of your job is ensuring that the utility has sufficient generating capacity to meet current and future customer needs. If you do not have enough capacity, you run the risks of brownouts and service interruption. If you have too much capacity, it may cost more to generate electricity.

  a. What forecasts do you need to do your job effectively?

  b. Are these short-range or long-range forecasts?

  c. What data do you need to be able to generate these forecasts?

- Your company designs and manufactures apparel for the North American market. Clothing and apparel is a style good, with a relatively limited life. Items not sold at the end of the season are usually sold through off-season outlet and discount retailers. Items not sold through discounting and off-season merchants are often given to charity or sold abroad.

  a. What forecasts do you need in this business to be successful?

  b. Are these short-range or long-range forecasts?

  c. What data do you need to be able to generate these forecasts?

  d. What are the implications of forecast errors?

- Consider an airline that operates a network of flights that serves 200 cities in the continental United States. What long-range forecasts do the operators of the airline need to be successful? What forecasting problems does this business face on a daily basis? What are the consequences of forecast errors for the airline?
- Apply the method of link relatives to the following data and calculate seasonal indices. Quarterly Figures

Quarter	1995	1996	1997	1998	1999
I	6.0	5.4	6.8	7.2	6.6
II	6.5	7.9	6.5	5.8	7.3
III	7.8	8.4	9.3	7.5	8.0
IV	8.7	7.3	6.4	8.5	7.1

-

The following table relates to the tourist arrivals during 1990 to 1996 in India:

Years :	1990	1991	1992	1993	1994	1995	1996
Tourists arrivals: (in millions)	18	20	23	25	24	28	30

Fit a straight line trend by the method of least squares and estimates the number of tourists that would arrives in the year 2000.

-

Below are given the figures of production (in thousand quintals) of a sugar factory.

Year	Production (thousand quintals)
1993	77
1995	88
1996	94
1997	85
1998	91
1999	98
2002	90

(i) Fit a straight line by the 'least squares' method and tabulate the trend values.

(ii) Eliminate the trend. What components of the series are thus left over?

(iii) What is monthly increase in the production of sugar?

- Calculate 5 yearly and 7 yearly moving averages for the following data of the numbers of commercial and industrial failure in a country during 1987 to 2002. Also plot the actual and trend values on a graph.

Year	No. of failures
1987	23
1988	26
1989	28
1990	32
1991	20
1992	12
1993	12
1994	10
1995	9
1996	13
1997	11
1998	14
1999	12
2000	9
2001	3
2002	1

- Consider the US Treasury Securities rate data in Table B.1 (Appendix B). Find the sample autocorrelation function and the variogram for these data. Is the time series stationary or nonstationary?
- Consider the time series data shown in Table below.

  a. Make a time series plot of the data.

  b. Use simple exponential smoothing with $\lambda = 0.2$ to smooth the first 40 time periods of this data. How well does this smoothing procedure work?

  c. Make one-step-ahead forecasts of the last 10 observations. Determine the forecast errors.

Period	y_t	Period	y_t	Period	y_t	Period	y_t	Period	y_t
1	48.7	11	49.1	21	45.3	31	50.8	41	47.9
2	45.8	12	46.7	22	43.3	32	46.4	42	49.5
3	46.4	13	47.8	23	44.6	33	52.3	43	44.0
4	46.2	14	45.8	24	47.1	34	50.5	44	53.8
5	44.0	15	45.5	25	53.4	35	53.4	45	52.5
6	53.8	16	49.2	26	44.9	36	53.9	46	52.0
7	47.6	17	54.8	27	50.5	37	52.3	47	50.6
8	47.0	18	44.7	28	48.1	38	53.0	48	48.7
9	47.6	19	51.1	29	45.4	39	48.6	49	51.4
10	51.1	20	47.3	30	51.6	40	52.4	50	47.7

- Reconsider the time series data shown in Table E4.1. a.

  a. Use simple exponential smoothing with the optimum value of λ to smooth the first 40 time periods of this data (you can find the optimum value from Minitab). How well does this smoothing procedure work? Compare the results with those obtained in Exercise 4.1.

  b. Make one-step-ahead forecasts of the last 10 observations. Determine the forecast errors. Compare these forecast errors with those from Exercise 4.1. How much has using the optimum value of the smoothing constant improved the forecasts?

MODULE-2

UNIT-1 **8L+0T+8P = 16 Hours**

AUTOREGRESSIVE INTEGRATED MOVING AVERAGE (ARIMA) MODELS

Introduction, linear models for stationary time series, nonstationary processes, time series model building, forecasting arima processes, seasonal processes.

UNIT-2 **8L+0T+8P = 16 Hours**

TRANSFER FUNCTIONS AND INTERVENTION MODELS

Introduction, transfer function models, transfer Function-Noise models, model specification, intervention analysis.

Survey Of Other Forecasting Methods: Multivariate time series models and forecasting, state space models arch and graph models, neural networks and forecasting.

PRACTICES:

- Consider the time series model.

  $$y_t = 150 - 0.5y_{t-1} + \varepsilon_t$$

  a. Is this a stationary time series process?

  b. What is the mean of the time series?

  c. If the current observation is $y_{100} = 85$, would you expect the next observation to be above or below the mean?

- Consider the time series model

  $y_t = 50 + 0.8y_{t-1} - 0.15 + \varepsilon_t$

  a. Is this a stationary time series process?

  b. What is the mean of the time series?

  c. If the current observation is $y_{100} = 160$, would you expect the next observation to be above or below the mean?

