NSRIT

AUTONOMOUS

# ACADEMIC RULES & REGULATIONS

2020

## U. G. PROGRAMS

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# Academic Rules and Regulations

# 2020

# Undergraduate Programs

**Choice Based Credit & Semester System (CBCSS)**

Nadimpalli Satyanarayana Raju Institute of Technology (NSRIT)
Sontyam, Andhra Pradesh 531173
(An Autonomous Institute, Affiliated to JNTUK, Kakinada, AP)
Accredited by NAAC with 'A' Grade

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## The Vision

To promote societal empowerment and become an institution of excellence in the field of engineering education and research

## The Mission

- To develop the students into outstanding professionals through innovative Teaching - Learning process
- To uphold research through long term Academia - Industry interaction
- To inculcate ethical standards and moral values

# Academic Regulations for B. Tech. (Regular, Honors and Minor with Specialization) Program

(For all the candidates admitted from the Academic Year 2020 – 2021 onwards)

B. Tech. (Regular: 160 Credits | Lateral Entry: 121) | B. Tech. (Honors/Minor - Regular: 180 Credits | Lateral Entry: 141)

## 1. Preliminary Definitions and Nomenclature

In this regulation, unless the context otherwise requires:

a. **Degree**:The academic award conferred upon a student on successful completion of a programme designed to achieve the defined attributes. It is referred to as Under-Graduate (UG) Degree, that is B.Tech. degree

b. **Program**: The cohesive arrangement of courses, co-curricular and extracurricular activities to accomplish predetermined objectives leading to the awarding of a degree. It also means specialization or discipline of B.Tech.

c. **Course**:Theory, Practical or Theory-cum-Practical subject studied in a semester, like Engineering Mathematics, Physics, etc.

d. "**University**" means Jawaharla Nehru Technological University Kakinada (JNTUK, Kakinada)

e. "**Institute**" means Nadimpalli Satyanarayana Raju Insitutute of Technology (NSRIT)

## 2. Eligibility for Admission

**2.1.** Admission to the B. Tech. (Regular, Honors and Minor with specialization) shall be made subject to the eligibility and qualifications as prescribed by Andhra Pradesh State Council for Higher Education (APSCHE), Government of Andhra Pradesh. The total number of seats as per the approved annual intake is categorized into two categories viz. Convenor Quota (Cat – A) and Management Quota (Cat – B) with a ratio of 70:30 (G. O. No. 52). The admission under Cat – A shall be done based on the merit score secured through state-wise common state commone entrance test i.e., AP Engineering Agricultural, Medical Common Entrance Test (AP – EAMCET). The allotment pertaining to Cat – B admission, the merit list based on 10+2 shall be taken as a benchmark in compliance with the norms issued by APSCHE

**2.2.** With regard to the students admitted through Lateral Entry Scheme, the students shall be admitted directly into semester III of the second year of B. Tech. programs. Under this scheme 10% seats of the sanctioned intake will be available in each program of study as supernumerary seats. Admissions to this three year B. Tech. lateral entry Programme will be through Andhra Pradesh Engineering Common Eligibility Test (ECET). The maximum period to complete B. Tech. under lateral entry scheme is six consecutive academic years from the date of joining

## 3. Duration and Medium of Instruction of the Program

The program duration for the award of degree in B. Tech. (Regular, Honors and Minor with specialization) will be of four academic years and each academic year will have two semesters. In case, if the student is unable to complete the program in the above said stipulated duration, he/she shall be permitted to complete the program of study within 8 consecutive academic years from the year of admission into B. Tech. program. For the students admitted through lateral entry scheme the duration of the program is 3 years and 6 years if the student fails to complete the program of study in the stiupulated duration of 3 years. The student who fails to meet the requirements for the award of B.

Tech. program during the above said extended duration shall forfeit the degree in B. Tech. program of study. The medium of instruction during the program of study is English.

**Academic Calendar:** As already mentioned, each academic year will have two semesters. Each academic year, an academic calendar will be issued by the Office of the Controller of Examinations (CoE) indicating the duration of instruction period, mid-term tests, semester-end examinations, practical examinations and eventually evaluation. Normally each semester will have sixteen weeks of instruction, one week of practical examinations and three to four weeks for descriptive examinations. In total, each semester will span for a maximum duration of 16 – 19 weeks.

## 4. Programs of Study

NSRIT offers seven programs of four year duration leading to Bachelor's Degree in Engineering and Technology (B. Tech.) as follows

i. Civil Engineering
ii. Computer Science and Engineering (CSE)
iii. Computer Science and Engineering (Artificial Intelligence and Machine Learning)
iv. Computer Science and Engineering (Data Science)
v. Electronics and Communication Engineering (ECE)
vi. Electrical and Electronics Engineering (EEE)
vii. Mechanical Engineering

## 5. Structure of Programs

### 5.1. Categorization of Courses

Each program shall have a common curriculum framework with well defined educational objectives, program outcomes and courses outcomes as per the philosophy of Outcome Based Education (OBE) in line with the Vision and Mission of the department offering the program and in turn in accordance with the Vision and Mission of the Institute. The program structure comprise of theoretical courses, practical courses, theory-cum-practical courses, MOOCs, summer and full semester internship, skill oriented courses, project work, seminars and other relevant courses meeting industry requirements. As the curriculum is framed with Choice Based Credit System (CBCS), the students have the flexibility in opting the courses of their choice under the category of electives. The courses of a particular program are categorized as follows

a. Foundation Courses
    i. Humanities and Social Science including Management (HSS)
    ii. Basic Science (BS)
    iii. Engineering Science (ES)
b. Professional Core Courses relevant to the chosen program of study
c. Electives
    i. Professional Electives (PE) relevant to the chosen program of study
    ii. Open Electives (OE) relevant to other programs of study
d. Project, Seminar and Internship
e. Skill Oriented Courses (SOC)
f. Mandatory Courses(MC) as prescribed by AICTE / UGC

## 5.2. Nomenclature of Credit Distribution

| No. | Nature of Course | Credit |
|---|---|---|
| 1 | Theory Course / Elective Course (per Hour) | 1.0 |
| 2 | Practical / Drawing Course (per Hour) | 0.5 |
| 3 | Summer Internship (2nd Year \| 3rd Year) | 1.5 \| 3.0 |
| 4 | Full Semester Internship | 6.0 |
| 5 | Capstone Project | 6.0 |
| 6 | Moocs (Per Hour) | 1.0 |
| 7 | Skill Advanced / Soft Skill Course (per Hour) | 2.0 |
| 8 | Mandatory Course | - |
| 9 | Counseling/Mentoring | - |
| 10 | Sports/Hobby Clubs/Activities | - |

## 5.3. Structure of Curriculum

| Sem | No. of Theory Courses | No. of Lab Courses, Internship, Term Paper, Project | Total Credits |
|---|---|---|---|
| I | 5 Theory | 3 + Sports/Hobby Clubs/Activities | 19.5 |
| II | 6 (5 Theory + 1 MC) | 3 + Sports/Hobby Clubs/Activities | 19.5 |
| III | 7 (5 Theory + 1 SOC + 1 MC) | 3 + Sports/Hobby Clubs/Activities | 21.5 |
| IV | 6 (5 Theory + 1 SOC) | 3 + Sports/Hobby Clubs/Activities | 21.5 |
| V | 7 (3 Theory + 1 PE + 1 OE + 1 SOC + 1 MC) | 2 + Sports/Hobby Clubs/Activities + Summer Internship #1 | 21.5 |
| VI | 7 (3 Theory + 1 PE +1 OE + 1 SOC + 1 MC) | 3 + Sports/Hobby Clubs/Activities | 21.5 |
| VII | 7 (3 PE + 2 OE (MOOCs) + 1 Elective (HSS) + 1 SOC ) | Summer Internship #2 | 23 |
| VIII | Project | Full Semester Internship | 12 |
| | | **Total Credits** | **160** |