- For each of the ARIMA models shown below, give the forecasting equation that evolves for lead times $\tau = 1, 2, \ldots, L$. In each case, explain the shape of the resulting forecast function over the forecast lead time.

  a. AR(1)

  b. AR(2)

  c. MA(1)

  d. MA(2)

  e. ARMA(1, 1)

  f. IMA(1, 1)

  g. ARIMA(1, 1, 0)

- Consider the transfer function model. Find the forecasts that are generated from this model.

$$y_t = \frac{-0.5 - 0.4B - 0.2B^2}{1 - 0.5B} x_{t-2} + \frac{1}{1 - 0.5B} \varepsilon_t.$$

- Find time series data of interest to you where a transfer function– noise model would be appropriate.

  a. Identify and fit the appropriate transfer function–noise model.

  b. Use an ARIMA model to fit only the y_t series.

  c. Compare the forecasting performance of the two models from parts a and b.

- Find a time series of interest to you that you think may be impacted by an outlier. Fit an appropriate ARIMA model to the time series and use either the additive outlier or innovation outlier model to see if the potential outlier is statistically significant.
- Show that an AR(2) model can be represented in state space form and Show that an MA(1) model can be written in state space form.

SKILLS:

- Acquire the fundamental time series analysis techniques.
- Analyse the various time series techniques for specific applications.
- Know the more advanced topics and current research literature of time series and forecasting.
- Ability to work in industry or in academic research in the field of time series and forecasting.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

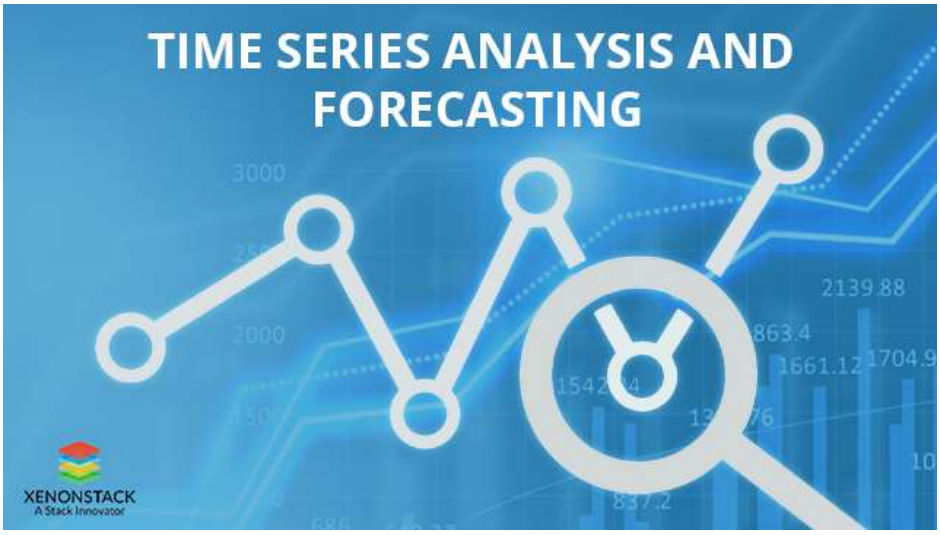
CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Explore the fundamental approaches for processing/analysing time series data and explore methods for forecasting.	Apply	1	1, 2, 12
2	Implement the techniques to have hands on experience with all the techniques.	Apply	1	1, 2, 5, 12
3	Able to design new changes in methods and make use of different existing techniques to enhance the fore casting performance.	Apply	1	1, 2, 3, 5, 12
4	Capable to analyse and compare real time models for problems or methods in time series data.	Analyze	2	1, 2, 3, 12
5	Going in depth to find out research outcomes.	Analyze	2	1, 3, 5, 2

TEXT BOOKS:

1. Douglas C. Montgomery, Cheryl L. Jennings, Murat Kulahci, “Introduction to Time Series Analysis and Forecasting”, 2015.
2. ROBERT YAFFEE with Monnie McGeo, “Introduction to Time Series Analysis and Forecasting with Applications of SAS and SPSS”, Pearson Education, 2000.

REFERENCE BOOKS:

1. Soren Bisgaard, Murat Kulahci, “Time Series Analysis and Forecasting by example”, 2011.
2. Ignacio Rojas, Hector Pomares Olga Valenzuela, “Time Series Analysis and Forecasting”, Springer, 2017.



https://www.xenonstack.com/blog/time-series-analysis

22CSB811 - KERNEL METHODS FOR PATTERN ANALYSIS

Hours per week:

L	T	P	C
2	0	2	3

PREREQUISITE KNOWLEDGE: Machine Learning, Python programming

COURSE DESCRIPTION AND OBJECTIVES:

The course kernel methods for pattern analysis (KMPA) deals with the advanced topics in pattern analysis. Pattern analysis mainly involves pattern classification, regression, and pattern clustering. This course primarily focuses on pattern analysis of data that is often not vectors of numbers. For example, protein sequences and structures in computational biology, text and XML documents in web mining, time series in finance, have structures which contain relevant information for the statistical problem but can hardly be encoded into finite-dimensional vector representations. Kernel methods are a class of algorithms well suited for such problems. Indeed, they extend the applicability of many statistical methods initially designed for vectors to virtually any type of data, without the need for explicit vectorization of the data. The goal of this course is to present the mathematical foundations of kernel methods, as well as the main approaches that have emerged so far in kernel design.

MODULE-1

UNIT-1 **8L + 0T + 8P = 16 Hours**

INTRODUCTION AND BACKGROUND

Introduction to Pattern Analysis: Pattern analysis tasks, Pattern analysis techniques, Learning methods

Non-Kernel Methods for Pattern Analysis: Polynomial curve fitting, Linear model for regression, Regularization, Bias-variance decomposition, Multilayer feed forward neural network, Auto-associative neural network, Radial basis function neural networks

UNIT-2 **8L + 0T + 8P = 16 Hours**

DEEP GENERATIVE MODELS

Boltzmann Machines, Restricted Boltzmann machines, Deep Belief Networks, Deep Boltzmann Machines, Generative Adversarial Networks

PRACTICES:

Implement Models for the following cases:

- Logisitic regression model with polynomial basis functions for datasets with (a) Linearly separable classes, (b) Nonlinearly separable classes, (c) Overlapping classes

- MLFFNN with 2 hidden layers using the cross-entropy error function for the datasets with(a)Linearly separable classes, (b) Nonlinearly separable classes, (c) Overlapping classes
- MLFFNN with 3-level stacked RBM based pre-training for Black and white image data
- Visualize Decision region plots for different models specified above
- Plot Confusion matrix for the test data of each dataset and for different models with the best performance.
- Display features extracted by different levels of stacked RBM at the end of pre-training

MODULE-2

UNIT-1 **8L + 0T + 8P = 16 Hours**

KERNEL METHODS FOR PATTERN ANALYSIS

Support vector machine, Support vector regression, Support vector data description, ν-support vector methods, Kernel K-means clustering, Kernel principal component analysis, Kernel Fisher discriminant analysis, Kernel canonical correlational analysis

Theory of kernels: Reproducing kernel Hilbert space, The Representer theorem, Mercer's theorem, Operations on kernels, Kernels for structured data: Strings, Sets, Graphs and Trees, Kernel learning methods

UNIT-2 **8L + 0T + 8P = 16 Hours**

MACHINE LEARNING PARADIGMS FOR PATTERN ANALYSIS

Paradigms in machine learning: Supervised learning, Semi-Supervised learning, Self-Supervised, Unsupervised learning, and Reinforcement learning. Semi-Supervised learning-Self-training method, Graph-based methods, Semi-supervised Gaussian mixture model, Semi-supervised support vector machine

PRACTICES:

- Implement Models for the following cases:
  - Linear kernel based SVM for a dataset with Linearly separable classes
  - Polynomial kernel-based C-SVM for Datasets with (a) Linearly separable classes, (b) Nonlinearly separable classes, (c) Overlapping classes
  - Gaussian kernel-based C-SVM for Datasets with (a) Linearly separable classes, (b) Nonlinearly separable classes, (c) Overlapping classes
  - Visualize Decision region plots for different models specified above
  - Plot Confusion matrix for the test data of each dataset and for different models with the best performance.
  - Images of kernel gram matrices to justify the choice of kernel parameters for the SVMs with bestperformance, for each kernel and for each dataset as specified above

- Implement Regression Model with ν-SVR using Gaussian kernel
- Implement outlier detection Model with ν-SVDD using Gaussian kernel
- Implement K-means clustering for a 2-dimensional data of nonlinearly separable classes
- Implement Kernel K-means clustering using Gaussian kernel for a 2-dimensional data of nonlinearly separable classes
- Implement a Classification using kernels for structured data (Graph representation of data)
- Implement a semi-supervised learning approach for classification.

SKILLS:

- kernel-based pattern analysis
- Model building for non-structured data
- Scikit learn/ Tensor Flow/ Keras tool usage

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

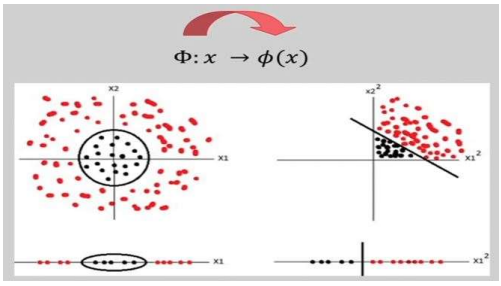
CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Analyze the suitability of kernels for the given supervised and unsupervised problems	Analyze	1,2	2, 4
2	Designing kernels appropriate for given data	Design	1	3
3	Usage of tools to implement complex models	Apply	1,2	1, 5
4	Application of kernels for pattern analysis	Apply	1,2	1

TEXT BOOKS:

1. B. Scholkopf and A.J.Smola, "Learning with Kernels – Support Vector Machines, Regularization, Optimization and Beyond", The MIT Press, 2002
2. Ian Good fellow and Yoshua Bengio and Aaron, **"**Deep Learning**",** 1st Edition, An MIT Press Book, 2016

REFERENCE BOOKS:

1. S. Haykin, "Neural Networks and Learning Machines", 3rd edition, Prentice Hall of India, 2011.
2. Satish Kumar, "Neural Networks, A Classroom Approach", Tata McGraw -Hill, 2007
3. C.M.Bishop, "Pattern Recognition and Machine Learning", Cambridge University Press, 2006
4. V.Vapnik, "Statistical Learning Theory", John Wiley & Sons, 199



https://2.bp.blogspot.com/-QkK6YNURAeA/W5DrwnnGr5I/AAAAAAAADwQ/SFE6Uj_nTwk93ZXs5wvuhnZQDXFQD833QCLcBGAs/s1600/m.JPG

22CSB812 - WIRELESS SENSOR NETWORKS

Hours per week:

L	T	P	C
2	0	2	3

PREREQUISITE KNOWLEDGE: Computer Networks.

COURSE DESCRIPTION AND OBJECTIVES:

In this course we will provide an introduction to Wireless Sensor Networks (WSN) and cover latest topics in WSNs. The goal of this course is to give an overview of fundamental problems in the area of WSNs. We will discuss existing solutions for some of these problems. Data aggregation, information dissemination, security issues, power management, localization, topology control, routing, and security, are the topics will be covered in this course.

MODULE-1

UNIT-1 **8L+0T+8P=16 hours**

INTRODUCTION

Introduction to Wireless Sensor Networks: Background of Sensor Network, Motivations, Performance metrics, Design factors, Sensor node hardware's and software's.

WSN Architecture: Traditional layered stack, roles and challenges, Enabling technologies in WSN, Applications of WSN, Physical layer and transceiver design considerations in WSNs.

UNIT-2 **8L+0T+8P=16 hours**

MAC PROTOCOLS FOR WSN

Medium Access Control Protocols for WSN: Introduction, Fundamentals of MAC Protocols, Contention-Free, Contention-Based and Hybrid MAC Protocols, Data aggregation and fusion, Distributed data bases.