## 5.4. Credit Distribution for each Category

| No. | Category | Credits | |
|---|---|---|---|
| | | Regular | Lateral |
| 1 | **Foundation Courses** | **55.5** | **13.5** |
| | Humanities and Social Science including Management | 10.5 | 06.0 |
| | Basic Science (BS) | 21.0[1] | 06.0[1] |
| | Engineering Science (ES) | 24.0[1] | 04.5[1] |
| 2 | **Professional Core Courses** | **51.0[1]** | **51.0[1]** |
| 3 | **Electives** | **27.0** | **27.0** |
| | Professional Electives | 15.0 | 15.0 |
| | Open Electives | 12.0 | 12.0 |
| 4 | **Project, Seminar and Internship** | **16.5** | **16.5** |
| 5 | **Skill Oriented Courses** | **10.0** | **10.0** |
| 6 | **Mandatory Courses**as prescribed by AICTE and UGC (Not to be accounted for CGPA) | - | - |
| 7 | **Audit Course** | - | - |
| Minimum credits to be earned for the award of the B. Tech. (Regular) degree | | **160** | **121** |

[1]The total number of credits may have marginal variation from one program to other program based on the requirement to accomadate few eseential courses related to the program of study

### 5.5. Assessment Pattern for the Courses

With the true spirit of implementing Outcome Based Education (OBE), each course is designed with customized assessment pattern addressing the various cognitive levels of Revised Bloom's Taxonomy (RBT) with appropriate proportion covering the breadth and depth of the courses. The percentage of various conginitve levels of RBT pertaining to each course is indicated in the syllabus to enable the examiner to develop the assessment instrument in the form of question paper to measure the attainment of course outcomes (COs) that contributes to the attainment of Program Outcomes (POs).The question papers shall be designed with a combination of short answer (40% may be from self study topics) and long answer questions or MCQ that fits best to the assessment. With regard to the assessment pattern for the skill oriented courses, appropriate assessment instrument shall be developed by the respective department that suits to assess the skills that are expected from the courses by taking approval from the competent authority of the Institution before deploying for assessment.

### 5.6. Internship

As per the guidelines specified in these regulations, each student is expected to undergo internship in the form of summer and Full Semester Internship (FSI) during the program of study and it is mandate for all the students. The curriculum offers two summer internships i.e., one at the end of second year and the other one is at the end of third year of study; each one spans for a duration of six weeks. With regard to the FSI, the curriculum provides flexibility at two different slots during VII and VIII semesters with a span of 12 weeks – 16 weeks. The students who are opting FSI either during semester VII or VIII shall register for the course during the semester V through the Head of the department and the same shall be forwarded to the Office of Controller of Examination (CoE) and Internship Cell. To ensure effective implementation of FSI, the Institute shall depute 50% of the interns during semester VII and the rest during semester VIII. Accordingly, the courses pertaining to the semesters shall be inter-changed. The students who are opting for FSI in semester VIIIshall be permitted to take up the capstone projectat the industries along with the FSI in the same industry,if he/she is interested and submit a separate report along with internship/training report. Students will be evaluated by a panel of internal and external subject matter experts (SMEs) nominated by the Office of the CoE.

### 5.7. Project Work

Each student is expected to carryout one capstone project relevant to his/her program of study or interdisciplinary of nature leading to design, development of solutions, and fabrication of system component or a product. On successful completion of the project work, the students are expected to submit a detailed project report along with the working models, if any for evaluation. The office of the CoE shall nominate a team of experts to assess the quality and evaluate the project as per the evaluation guidelines prescribed in the academic regulation.In case, if any student is interested in doing industry oriented project (Individual) atthe industries or research organization, he/she shall take up the project duly approved by the Head of the Department, CoE and the Head of the Institution well before the commencement of the course. In such cases, the students should inform the respective department well in advance, preferably during semester VII. The students

who opted FSI in the semester VII shall take up the courses as precirbed in the curriculum during semester VIII along with the capstone project.

**5.8. Statutory Mandatory Courses and Audit Courses**

Mandatory courses are those courses which are designed in line with the requirement of AICTE.These courses do not carry any credits and are not accounted for the calculation of CGPA.The students shall register for the courses in the respective semester as specified in the curriculum. All the students (regular and lateral entry students) shall complete the mandatory course by taking two conitnuos assessment as well as fulfilling the attendance requirement. A minimum of 40% of marks (average of two continuous assessment) is required to complete the course and the status of completion will be indicated in the grade memo. In addition to the above, the curriculum provides flexibility to nurture employability skills through audit courses and it mandatory for all students to complete the audit courses for the award of the degree and it will not be counted for the calculation of CGPA.

**5.9. MOOCs and Self Study Courses**

The Curriculum provides adequate flexibility for the students to take up MOOCs through self-study mode enabling them to learn the courses on independent mode with minimal guidance of faculty mentor to earn credits for the award of the degree B. Tech. (Regular) and B. Tech. (Honors & Minor with specialization) and the attendance is not mandatory. The courses shall be opted from MOOCs platform viz. NPTEL, SWAYAM or any other platforms as approved by the respective Board of Studies (BoS). The evaluation and assessment pattern for such courses which are part of the curriculum for the B. Tech. (Regular) Degree shall be carried out as similar to other regular theory courses. However, the evaluation and assessment of MOOCs for B. Tech. (Honors) and B. Tech. (Minor with speciliazation) shall be inline with the agencies or the platforms offering these courses. Further, if the grade is not specified by the particular agency or platform, the office of CoE shall follow the institutional SOP for the award of the grade and take necessary approval from the Academic Council through circulation. MOOCs shall be identified by the respective department taking necessary approval from the BoS and shall be intimated well in advance to the students. Futher, in case, if the student is preferred to undergo Semester Away Programme as per Clause 5.11 during semester VII, the credits earned through self-study courses shall be compensated for the calculation of CGPA. This semester away program provides flexibility to the students to select the semester VII either with regular courses as specified in the curriculum or with the semester away program.