Localization: Global location (GPS-based) and relative location (Beacon-based). Localization methods: anchor-free, anchor-based, range-free, range-based. Clustering in WSN, Types of clustering.

PRACTICES:

- Implement different network topologies in WSN using NS2 Simulator/Arduino boards.
- Implement traffic signaling using Arduino boards.
- Establish communication between the two motes with Wi-Fi, XBee, modules on arduino and raspberry pi.
- Create cluster formation with m number of motes in WSN by using Arduino and raspberry pi.
- Collect the sensor geographical location information using Raspberry pi.

MODULE-2

UNIT-1 **8L+0T+8P=16 hours**

ROUTING PROTOCOLS

Routing protocols for WSN: Introduction, Routing Challenges and Design Issues in WSN, Flooding and its variants, LEACH, Location-based protocols and energy-aware routing.

Transport Control Protocols for WSN: Feasibility of Using TCP or UDP for WSNs, TCP Design Issues, Existing TCPs in WSN: CODA, ESRT, RMST, PSFQ, GARUDA, ATP, Problems with TCP, Performance of TCP.

UNIT-2 **8L+0T+8P=16 hours**

SECURITY

Security: Fundamentals, Security challenges in WSN, Security Attacks, Protocols and Mechanisms for Security, IEEE 802.15.4 and ZigBee Security, Sensor Network programming, Node-Centric Programming: nesC Language, TinyGALS, Sensor Network Simulators: Network Simulator Tools and Environments.

PRACTICES:

- Implement transmission between mobile nodes based on TCP and CBR traffic in WSN nodes using NS2 simulator.
- Implement a Low Energy Adaptive Hierarchy protocol using Simulation Tool.
- Implement different attack and its preventions in WSN using Arduino boards.

SKILLS:

- To know the fundamentals of wireless sensor networks and its application to critical real time scenarios.
- To study the various protocols at various layers and its differences with traditional protocols.
- To know the issues pertaining to sensor networks and the challenges involved in managing a sensor network.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Design a wireless sensor network for given sensor data using microcontroller, transceiver, middleware and operating system.	Create	1	3
2	Evaluate the performance of schedule based and random Medium Access Control protocols for power consumption, fairness, channel utilization and control packet overhead.	Analyze	1	1, 2, 3

3	Evaluate the performance of low energy and geographic routing protocols for power consumption, scalability and latency parameters.	Analyze	2	1, 2, 3
4	Implement solutions to real world problems using various sensors and arduino boards.	Create	2	3

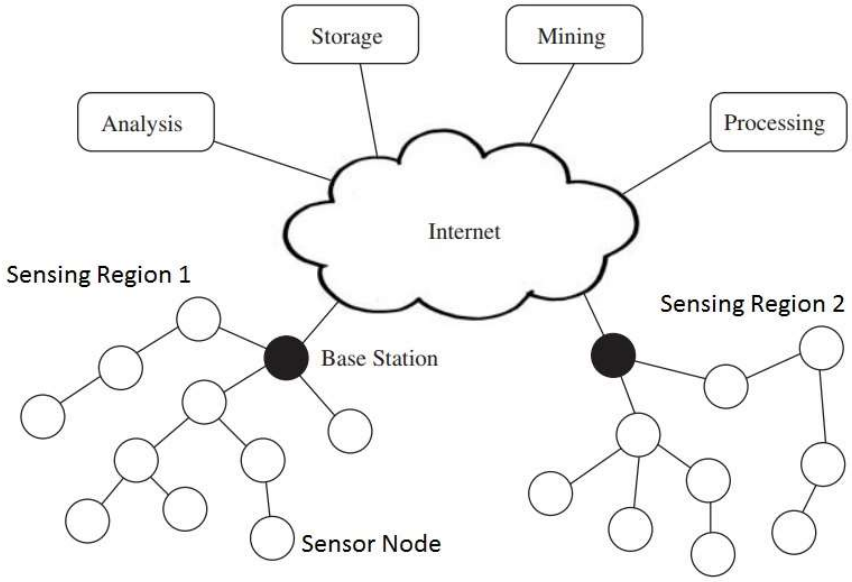
TEXT BOOKS:

1. Dargie, Waltenegus, and Christian Poellabauer. Fundamentals of wireless sensor networks: theory and practice. John Wiley & Sons, 2010.
2. Kazem Sohraby, Daniel Minoli and Taieb Znati, "Wireless Sensor Networks Technology, Protocols, and Applications", John Wiley & Sons, 2007.

REFERENCE BOOKS:

1. Holger Karl and Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley & Sons, Ltd, 2005.
2. Zhao and L. Guibas, "Wireless Sensor Networks", Morgan Kaufmann, San Francisco, 2004.

3. C. S. Raghavendra, K.M.Shivalingam and T.Znati, "Wireless Sensor Networks", Springer, New York, 2004.
4. Anna Hac, "Wireless Sensor Network Designs", John Wiley & Sons, 2004.



https://www.electronicshub.org/wireless-sensor-networks-wsn/

22CSB813 - MOBILE AD-HOC NETWORKS

Hours per week:

L	T	P	C
2	0	2	3

PREREQUISITE KNOWLEDGE: Computer Networks.

COURSE DESCRIPTION AND OBJECTIVES:

This course focuses on major aspects of ad hoc networking, from design through performance issues to application requirements. It starts with the design issues and challenges associated with implementations of ad hoc network applications. This includes mobility, disconnections, and battery power consumption. The course provides a detailed treatment of proactive, reactive, and hybrid routing protocols in mobile wireless networks. It also covers the IEEE 802.11 Wireless LAN and discusses their characteristics and operations. Through activities, the course gives students hands-on experience in designing a mobile ad hoc network using the NS2 simulator.

MODULE-1

UNIT-1 **8L+0T+8P=16 hours**

INTRODUCTION

Introduction to ad-hoc networks-definition, characteristics, features, applications; Characteristics of the wireless channel; Ad-hoc mobility models-indoor and outdoor models.

UNIT-2 **8L+0T+8P=16 hours**

MEDIUM ACCESS PROTOCOLS

MAC protocols- design issues, goals and classification; Contention-based protocols – with reservation, without reservation; Scheduling algorithms; Protocols using directional antennas; IEEE standards - 802.11a, 802.11b, 802.11g, 802.15; HIPERLAN.

Network Protocols: Routing protocols - design issues, goals, and classification; Proactive Vs reactive routing; Unicast routing algorithms; Multicast routing algorithms; Hybrid routing algorithm; Energy-aware routing algorithm; Hierarchical routing; QoS aware routing.

PRACTICES:

- Installation of NS-2 and basics of Tcl scripting.
- Tcl script for
  a. computing the arithmetic operations on two operands.
  b. finding the given number is prime or not using functions.
  c. finding the factorial value of a given number.
- Set the node property and routing protocol in the same MANET scenario.
- Analyse the performance of the MANET.
- Develop MAC Protocol using any suitable Network Simulator for MANETs to send the packet without any contention through wireless link using the following MAC protocols (CSMA/CA (802.11)). Analyze its performance with increasing node density and mobility.

- Simulate MANET environment using suitable Network Simulator and test with various mobility model such as Random walk, Random waypoint and Group mobility. Analyze throughput, PDR and delay with respect to different mobility models.

MODULE-2

UNIT-1 **8L+0T+8P=16 hours**

END-END DELIVERY AND SECURITY

Transport layer - issues in designing, transport layer classification, ad-hoc transport protocols; Security issues in ad-hoc networks - issues and challenges, network security attacks; Secure routing protocols.

UNIT-2 **8L+0T+8P=16 hours**

CROSS LAYER DESIGN

Cross layer design - need for cross layer design, cross layer optimization; Parameter optimization techniques; Cross layer cautionary perspective; Integration of adhoc with mobile IP networks.

PRACTICES:

- Create CBR traffic over UDP and TCP.
- Write an awk script that takes data from trace file and give the report for performance metrics such as packet delivery ratio, and throughput.
- Implement Transport Control Protocol in Sensor Network.
- Design and Implementation of Security algorithm for Wireless networks (b)Implementation of security protocol for mobile network.

SKILLS:

- Evaluate various routing protocols.
- Analyse the performance of MAC protocols for Ad-hoc networks.
- Analyse the performance of Network protocols for Ad-hoc networks.

COURSE OUT COMES:

Upon successful completion of this course, students will have the ability to:

CO. No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Summarize the protocols used at the MAC layer and scheduling mechanisms to express the mathematical properties.	Evaluate	1	1, 12
2	Apply proactive and reactive routing algorithms to find optimal paths.	Apply	1	1, 2, 5, 12
3	Analyze types of routing protocols used for unicast and multicast routing.	Analyse	1	1, 2, 5, 12

4	Compare the performance of various routing protocols in ad-hoc networks.	Analyse	2	1, 2
5	Develop the network security solution and routing mechanism.	Apply	2	1, 2, 12

TEXT BOOKS:

1. C. Siva Ram Murthy and B. S. Manoj, "Ad hoc Wireless Networks Architecture and Protocols", 2nd Edition, Pearson Edition, 2007.
2. Charles E. Perkins, "Ad hoc Networking", 1st Edition, Addison – Wesley, 2000.

REFERENCE BOOKS:

1. Stefano Basagni, Marco Conti, Silvia Giordano and Ivan stojmenovic, "Mobile ad-hoc networking", Wiley-IEEE press, 1st Edition, 2004.
2. Mohammad Ilyas, "The Handbook of Adhoc Wireless Networks", 1st Edition, CRC press, 2002.
3. T. Camp, J. Boleng and V. Davies "A Survey of Mobility Models for Ad Hoc Network Research" Wireless Commun. and Mobile Comp., Special Issue on Mobile Ad Hoc Net working Research, Trends and Applications, vol. 2, no. 5, 2002, pp. 483–502.
4. A survey of integrating IP mobility protocols and Mobile Ad hoc networks, Fekri M. Abduljalil and Shrikant K. Bodhe, IEEE communication Survey and tutorials, v no.1, 2007.
5. V. T. Raisinhani and S.Iyer "Cross Layer Design Optimization in Wireless Protocol Stacks" Comp. Communication, Vol 27 no. 8, 2004.

https://www.educba.com/mobile-ad-hoc-network/

22CSB814 - BLOCK CHAIN TECHNOLOGY

Hours per week:

L	T	P	C
2	0	2	3

PREREQUISITE KNOWLEDGE: Cryptography and Network Security

COURSE DESCRIPTION AND OBJECTIVES:

This course covers the technical aspects of public distributed ledgers, block chain systems, cryptocurrencies, and smart contracts. Students will learn how these systems are built, how to interact with them, how to design and build secure distributed applications.

MODULE-1

UNIT-1 **8L+0T+8P=16 Hours**

INTRODUCTION TO BLOCKCHAIN

Backstory of Blockchain, Blockchain, centralized vs. Decentralized Systems, Layers of Blockchain, Importance of Blockchain, Blockchain Uses and Use Cases.

UNIT-2 **8L+0T+8P=16 Hours**

BLOCKCHAIN AND BITCOIN WORKING

How Blockchain Works: Laying the Blockchain Foundation, Cryptography, Blockchain- Merkle trees, Properties of Blockchain Solutions, Blockchain Transactions, Distributed Consensus Mechanisms, Blockchain Applications-Scaling Blockchain.