**5.10. Industry Supported Courses**

a. Students can opt for one-credit courses, offered by experts from industry/research organizations which are approved by academic council. Students can register such coursesfrom his/her second year of study as and when these courses are conducted by various departments. A student is also permitted to register for the courses of other departments, provided the student has fulfilled the necessary pre-requisites of the course being offered andsubject to the approval of both the Heads of Departments. There is no limit to the number of one credit or two credit courses a student can register during the programme of study. However, a student can register for only one course in a semester. These courses are evaluated by the respective course coordinator of the programme. The

maximum number of credits that can be earned from industry supported courses is limited to four

b. If a student does not successfully complete the registered industry supported one- credit or two credit courses in a semester, the registration of that course will be considered as cancelled. Further, it will not be treated as arrear and no supplementary examination will be conducted; alternatively, if he/she wishes, he/she can re-register for the same course in the ensuing semesters and successfully complete it as and when it is offered subsequently
c. The credits earned through these courses will be treated over and above the credit requirement for the award of the B. Tech. (Regular, Honours and Minor with specialization) programs

**5.11. Semester Away Programme (SAP) to Promote Multi-disciplinary Skills (Choice Based Semester System):** The interested students can have the option of undergoing Semester Away Programme leveraging Choice Based Semester System during semester VII with Higher Learning Institutions at Foreign Countries or Institutions of National Repute or Research Organizations in India, by earning necessary equivalent credits in the semester VII through course study, projects or whatever terms and conditions as prescribed by the respective organization.In addition to the above, the students can opt a combination of 1-, 2-, 3-, 4-credit courses to compensate the credits required for semester VII on self study mode in case of shortage of credits.The students who are interested to opt for SAP shall register to the office of CoE during the beginning of semester III and initiate self-study mode for futuristic compensation of credits. The registration for this SAP is valid as long as the students maintain 7.5 CGPA in all semesters with no history of arrears. Incase, if the student fails to register during the above said period, he/she may register for the same by taking prior permission from the respective Head of the Department. Further, the students are encouraged to opt inter-disciplinary courses of their interest (need not be in the area of the program of study). The Controller of Examinations shall ensure that necessary approvals are taken from the Academic Council well before the time period of their SAP. In case of any uncertain circumstances, if the student fails to complete SAP, the registration will be cancelled automatically and he/she can earn the credits required for that particular semester through self-study mode.

**5.12. Procedure for Awarding Marks for Continuous Assessment**

**Theory** (Internal: 30 Marks | External 70 Marks)

**Continuous Internal Examination #1 and #2**

| | |
|---|---|
| Descriptive Examination | : 20 Marks |
| Objetive Type Examination | : 05 Marks |
| Assignment | : 05 Marks |

The final internal marks will be awarded by considering 80% of marks secured in the best of the two continuous internal evaluation and 20% marks secured in the other internal test.

**Laboratory Courses** (Internal: 30 Marks | External: 70)

| | |
|---|---|
| Total Internal Marks | : 30 Marks |
| Distribution for Continuous Evaluation | |
| Continuous Assessment | : 10 Marks |

| | |
|---|---|
| Record | : 10 Marks |
| Internal Test | : 10 Marks |
| Total External Marks | : 70 Marks |

**Drawing and Design Related Courses** (Internal: 30 Marks | External: 70 Marks)

| | |
|---|---|
| Total Internal Marks | : 30 Marks |
| Distribution for Continuous Evaluation | |
| Continuous Assement | : 15 Marks |
| Internal Test | : 15 Marks |
| Total External Marks | : 70 Marks |

There shall be two internal tests in a semester for 15 marks each and final marks will be calculated by considering 80% of marks secured in the best of the two internal tests and 20% marks secured in the other internal test. The marks obtained will be added to the marks secured during the continuous assessment process.

**Summer Internship** (Internal: 50 Marks)

| | |
|---|---|
| Interim Assessment and Report Writing | : 20 Marks |
| Final Presentation | : 30 Marks |

**Full Summer Internship** (Internal: 100 Marks | External: 100 Marks)

| | |
|---|---|
| Interim Review #1 (Industry Supervisor) | : 20 Marks (Rubrics based) |
| Interim Review #2 (Industry Supervisor) | : 30 Marks (Rubrics based) |
| Terminal Presentation | : 20 Marks (Presentation) |
| Report | : 30 Marks |

In all the continuous assessment pertaining to internship, the major focus of the assessment will be predominently on skills and application of knowledge viz. Communication Skills, Team-work, Organization Skills, Interpersonal Skills, Analytical and Problem Solving Skills, Leadership Skills, Work Ethics and any specific intiatives by the interns.

**Skill Oriented Courses** (Internal: 50 Marks)

| | |
|---|---|
| Interim Assessment and Report Writing | : 20 Marks |
| Outcomes | : 20 Marks |
| Final Presentation | : 10 Marks |

The outcomes shall be in the form of design, development of working model of a system component or a product and these 20 marks shall be awarded based on Rubrics that addresses Critical Thinking, Creativity, Collaboration and Communication.

**Project** (Internal: 100 Marks | External: 100 Marks)

Distribution of Marks (Continuous Internal Assessment)

| | |
|---|---|
| Innovativeness of the Project | : 10 Marks |
| Literature Survey | : 05 Marks |
| Experimentation/ Simulation | : 15 Marks |
| Presentation, Interpretation & Analysis of Results | : 20 Marks |
| Interim Review #1(Presentation) | : 05 Marks |

| | |
|---|---|
| Interim Review #2 (Presentation) | : 05 Marks |
| Product Development | : 20 Marks |
| Terminal Presentation | : 10 Marks |
| Report | : 10 Marks |

A student shall earn the following percentage of minimum percentage of marks in each theory, practical, design and drawing course in B. Tech. program.

- A minimum of 35% (24 and above out of 70 marks) of marks for each course in the semester end examinations Continuous Internal Assessent (CIA) and Semester End Examinations (SEE) and
- A minimum of 40% marks (16 and above out of 30 marks) for each course considering both CIA and SIE taken together

## 6. Attendance Finalization and Result Declaration

### 6.1. Procedure

The attendance shall be calculated as per this autonomous regulation 2020 for the students to appear for the end semester examinations as per clause 6.2. The Institute shall formulate a committee "Joint Board" constituting of Principal (Chairman), Chairpersons of all Boards of Studies, Controller of Examinations (Member Secretary) and two senior members of faculty. The tenure for the senior members of faculty shall be of 2 years. The member secretary shall place the attendance of all the students before the Joint Board for approval before the finalization and declaration of attendance. The same procedure shall be adopted for declaring the end semester examination results.

### 6.2. Attendance Requirements and Result Declaration Procedure

a. A student shall be eligible to appear for the end semester examinations if he/she acquires a minimum of 75% of attendance in aggregate of all the courses in a semester and shortage of attendance below 65% shall in no case be condoned and such cases will not be permitted to appear for the end semester examinations
b. Condonation for shortage of attendance in aggregate up to 10% (65% and above and below 75%) in each semester shall be permittedbased on medical leave (hospitalization / accident / specific illness) and on-duty leave for participation in College / University / State / National / International Sports events with prior approval from the competent authority. After taking necessary approval from the Head of the Institution or Competent Authority, the student shall be permitted to appear for the end-semester examination by paying the condonation fee as prescribed by the Office of CoE. However, the student who have represented the college in outside world activities shall be exempted in paying the condonation fee
c. A student who has secured less than 40% of attendance in a particular course shall not be permitted to appear for the end semester examination though he/she maintains more than 75% of attendance in aggregate of all courses in that particular semester. In such cases, the student need to reappear physically as and when the courses are being offered by the respective department and accordingly the time-table shall be optimized to avoid overlapping
d. Students, who do not meet the minimum required attendance in a semester, shall be detained in that particular semester and they will not be promoted to the next semester. In such cases, the student need to rejoin in that particular semester in the subsequent academic year

e. Academic regulations applicable to the semester in which re-admission is sought shall be applicable to the re-admitted student
f. In case if there are any professional electives and/or open electives, the same may also be re-registered if offered by the respective program of study. However, if those electives are not offered in the later semesters, alternatively, the students may opt other electives from the same set of elective courses offered under that category in that particular semester

**7. Promotion Policies**

During the four year (Regular) or three year (Lateral) program of study, it is mandatory for all students to maintain a minimum of 40% of the credits pertaining to the current year of study to get promoted to subsequent year of study, say 2nd year to 3rd year and so on. In case if the student fails to earn the necessary percentage of credits required for promoting to subsequent year of the program of study, he/she will be detained and he/she need to earn the required credits and take re-admission in the subsequent years of the academic year to complete the B. Tech. degree program.

**8. Eligibility for the Award of the Degree**

A student shall be declared to eligible for the award of the degree in B. Tech. (Regular) program if he/she has fulfilled the following requirements

a. The student should earn the minimum requirement of credits (160 for regular admission and 121
credits for lateral entry) and cleared all the mandatory courses as prescribed in the curriculum within the maximum duration of eight consecutive academic years (Regular) and six consecutive academic years (Lateral) from date of admission
b. The student should maintain more than 5 CGPA at any point of time
c. The student shall not have any pending disciplnary issues

The student shall forfeit his/her Degree and his/her admission stands cancelled if he/she fails to meet the above compliance.

**9. Award of Grades**

| Range of Marks | Letter Grade | Grade Point |
|---|---|---|
| >= 90 | 'O' | 10 |
| >= 80 < 90 | 'A+' | 09 |
| >= 70 < 80 | 'A' | 08 |
| >= 60 < 70 | 'B+' | 07 |
| >= 50 < 60 | 'B' | 06 |
| >= 40 < 50 | 'C' | 05 |
| < 40 | 'F' | 0 |
| Absent | 'AA' | 0 |
| Non completion of a semester (Repeat) | 'I' | 0 |
| Withdrawal from end semester examination | 'W' | 0 |

After completion of the programme, the Cumulative Grade Point Average (CGPA) from the I Semester to VIII Semester (from III to VIII semester for lateral entry) is calculated using the formula:

$$CGPA = \frac{\sum_{i=1}^{n-1}(c_i \times g_i)}{\sum_{i=1}^{n-1} c_i}$$

where 'n' is the number of courses registered for, '$c_i$' is the credits allotted to the given course and '$g_i$' is the grade point secured in the corresponding course

**10. Classification of the Degree Awarded**

a. **B. Tech. (Honors):** In addition to the requirement as cited in (10.c), if the student secures 20 additional credits in accordance with the clause (14), he/she shall be declared with B. Tech. (Honors)
b. **B. Tech. (Minor with Specialization):** In addition to the requirement as cited in (10.c), if the student secures 20 additional credits in accordance with the clause (15), he/she shall be declared with B. Tech. (Minor with Specialization)
c. **B. Tech. (Regular) - First Class with Distintion:** The student who qualifies for the award of the B. Tech. degree in the chosen program of study with 160 credits (Regular) and 121 credits (Lateral) within five consecutive academic years (Considering the formal approval for the break of study from the competent authority) from the date of admission at his/her first attempt maintaining 7.5 CGPA and above shall be declared to have passed in first class with distintion and should not have been prevented from appearing end semester examinations for the want of attendance requirements
d. **B. Tech. (Regular) - First Class:** The student who qualifies for the award of the B. Tech. degree in the chosen program of study with 160 credits (Regular) and 121 credits (Lateral) within four consecutive academic years from the date of admission maintaining 6.75 CGPA and above shall be declared to have passed in first class and should not have been prevented from appearing end semester examinations for the want of attendance requirements
e. **B. Tech. (Regular) - Second Class:** The student who qualifies for the award of the B. Tech. degree in the chosen program of study with 160 credits (Regular) and 121 credits (Lateral) within eight consecutive academic years from the date of admission maintaining 5.75 CGPA and above and less than 6.75 CGPA shall be declared to have passed in second class
f. **B. Tech. (Regular) - Pass:** All other students who have not covered and qualifies for the award of the degree maintaining 5.00 CGPA and above and less than 5.75 CGPA shall be declared to get Pass with minimum credit requirement for the award of the degree in B. Tech. program

**11.Flexibility to Add or Drop Self Study Courses (SSC)**

a. It is mandatory that all the students need to earn the minimum number of the credits for the award of B. Tech. degree in their respective program of study. However, a student can earn more number of credits if he/she opt, by registering additional courses, from the list of courses available in the curriculum of all disciplines, over and above to the existing courses from semester IV – VI. The student shall be permitted to drop any SSC at any point of time and registration for such courses gets cancelled and will not be reflected in Cumulative Grade Memo (CGM)
b. All the courses registered and cleared by a student in this mode will be mentioned in the CGM as additional acquired. However, the CGPA is calculated as per the minimum requirement of the credits for the award of the B. Tech. degree

**12. Withdrawal from the Examination**

a. A candidate may, for valid reasons, be granted permission by the Principal to withdraw from appearing for the examination in any course or courses of only one semester examination during the entire duration of the Degree Programme. Also, only ONE application for withdrawal is permitted for that semester examination in which withdrawal is sought
b. Withdrawal application shall be valid only if the candidate is otherwise eligible to write the examination and if it is made prior to the commencement of the examination in that course or courses and also recommended by the Head of the Department
c. Such withdrawal from the examination shall be treated as absent for the 1st attempt to the respective examination and will lose the eligibility for First Class with Distinction
d. If any student is intended to drop FSI subsequent to his/her registration followed by allotment, he/she needs to re-register the course

**13.Transitory Regulations:** To enable the students to take admission or entry into NSRIT from other Institution either by Transfer, Re-admission, Admission, or Transfer from other engineering Institution affiliated to JNTUK/Academic regulation within the Institute, the following regulations shall be followed based on the nature of case as cited above.

- Transfer of candiate from aAutonomous / Non-Autonomous Institution affiliated to JNTUK
- Within the Institution from one regulation to other academic regulation

**a.** Transfer of a candidate from aAutonomous / Non-Autonomous Institution affiliated to JNTUK

Any canddate who is interested to take admission in NSRIT from a non-autonomous engineering institution affiliated to the parent university either in the semester III or thereafter, shall acquire the credits required for graduation as per the Institute autonomous regulations and the candidature shall be treated under following category

Students from non-autonomous institution seeking admission into semester III shall be treated in par with the students taking admission for 3 year program of study (i.e. lateral entry students) and should have cleared all the courses in the semester I and II as per university regulation. The same shall be calculated as per NSRIT regulations if the student is seeking admission into NSRIT from an autonomous institution. The credits earned during semester I and II shared be calculated as per the Institute autonomous regulations and in case if the earned credits during first two semestersare not adequate to take admission in the third semester, the student shall take additional courses approved by the respective Board of Studies and Academic council during semester III at NSRIT on self study mode and the same procedure shall be followed for taking admission into higher semesters

**b. Within the Institution from one regulation to other academic regulation**

A student taking admission under one regulation, say Academic Regulation 2020 in the first year, shall continue with the same regulation and should earn the necessary credits as metioned in the academic regulation at the time of joining. However, In case of readmission into a subsequent new regulation, and if the readmission is into any of the semesters from semester I through IV, the student shall follow the current regulations to which he/she taking admission and continue with the same regulation till graduation. In case of any credit shortage, the necessary credits shall

be earned on self study mode to compensate the required number of credits. In case of excess credits, it will be treated as over and above.