How Bitcoin Works: The History of Money, Dawn of Bitcoin, Bitcoin- The Bitcoin Blockchain, The Bitcoin Network- Bitcoin Scripts, Full Nodes vs. SPVs, Bitcoin Wallets.

PRACTICES:

- Generate the crypto material for the various participants in the bootstrapping network.
- Generate the genesis block for the Ordered node and start ordering service (solo node) in the bootstrapping network.
- Generated the configuration transaction block to create a new channel in the bootstrapping network.
- Sign the configuration block and create the new channel.
- Make peers of all the organizations join the channel that we created in the bootstrapping network.
- Setup Metamask in the System and Create a wallet in the Metamask with Test Network.
- Create multiple accounts in Metamask and perform the balance transfer between the accounts and describe the transaction specifications.
- Create a custom RPC network in Metamask and connect it with Ganache tool and transfer the ether between ganache account.

MODULE-2

UNIT-1 **8L+0T+8P=16 Hours**

ETHEREUM WORKING

How Ethereum Works: From Bitcoin to Ethereum -Enter the Ethereum Blockchain-Ethereum Smart Contracts Ethereum Virtual Machine and Code Execution - Ethereum Ecosystem.

UNIT-2 **8L+0T+8P=16 Hours**

BLOCKCHAIN APPLICATION DEVELOPMENT

Decentralized Applications - Blockchain Application, Development-Interacting with the Bitcoin Blockchain -Interacting Programmatically with Ethereum Interacting Programmatically with Ethereum—Creating a Smart Contract-Interacting Programmatically with Ethereum—Executing Smart Contract Functions-Blockchain Concepts Revisited-Public vs. Private Blockchains-Decentralized Application Architecture

PRACTICES:

- Install and Getting Started with the Bitcoin core client. Write a program to get a Bitcoin and create transaction.
- Write a program to implement application on bitcoin.
- Setup the Ethereum development environment. Generate addresses and create transaction.
- Write a program to implement application on Ethereum.
- Write a program to create smart contract.

SKILLS:

- List the differences between proof-of-work and proof-of-stake consensus.
- Send and read transactions in block-chain systems.
- Evaluate security, privacy, and efficiency of a given blockchain system.

COURSE OUTCOMES:

Upon successful completion of the course, students will have the ability to:

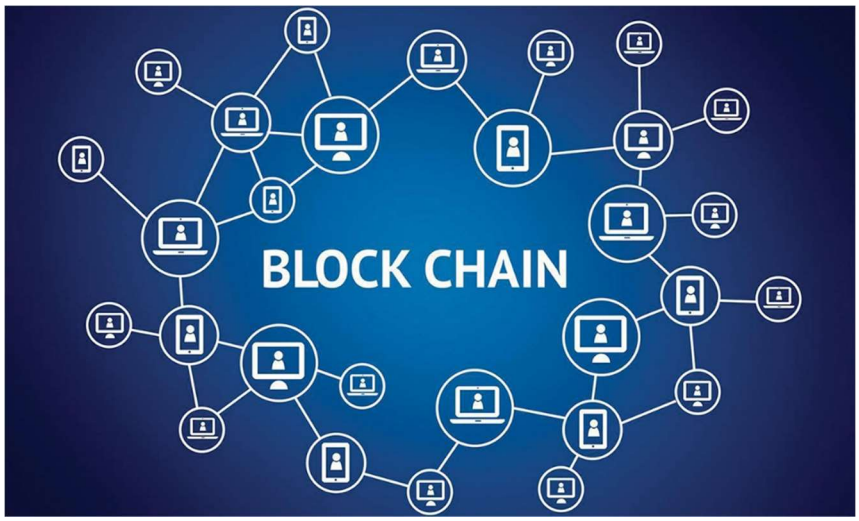
CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with POs
1	Apply the process involved in decentralization of Bit coin development.	Apply	2	3
2	Analyse the interaction process with blockchain systems.	Analyze	1	1, 2, 3
3	Design, build, and deploy smart contracts and distributed applications.	Analyze	1	1, 2, 3
4	Demonstrate the usage of Ethereum tool.	Create	2	1,3,5

TEXT BOOK:

1. A. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, Princeton University Press, 2016.

REFERENCE BOOKS:

1. Satoshi Nakamoto, Bitcoin: A Peer-to-Peer Electronic Cash System, 2016.
2. DR. Gavin Wood, "ETHEREUM: A Secure Decentralized Transaction Ledger," Yellow paper. 2014.
3. A. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, Bitcoin and Cryptocurrency. Technologies: A Comprehensive Introduction, Princeton University Press, 2016.
4. Melanie Swan, Blockchain - Blueprint for a new economy, O'Reilly Media, Inc., 2015.



https://blogs.iadb.org/caribbean-dev-trends/en/blockchain-technology-explained-and-what-it-could-mean-for-the-caribbean/

22CSB815 - MOBILE AND WIRELESS SECURITY

Hours per week:

L	T	P	C
2	0	2	3

PREREQUISITE KNOWLEDGE: Wireless Networks

COURSE DESCRIPTION AND OBJECTIVES:

The objective of this course is to Familiarize with the issues and technologies involved in designing a wireless and mobile system that is robust against various attacks. Students undergoing this course gain knowledge and understanding of the various ways in which wireless networks can be attacked and have a broad knowledge of the state-of-the-art and open problems in wireless and mobile security.

MODULE-1

UNIT–1 **8L+0T+8P = 16 Hours**

SECURITY IN MOBILE CELLULAR NETWORKS

Security issues in GSM, 3G and 4G networks, Authentication and encryption, Security concerns in 5G networks. Security in General Wireless/Mobile Networks: High Performance Elliptic Curve Cryptographic Co-processor, An Adaptive Encryption Protocol in Mobile Computing.