In both the cases (a) and (b), the details shall be forwarded to the parent university along with the proceedings of the Academic Council.

14. **B.Tech. (Honors):** The curriculum provides flexibility to enable the students to register for B.Tech. (Honors) program by earning additional 20 credits which is over and above the requirement for the award of B.Tech.(Regular) degree. He/She shall register in the office of the CoE during semester III provided he/she secures ≥8 CGPA without backlogs in earlier semesters. If he/she wishes to withdraw from B.Tech. (Honors) program at any point of time, the credits obtained will not be compensated for the award of the degree and considered as over and above. The maximum enrollment B. Tech. (Honors) shall be restricted to 10% of the total intake in a particular batch of students.

    The additional 20 credits shall be earned by opting four 4-credit courses offered by the respective program of study which are categorized in the curriculum and these courses shall be offered with a combination of guided learning or taught courses or self study mode depemding on the total number of students registered for that particular course and the Chairpeson of the Board of Studies reserves the right to decide the mode of delivery. Apart from this, he/she shall choose two 2-credit MOOCs of 30 hours or 6 weeks duration. Above all, if any student fails to maintain the 8 SGPA in the subsequent semesters after semester III, the registration for the B. Tech. (Honors) program stands cancelled without any notification. In case of students admitted through lateral entry, the CGPA compliance will be considered from semester III onwards as already mentioned.

15. **B.Tech. (Minor with Specialization):** The curriculum provides flexibility to enable the students to register for B. Tech. (Minor with Specialization) program by earning additional 20 credits which is over and above the requirement for the award of B. Tech. (Regular) degree. He/She shall register in the office of the CoE during the semester III provided he/she secures ≥8 CGPA without backlogs in earlier semesters. If he/she wishes to withdraw from B. Tech. (Minor with Specialization) program at any point of time, the credits obtained will not be compensated for the award of the degree and considered as over and above. In case of students admitted through lateral entry, the CGPA compliance will be considered from semester III onwards.

    The student shall opt three inter-disciplinary courses each of 3-credit as listed in the curriculum offered by other programs and one 3-credit MOOCs of 30 hours or 6 weeks duration in addition to a project of 8-credit leading to design, process development, system component design & fabrication and application development relevant to the chosen field of interest prescribed in the curriculum.

16. **Temporary Break of Study from the Program**: The curriculum provides flexibility for the students having ≥9 CGPA to take a break of one year at any time after the end of I/II/III year of study to pursue entrepreneurship on full time. This period of gap shall be counted for the maximum time of graduation. A committee approved by the Academic Council shall be constituted to evaluate the proposal submitted by the student and the committee shall decide on permitting the student for availing the break of study.

**17. Revision of the Academic Regulations and Curriculum**

The Joint Board Committee and the Academic Council of the Institute reserve the right to revise, change or amend the regulations, the scheme of examinations, the curriculum and the syllabi from time to time if found necessary.

**18. Representation of Special Cases**

In case of any clarification in the interpretation of the above rules and regulations, they shall be referred to the Joint Board Committee through the Head of the Institution. The Joint Board Committee will offer suitable interpretations/clarifications/amendments required for special case on such references and get them ratified in the next meeting of the Academic Council. The decision of the Academic Council is final.

## Computer Science and Engineering (Artificial Intelligence and Machine Learning)

**Preamble:** The curriculum of B. Tech. Computer Science and Engineering (Artificial Intelligence and Machine Learning) program offered by the Department of Computer Science and Engineering under Academic Regulation 2020 is prepared in accordance with the curriculum framework of AICTE, UGC and Andhra Pradesh State Council of Higher Education (APSCHE). Further this Outcome Based Curriculum (OBC) is designed with Choice Based Credit and Semester System (CBCSS) enabling the learners to gain professional competency with multi-disciplinary approach catering the minimum requirement (Program Specific Criteria) of Lead Societies like ACM and other Professional Bodies as per the Engineering Accreditation Commission (EAC) of ABET and NBA. In addition, the curriculum and syllabi are designed in a structured approach by deploying Feedback Mechanism on Curriculum from various stakeholders viz. Industry, Potential Employers, Alumni, Academia, Professional Bodies, Research Organizations and Parents to capture their voice of the respective stakeholders.

The Curriculum design, delivery, and assessment, the three major pillars of academic system are completely aligned in line with Outcome Based Education (OBE) to assess and evaluate the learning outcomes to facilitate the learners to achieve their Professional and Career Accomplishments.

### The Vision

To become the Centre of Excellence for technically competent and innovative computer engineers

### The Mission

- To provide quality education and spread professional & technical knowledge, leading to a career as computer professionals in different domains of industry, governance, and academia
- To provide state-of-the art environment for learning and practices
- To impart hands on training in latest methodologies and technologies

**Program Educational Objectives (PEOs)**

The PEOs are the educational goals that reflect Professional and Career Accomplishments that a graduate should attain after 4 – 5 years of his/her graduation.

The graduates of Computer Science and Engineering (Artificial Intelligence and Machine Learning) of NSRIT will

1. Be Engineering professionals/innovators/entrepreneurs by adapting and engaging themselves in technology deployment and implementation in the industry
2. Have a sustained satisfactory professional career in their chosen profession as an individual and/or as a team member/team lead in an IT or allied industry
3. Engage themselves in life-long learning in advanced studies based on the demand driven need of the industries for their professional and career accomplishments

**Program Outcomes (POs)**

The POs are the transactional statements of graduate attributes (GAs) that each graduating engineer should possess in terms of knowledge, skill and behavior with a minimum target performance level at the time of graduation as fixed by the program of study seeking continuous improvement year on year.

The graduates of Computer Science and Engineering of NSRIT will be able to demonstrate the following outcomes in terms knowledge, skill and behavioral competencies at the time of graduation with the expected target performance level.

1. Apply the knowledge of basic sciences and fundamental engineering concepts in solving engineering problems (Engineering Knowledge)
2. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences (Problem Analysis)
3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations (Design/Development of Solutions)
4. Perform investigations, design and conduct experiments, analyse and interpret the results to provide valid conclusions (Investigation of Complex Problems)
5. Select/develop and apply appropriate techniques and IT tools for the design & analysis of the systems (Modern Tool Usage)
6. Give reasoning and assess societal, health, legal and cultural issues with competency in professional engineering practices (The Engineer and Society)
7. Demonstrate professional skills and contextual reasoning to assess environmental/societal issues for sustainable development (The Environment and Sustainability)
8. Demonstrate Knowledge of professional and ethical practices (Ethics)
9. Function effectively as an individual, and as a member or leader in diverse teams, and in multi-disciplinary situations (Individual and Team Work)
10. Communicate effectively among engineering community, being able to comprehend and write effectively reports, presentation and give / receive clears instructions (Communication)
11. Demonstrate and apply engineering & management principles in their own / team projects in multidisciplinary environment (Project Finance and Management)
12. Recognize the need for, and have the ability to engage in independent and lifelong learning (Life Long Learning)

## Program Specific Outcomes (PSOs)

1. Apply the conceptual knowledge of computer science, machine learning and deep learning to solve real world problems
2. Develop skills to design and develop systems/applications to provide AI based solutions

## Category-wise Credit Distribution of Courses

| Category | | AICTE | APSCHE | NSRIT (A) |
|---|---|---|---|---|
| HS | Humanities and Social Science | 12.0 | 10.5 | 10.5 |
| BS | Basic Science | 25.0 | 18.0 | 21.0 |
| ES | Engineering Science | 24.0 | 22.5 | 19.5 |
| PC | Professional Core | 48.0 | 55.5 | 55.5 |
| PE | Professional Elective | 18.0 | 15.0 | 15.0 |
| OE | Open Elective | 18.0 | 12.0 | 12.0 |
| IN | Internship (s), Project & Seminars | 15.0 | 16.5 | 16.5 |
| SC | Skill Oriented Courses | - | 10.0 | 10.0 |
| MC | Mandatory Courses | - | - | - |
| AC | Audit Course | - | - | - |
| | Total no. of credits | 160 | 160 | 160 |

## Computer Science and Engineering (Artificial Intelligence and Machine Learning)

| Credit requirement for the award of the degree under academic Regulation 2020 – 2021 for the candidates admitted from the academic year 2021 onwards | | |
|---|---|---|
| | Four Years | Three Years |
| B. Tech. (Regular Degree) | 160 | 121 |
| B. Tech. (Honors Degree) | 180 | 141 |
| B. Tech. (With minor specialization other than Chosen Branch of Engg. & Tech.) | 180 | 141 |

| No. | Course Code | Course | POs | Contact Hours | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T* | P | C | |
| **Semester I** | | | | | | | | |
| 01 | 20HSX01 | Communicative English | 10 | 3 | 0 | 0 | 3.0 | HS |
| 02 | 20BSX11 | Linear Algebra and Differential Equations | 1, 12[1] | 3 | 1 | 0 | 3.0 | BS |
| 03 | 20BSX33 | Applied Physics | 1 | 3 | 1 | 0 | 3.0 | BS |
| 04 | 20ESX02 | Programming for Problem Solving using 'C' | 1 | 1 | 0 | 4 | 3.0 | ES |
| 05 | 20CS101 | Fundamentals of Computer Science | 1 | 3 | 0 | 0 | 3.0 | ES |
| 06 | 20HSX02 | Communicative English Laboratory | 1, 10 | - | - | 3 | 1.5 | BS |
| 07 | 20BSX34 | Applied Physics Laboratory | 1, 4 | - | - | 3 | 1.5 | HS |
| 08 | 20ESX07 | Programming for Problem Solving using 'C' Lab | 1, 4 | - | - | 3 | 1.5 | ES |
| | | | Sub-total | 13 | 02 | 13 | **19.5** | |
| **Semester II** | | | | | | | | |
| 01 | 20BSX12 | Partial Differential Equations and Vector Calculus | 1 | 3 | 1 | 0 | 3.0 | BS |
| 02 | 20BSX23 | Applied Chemistry | 1 | 3 | 1 | 0 | 3.0 | BS |
| 03 | 20ESX05 | Basic Electrical and Electronics Engineering | 1 | 3 | 1 | 0 | 3.0 | ES |
| 04 | 20CS201 | Data Structures using 'C' | 1 | 3 | 1 | 0 | 3.0 | ES |
| 05 | 20EC203 | Digital Logic Design | 1 | 3 | 1 | 0 | 3.0 | ES |
| 06 | 20BSX24 | Applied Chemistry Laboratory | 1, 4 | 0 | 0 | 3 | 1.5 | BS |
| 07 | 20CS202 | Data Structures using 'C' Laboratory | 1, 4 | 0 | 0 | 3 | 1.5 | ES |
| 08 | 20ESX08 | Basic Electrical & Electronics Engineering Lab | 1, 4 | 0 | 0 | 3 | 1.5 | ES |
| 09 | 20MCX01 | Environmental Science | 1 | 2 | 0 | 0 | - | MC |
| | | | Sub-total | 17 | 05 | 09 | **19.5** | |
| **Semester III** | | | | | | | | |
| 01 | 20BSX16 | Mathematical Foundations for Computer Science | 1 | 3 | 1 | 0 | 3.0 | BS |
| 02 | 20AI302 | Artificial Neural Networks | 1, 3 | 3 | 1 | 0 | 3.0 | PC |
| 03 | 20CS303 | Database Management Systems | 1, PSO1 | 3 | 1 | 0 | 3.0 | PC |
| 04 | 20CS304 | Object Oriented Programming through C++ | 1 | 3 | 1 | 0 | 3.0 | PC |
| 05 | 20CS305 | Computer Organization | 1 | 3 | 0 | 0 | 3.0 | PC |
| 06 | 20AI306 | Artificial Neural Networks Programming Lab | 4 | - | - | 3 | 1.5 | PC |
| 07 | 20CS307 | Database Management Systems Laboratory | 1, 4, PSO1 | - | - | 3 | 1.5 | PC |
| 08 | 20CS308 | Object Oriented Programming through C++ Lab | 1, 4 | - | - | 3 | 1.5 | PC |
| 09 | | MOOCs | 12 | 0 | 0 | 0 | 2.0 | SC |
| 10 | 20MCX02 | Constitution of India | 8 | 2 | - | 0 | - | MC |
| | | | Sub-total | 18 | 4 | 9 | **21.5** | |

* Suggested hours for tutorial
[1] By default, all courses are mapped to PO 12 as they are weakly contributing