UNIT–2 **8L+0T+8P = 16 Hours**

SECURITY IN WIRELESS LANS

Cross Domain Mobility Adaptive Authentication, AAA Architecture and Authentication for wireless LAN Roaming, Experimental Study on Security Protocols in WLANs.

PRACTICES:

- Basic Configuration of Wireless Networks using Cisco AP.
- Configuring Shared Key Authentication on Cisco AP.
- Observe the MAC Settings for the Linksys.
- Evaluating Radio Frequency (RF) Loss.
- Modifying AP Transmit Power and Antenna Diversity.
- Investigating Co-Channel Interference using Linksys Router.

MODULE-2

UNIT–1 **8L+0T+8P = 16 Hours**

SECURITY IN AD HOC NETWORKS

Pre-authentication and authentication models in Ad Hoc Networks, Promoting Identity-based key management, attacks and countermeasures, Secure and resilient data aggregation, Secure routing in MANET, Intrusion Detection System in MANET.

UNIT–2 **8L+0T+8P = 16 Hours**

SECURITY IN SENSOR NETWORKS AND IOT

Security Issues, Key Management Schemes, Secure Routing in Sensor Networks, Energy-aware security mechanisms, Security, and privacy issues in IoT, Identity and access management, Data Integrity, Best practices for IoT security.

PRACTICES:

- Measuring Ad Hoc Mode Throughput.
- Measuring Infrastructure Mode Throughput with a Cisco AP.
- Measuring Infrastructure Mode Throughput with a Linksys Router.
- Upgrade the Linksys firmware using DD-WRT.
- Setup DD-WRT Router in Repeater Mode.
- Explore issues in Wireless LAN Security.

SKILLS:

- Categorize various security issues in mobile computing.
- Compare security protocols.
- Learn various security issues involved in IoT.

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with PO's
1	Apply various tools for technologies in the design of mobile system against various attacks.	Apply	2	1,2,5
2	Comprehend the fundamental concepts of mobile and wireless network security.	Analyse	1	1,2
3	Analyse security threats in wireless networks and design strategies to manage network security.	Analyse	1	1,2,3
4	Design secured network application considering all possible threats.	Analyse	2	1,2,3
5	Evaluate performance of various security mechanisms in handling attacks in mobile.	Evaluate	2	1,2,3

TEXT BOOKS:

1. Y. Xiao, X. Shen, D. Z.Du, Wireless Network Security, Springer International Edition, 2010.
2. Lei Chen, JiahuangJi, Zihong Zhang, Wireless Network Security, Springer Science & Business Media, 2013.

REFERENCE BOOKS:

1. W. Stallings. Cryptography & Network Security: Principles and Practice, 7th Edition, Prentice Hall, 2017.

2. NoureddineBoudriga, Security of Mobile Communications, CRC Press, 2009.
3. Patrick Traynor, Patrick McDaniel, and Thomas La Porta, Security for telecommunications Networks, Springer, 2008.
4. Frank Adelstein, Sandeep K.S. Gupta, Golden G. Richard III, and Loren Schwiebert, Fundamentals of Mobile and Pervasive Computing, McGraw-Hill Professional, 2013.

https://www.cse.wustl.edu/~jain/cse571-09/ftp/wimax1/index.html

22CSB816 - ADVANCED CRYPTOGRAPHY

Hours per week:

L	T	P	C
2	0	2	3

PREREQUISITE KNOWLEDGE: Computer Networks, Cryptography and Network Security

COURSE DESCRIPTION AND OBJECTIVES:

The objective of this course is to emphasize on primitives and protocols of cryptography. Students undergoing this course gain knowledge and understanding of basic, intermediate and advanced protocols used in real world implementations.

MODULE-1

UNIT-1 **8L+0T+8P = 16 Hours**

CRYPTOGRAPHIC PROTOCOLS

Protocol Building Blocks: Introduction to Protocols, Communications Using Symmetric Cryptography, One-Way Functions, One-Way Hash Functions, Communications Using Public-Key Cryptography, Digital Signatures, Digital Signatures with Encryption, Random and Pseudo-Random Sequence Generation.

Basic Protocols: Key Exchange, Authentication, Authentication and Key Exchange, Formal Analysis of Authentication and Key-Exchange Protocols,

UNIT-2 **8L+0T+8P = 16 Hours**

INTERMEDIATE PROTOCOLS

Multiple-Key Public-Key Cryptography, Secret Splitting, Secret Sharing, Cryptographic Protection of Databases.

Timestamping Services, Subliminal Channel, Undeniable Digital Signatures, Designated Confirmer Signatures, Proxy Signatures, Group Signatures, Fail-Stop Digital Signatures, Computing with Encrypted Data, Bit Commitment, Fair Coin Flips, Mental Poker, One-Way Accumulators, All-Or-Nothing Disclosure of Secrets, Key Escrow.

PRACTICES:

- Perform encryption and decryption using following transposition techniques i. Rail fence ii. Row & Column Transformation
- Implement the Diffie-Hellman Key Exchange algorithm for client-server model.
- Calculate the message digest of a text/image/video using the SHA-1 algorithm.
- Implement the SIGNATURE SCHEME - Digital Signature Standard.

MODULE-2

UNIT-1 **8L+0T+8P = 16 Hours**

ADVANCED PROTOCOLS

Zero-Knowledge Proofs, Zero-Knowledge Proofs of Identity, Blind Signatures, Identity-Based Public-Key Cryptography, Oblivious Transfer, Oblivious Signatures, Simultaneous Contract Signing, Digital Certified Mail, Simultaneous Exchange of Secrets.

UNIT-2 **8L+0T+8P = 16 Hours**

THE REAL-WORLD EXAMPLE IMPLEMENTATIONS

IBM Secret-Key Management Protocol, Mitrenet, ISDN, STU-III, Kerberos, Kryptoknight, Sesame, IBM Common Cryptographic Architecture, ISO Authentication Framework, Privacy-Enhanced Mail (PEM), Message Security Protocol (MSP) Pretty Good Privacy (PGP), Smart Cards, Public-Key Cryptography Standards (PKCS), Universal Electronic Payment System (UEPS), Clipper, Capstone, AT&T Model 3600 Telephone Security Device (TSD).