| No. | Course Code | Course | POs | Contact Hours | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | C | |
| Semester IV | | | | | | | | |
| 01 | 20HSX03 | Managerial Economics & Financial Analysis | 11 | 3 | 0 | 0 | 3.0 | HS |
| 02 | 20BSX15 | Probability and Statistics | 2, 5 | 3 | 1 | 0 | 3.0 | BS |
| 03 | 20CS502 | Computer Networks | 1, 2 | 3 | 0 | 0 | 3.0 | PC |
| 04 | 20CS404 | Operating Systems | 1 | 3 | 1 | 0 | 3.0 | PC |
| 05 | 20CS302 | Design and Analysis of Algorithms | 1, 2, 3 | 3 | 1 | 0 | 3.0 | PC |
| 06 | 20CS306 | Design and Analysis of Algorithms Lab | 4 | 0 | 0 | 3 | 1.5 | PC |
| 07 | 20AI406 | Python Programming for Statistics Laboratory | 4, 5 | 0 | 0 | 3 | 1.5 | PC |
| 08 | 20CS408 | Operating Systems Lab | 4 | 0 | 0 | 3 | 1.5 | PC |
| 09 | 20AIS02 | Competitive Programming Essentials | 3, 4, 5 | 1 | 0 | 2 | 2.0 | SC |
| | | | Sub-total | 16 | 3 | 11 | **21.5** | |
| Semester V | | | | | | | | |
| 01 | 20CS405 | Theory of Computation | 1, 2 | 3 | 1 | 0 | 3.0 | PC |
| 02 | 20AI502 | Artificial Intelligence | 1, 2 | 3 | 1 | 0 | 3.0 | PC |
| 03 | 20AI503 | High Performance Computing | 2, 3, 5 | 3 | 1 | 0 | 3.0 | PC |
| 04 | - | Open Elective I | | 3 | 0 | 0 | 3.0 | OE |
| 05 | - | Professional Elective I | | 3 | 0 | 0 | 3.0 | PE |
| 06 | 20AI506 | Application Development Laboratory | 5, PSO1, PSO2 | 0 | 0 | 3 | 1.5 | PC |
| 07 | 20AI507 | Artificial Intelligence Laboratory | 4, 5 | 0 | 0 | 3 | 1.5 | PC |
| 08 | | MOOCs | 12 | 0 | 0 | 0 | 2.0 | SC |
| 09 | 20MCX03 | Intellectual Property Rights and Patents | | 2 | 0 | 0 | 0 | MC |
| 10 | | Summer Internship #1[2] | 5, 8, 9, 10, PSO1 | 0 | 0 | 0 | 1.5 | TG |
| 11 | | Technical Paper Writing | | 0 | 0 | 2 | - | AC |
| | | | Sub-total | 17 | 3 | 08 | **21.5** | |
| Semester VI | | | | | | | | |
| 01 | 20CS603 | Modern Software Engineering | 1, 2, 3 | 3 | 0 | 0 | 3.0 | PC |
| 02 | 20AI602 | Deep Learning Principles and Practices | 2, 3, 5 | 3 | 1 | 0 | 3.0 | PC |
| 03 | 20AI603 | Machine Learning | 1, 2 | 3 | 1 | 0 | 3.0 | PC |
| 04 | - | Professional Elective II | | 3 | 1 | 0 | 3.0 | PE |
| 05 | - | Open Elective II | | 3 | 0 | 0 | 3.0 | OE |
| 06 | 20CS608 | Modern Software Engineering Laboratory | 4, 5 | 0 | 0 | 3 | 1.5 | PC |
| 07 | 20AI607 | Deep Learning Laboratory | 4, 5 | 0 | 0 | 3 | 1.5 | PC |
| 08 | 20AI608 | Machine Learning Lab | 4, 5 | 0 | 0 | 3 | 1.5 | PC |
| 09 | 20AIS04 | Datasets & Packages for ML Engineer - 1 | 4, 5 | 0 | 0 | 4 | 2.0 | SC |
| 10 | 20MCX04 | Indian Traditional Knowledge | | 2 | 0 | 0 | - | MC |
| | | | Sub-total | 17 | 3 | 13 | **21.5** | |
| Semester VII | | | | | | | | |
| 01 | - | Professional Elective III | | 3 | 0 | 0 | 3.0 | PE |
| 02 | - | Professional Elective IV | | 3 | 0 | 0 | 3.0 | PE |
| 03 | - | Professional Elective V | | 3 | 0 | 0 | 3.0 | PE |
| 04 | - | Open Elective III | | 2 | 0 | 2 | 3.0 | OE |
| 05 | - | Open Elective IV | | 2 | 0 | 2 | 3.0 | OE |
| 06 | 20HSX04 | Professional Ethics | 8 | 3 | 0 | 0 | 3.0 | HS |
| 07 | 20SAI05 | Datasets & Packages for ML Engineer - 2 | 4, 5 | 0 | 0 | 4 | 2.0 | SC |
| 08 | - | Summer Internship #2[1] | All POs | 0 | 0 | 0 | 3.0 | TG |
| | | | Sub-total | 16 | 0 | 8 | **23** | |
| Semester VIII | | | | | | | | |
| 01 | | Full Semester Internship[3] | 5 – 10, PSOs | | | | 06 | |
| 02 | | Capstone Project[3] | 5 – 10, PSOs | | | | 06 | |
| | | | Sub-total | | | | **12.0** | |
| | | | **Total Credits** | | | | **160** | |

[2] The work pertaining to Summer Internship #1 and #2 shall be completed at the end of Semesters IV and VI respectively. The assessment shall be carried out during Semesters V and VII

[3] Students opting for FSI in VII semester have to take up courses of VII semester in VIII semester