PRACTICES:

- Demonstrate intrusion detection system (ids) using any tool eg. Snort or any other s/w.
- Automated Attack and Penetration Tools Exploring N-Stalker, a Vulnerability Assessment Tool
- Defeating Malware i. Building Trojans ii. Rootkit Hunter

SKILLS:

- Analyse Key Management techniques.
- Examine the issues and structure of Authentication Service.
- Design a security solution for a given application

COURSE OUTCOMES:

Upon successful completion of this course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with PO's
1	Analyse the commonly used cryptographic primitives and protocols.	Analyse	1	1,2,3
2	Analyse difficulties involved in employing cryptographic tools to build secure systems.	Analyse	2	1,2,5
3	Implement intermediate protocols for their performance in security.	Evaluate	1	1,2,3
4	Evaluate various tools used in real world for security.	Evaluate	2	1,2,5
5	Create attack scenarios in the existing networks.	Create	2	1,2

TEXT BOOKS:

1. Bruce Schneier, Applied Cryptography: Protocols, Algorithms and Source Code in C, 20th Anniversary Edition, Wiley 2015.
2. Paar, Christof, and Jan Pelzl, Understanding cryptography: a textbook for students and practitioners, Springer 2011.

Reference Book:

1. Martin, Everyday Cryptography: Fundamental Principles & Applications, Oxford University Press, 2017.
2. W. Stallings. Cryptography & Network Security: Principles and Practice, 7th edition, Prentice Hall 2018.

https://null-byte.wonderhowto.com/how-to/advanced-cryptography-total-guide-0168727/

22CSB817 - DIGITAL FORENSICS

Hours per week:

L	T	P	C
2	0	2	3

PREREQUISITE KNOWLEDGE: Cyber Security and Cyber Laws, Cryptography and Network Security

COURSE DESCRIPTION AND OBJECTIVES:

This course focuses on understanding forensic terminologies and approaches along with variety of tools used for digital forensic investigations. The objective of this course is to understand digital forensics and its usage in solving computer crimes. By end of the course, students will be able to identify improper usage of computer systems and legal concepts in digital forensic investigation stages.

MODULE-1

UNIT-1 **6L+0T+6P = 12 Hours**

INTRODUCTION

Computer forensics fundamentals, Benefits of forensics, computer crimes, computer forensics evidence and courts, legal concerns and private issues, Steps of computer forensics.

Understanding Computing Investigations: Procedure for corporate High-Tech investigations, understanding data recovery work station and software, conducting and investigations.

UNIT-2 **10L+0T+10P = 20 Hours**

DATA ACQUISITION

Understanding storage formats and digital evidence, determining the best acquisition method, acquisition tools, validating data acquisitions, performing RAID data acquisitions, remote network acquisition tools, other forensics acquisitions tools.

PRACTICES:

- Recover Deleted Files using Forensics Tools.
- Study the steps for hiding and extract any text file behind an image file/ Audio file using Command Prompt.
- Extract Exchangeable image file format (EXIF) Data from Image Files using Exifreader
- Software How to make the forensic image of the hard drive using EnCase Forensics.
- Restoring the Evidence Image using EnCase Forensics.

MODULE-2

UNIT-1 **6L+0T+6P = 12 Hours**

PROCESSING CRIMES AND INCIDENT SCENES

Securing a computer incident or crime, seizing digital evidence at scene, storing digital evidence, obtaining digital hash, reviewing case.

UNIT-2 **10L+0T+10P = 20 Hours**

CURRENT COMPUTER FORENSICS TOOLS

Software, hardware tools, validating and testing forensic software, addressing data-hiding techniques, performing remote acquisitions, E-Mail investigations- investigating email crime and violations, understanding E-Mail servers, specialized E-Mail forensics tool.

PRACTICES:

- Study of Computer Forensics and different tools used for forensic investigation.
- Live Forensics Case Investigation using Autopsy.
- Collect Email Evidence in Victim PC.
- Extracting Browser Artifacts.
- View Last Activity of Your PC.
- Find Last Connected USB on your system (USB Forensics).
- Comparison of two Files for forensics investigation by Compare IT software.

SKILLS:

- Identify sources and methods of system intrusion.
- Create bitwise images of hard drives for forensic analysis.
- Collecting evidences from log files.

COURSE OUTCOMES:

Upon successful completion of the course, students will have the ability to:

CO No.	Course Outcomes	Blooms Level	Module No.	Mapping with PO's
1	Apply basic legal concepts related to digital forensics and evidence collection.	Apply	1	1,2,3
2	Analyze various digital forensics frameworks and its usage to solve crimes.	Analyse	1	1,2,3
3	Analyze artifacts like logs, packet captures, and registry.	Analyse	2	1,2,3
4	Demonstrate the ability to use forensic tools.	Create	2	1, 2, 5
5	Design and develop various forensic applications using variety of tools to carryout forensic investigation.	Analyse	2	1, 2, 3

TEXT BOOKS:

1. Warren G. Kruse II and Jay G. Heiser, “Computer Forensics: Incident Response Essentials”,Addison Wesley, 2020.
2. Nelson, B, Phillips, A, Enfinger, F, Stuart, C., “Guide to Computer Forensics and Investigations, 6th edition, Thomson Course Technology, 2020, ISBN: 0-619-21706-5.

REFERENCE BOOK:

1. Vacca, J, Computer Forensics: Computer Crime Scene Investigation, 2nd Ed, Charles River Media, 2015, ISBN: 1-58450-389.

https://www.electrosoft-inc.com/resources/digital-forensics