## List of Electives

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Professional Elective #1 | | | | | | | | |
| 1 | 20AI001 | Fundamentals of Image Processing | | 3 | 0 | 0 | 3.0 | PE |
| 2 | 20AI002 | Cryptography | | 3 | 0 | 0 | 3.0 | PE |
| 3 | 20AI003 | Cloud Computing Essentials | | 3 | 0 | 0 | 3.0 | PE |
| Professional Elective #2 | | | | | | | | |
| 5 | 20AI004 | Computer Vision and Applications | | 3 | 1 | 0 | 3.0 | PE |
| 6 | 20AI005 | Cyber Security | | 3 | 0 | 0 | 3.0 | PE |
| 7 | 20AI006 | Social Network Analysis | | 3 | 1 | 0 | 3.0 | PE |
| Professional Elective #3 | | | | | | | | |
| 9 | 20AI007 | Bio-informatics | | 3 | 0 | 0 | 3.0 | PE |
| 10 | 20AI008 | Fundamentals of Blockchain | | 3 | 0 | 0 | 3.0 | PE |
| 11 | 20AI009 | Big Data Analytics | | 3 | 1 | 0 | 3.0 | PE |
| Professional Elective #4 | | | | | | | | |
| 13 | 20AI010 | Soft Computing | | 3 | 0 | 0 | 3.0 | PE |
| 14 | 20AI011 | Cyber Threat Analysis | | 3 | 0 | 0 | 3.0 | PE |
| 15 | 20AI012 | Distributed Computing | | 3 | 0 | 0 | 3.0 | PE |
| Professional Elective #5 | | | | | | | | |
| The curriculum provides academic flexibility to choose any of the domain specific courses from MOOCs as approved by the respective Board of Studies and Academic Council. The students can take up this course on self-study mode. The course shall be of 45 – 60 hours duration (4-credits) and the assessment shall be as per the academic regulation 2020. | | | | | | | | PE |
| Open Elective #1 | | | | | | | | |
| 25 | 20CEO01 | Urban Environmental Service | | 3 | 0 | 0 | 3.0 | OE |
| 26 | 20CSO01 | Data Structures and Algorithms | | 3 | 0 | 0 | 3.0 | OE |
| 27 | 20AIO01 | Machine Learning for Engineers | | 3 | 0 | 0 | 3.0 | OE |
| 28 | 20DSO01 | Introduction to Database Management Systems | | 3 | 0 | 0 | 3.0 | OE |
| 29 | 20ECO01 | Architecture and Algorithms of IoT | | 3 | 0 | 0 | 3.0 | OE |
| 30 | 20EEO01 | Introduction to Renewable Energy Sources | | 3 | 0 | 0 | 3.0 | OE |
| 31 | 20MEO01 | Nano Technology | | 3 | 0 | 0 | 3.0 | OE |
| 32 | 20SHO01 | Women and Society | | 3 | 0 | 0 | 3.0 | OE |
| Open Elective #2 | | | | | | | | |
| 33 | 20CEO02 | Ecology, Environment and Resources | | 3 | 0 | 0 | 3.0 | OE |
| 34 | 20CSO02 | Designing the Internet of Things | | 3 | 0 | 0 | 3.0 | OE |
| 35 | 20AIO02 | Fundamentals of Deep Learning | | 3 | 0 | 0 | 3.0 | OE |
| 36 | 20DSO02 | Introduction to Data Science | | 3 | 0 | 0 | 3.0 | OE |
| 37 | 20ECO02 | IoT for Smart Grids | | 3 | 0 | 0 | 3.0 | OE |
| 38 | 20EEO02 | Electrical Safety and Management | | 3 | 0 | 0 | 3.0 | OE |
| 39 | 20MEO02 | Fundamentals of Automobile Engineering | | 3 | 0 | 0 | 3.0 | OE |
| Open Elective #3 | | | | | | | | |
| 40 | 20CEO03 | Disaster, Risk mitigation and Management | | 3 | 0 | 0 | 3.0 | OE |
| 41 | 20CS302 | Operating Systems | | 3 | 0 | 0 | 3.0 | OE |
| 42 | 20AIO03 | Fundamentals of AI | | 3 | 0 | 0 | 3.0 | OE |
| 43 | 20DSO03 | Introduction to Big Data | | 3 | 0 | 0 | 3.0 | OE |
| 44 | 20ECO03 | Privacy and Security in IoT | | 3 | 0 | 0 | 3.0 | OE |
| 45 | 20EEO03 | Low-cost Automation | | 3 | 0 | 0 | 3.0 | OE |
| 46 | 20MEO03 | Industrial Automation | | 3 | 0 | 0 | 3.0 | OE |
| 47 | 20SHO02 | Design Innovations | | 3 | 0 | 0 | 3.0 | OE |
| Open Elective #4 | | | | | | | | |
| The curriculum provides academic flexibility to choose any of the inter-disciplinary courses from MOOCs as approved by the respective Board of Studies and Academic Council. The students can take up this course on self-study mode. The course shall be of 45 – 60 hours duration and the assessment shall be as per the academic regulation 2020. | | | | | | | | OE |
| B. Tech. (Honors) | | | | | | | | |
| **Category I** | | | | | | | | |
| 1 | 20DSH01 | Text Analytics | | 4 | 0 | 0 | 4.0 | HO |
| 2 | 20AIH02 | **Advanced Data Structures and Algorithms** | | 4 | 0 | 0 | 4.0 | HO |
| 3 | 20AIH03 | **Game Theory** | | 4 | 0 | 0 | 4.0 | HO |
| **Category II** | | | | | | | | |
| 4 | 20DSH04 | Recommender Systems | | 4 | 0 | 0 | 4.0 | HO |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 5 | 20AIH05 | **Video Analytics** | | 4 | 0 | 0 | 4.0 | HO |
| 6 | 20AIH06 | **Game Programming** | | 4 | 0 | 0 | 4.0 | HO |
| **Category III** | | | | | | | | |
| 7 | 20DSH07 | Data Analysis with MATLAB | | 4 | 0 | 0 | 4.0 | HO |
| 8 | 20AIH08 | **Natural Language Processing** | | 4 | 0 | 0 | 4.0 | HO |
| 9 | 20AIH09 | **3D Graphics and Animations** | | 4 | 0 | 0 | 4.0 | HO |
| **Category IV** | | | | | | | | |
| 10 | 20DSH10 | Data Preparation and Cleaning | | 4 | 0 | 0 | 4.0 | HO |
| 11 | 20AIH11 | **Digital Forensics** | | 4 | 0 | 0 | 4.0 | HO |
| 12 | 20AIH12 | **Augmented Reality and Virtual Reality** | | 4 | 0 | 0 | 4.0 | HO |
| B. Tech. (Minor with Specialization) | | | | | | | | |
| **Category I** | | | | | | | | |
| 1 | 20CEM01 | Air Pollution | | 3 | 0 | 0 | 3.0 | MI |
| 2 | 20CSM01 | E Commerce | | 3 | 0 | 0 | 3.0 | MI |
| 3 | 20MEM01 | Biomaterials | | 3 | 0 | 0 | 3.0 | MI |
| 4 | 20EEM01 | Basic Control systems | | 3 | 0 | 0 | 3.0 | MI |
| 5 | 20ECM01 | Fundamentals of Electronics | | 3 | 0 | 0 | 3.0 | MI |
| 6 | 20AIM01 | Fundamentals of Neural Networks | | 3 | 0 | 0 | 3.0 | MI |
| 7 | 20DSM01 | Introduction to R Programming | | 3 | 0 | 0 | 3.0 | MI |
| **Category II** | | | | | | | | |
| 8 | 20CEM02 | Climate Change Mitigation and Adaptation | | 3 | 0 | 0 | 3.0 | MI |
| 9 | 20CSM02 | Knowledge Discovery and Databases | | 3 | 0 | 0 | 3.0 | MI |
| 10 | 20MEM02 | Micro Electromechanical Systems | | 3 | 0 | 0 | 3.0 | MI |
| 11 | 20EEM02 | Design of Photovoltaic Systems | | 3 | 0 | 0 | 3.0 | MI |
| 12 | 20ECM02 | Digital Electronics | | 3 | 0 | 0 | 3.0 | MI |
| 13 | 20AIM02 | Machine Learning with Python | | 3 | 0 | 0 | 3.0 | MI |
| 14 | 20DSM02 | Data Management and Analysis | | 3 | 0 | 0 | 3.0 | MI |
| **Category IIII** | | | | | | | | |
| 15 | 20CEM03 | Sustainability and Pollution Prevention Practices | | 3 | 0 | 0 | 3.0 | MI |
| 16 | 20CSM03 | Database Security | | 3 | 0 | 0 | 3.0 | MI |
| 17 | 20MEM03 | Surface Engineering | | 3 | 0 | 0 | 3.0 | MI |
| 18 | 20EEM03 | Electrical Engineering Material Science | | 3 | 0 | 0 | 3.0 | MI |
| 19 | 20ECM03 | Analog Electronic Circuits | | 3 | 0 | 0 | 3.0 | MI |
| 20 | 20AIM03 | Interpretable Machine Learning | | 3 | 0 | 0 | 3.0 | MI |
| 21 | 20DSM03 | Data Governance | | 3 | 0 | 0 | 3.0 | MI |

**List of Honors offered by Computer Science and Engineering (AI & ML) Program**

1. **Data Analytics**
2. **Surveillance Systems**
3. **Game Programming**

List of Minor Specializations offered by Computer Science and Engineering (AI & ML) Program

1. Machine Learning and Deep Learning

## PE 20AI007 Bio informatics 3 0 0 3

**Pre-requisite Basics of biology**

At the end of the course, students will be able to

| Code | Course Outcomes | Mapping with POs | DoK |
|---|---|---|---|
| 20AI007.1 | Understand the basic concepts of bioinformatics | - | L1, L2 |
| 20AI007.2 | Describe the methods of data analysis | | L1, L2 |
| 20AI007.3 | Explain various models for bioinformatics | | L1, L2 |
| 20AI007.4 | Explain the different pattern matching visualization methods of bioinformatics | | L1, L2 |
| 20AI007.5 | Understand the concepts of microarray analysis | | L1, L2 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos

L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create. DoK: Depth of Knowledge

**Unit I: Introduction** **9 hours**

Need for Bioinformatics technologies – Overview of Bioinformatics technologies Structural bioinformatics – Data format and processing – Secondary resources and applications – Role of Structural bioinformatics - Biological Data Integration System.

*Different data formats*

**Unit II: Data warehousing and mining in Bioinformatics** **9 hours**

Bioinformatics data – Data warehousing architecture – data quality – Biomedical data analysis – DNA data analysis – Protein data analysis – Machine learning – Neural network architecture and applications in bioinformatics

*Data analytical tools for DNA*

**Unit III: Modelling for Bioinformatics** **9 hours**

Hidden markov modelling for biological data analysis – Sequence identification –Sequence classification – multiple alignment generation – Comparative modelling –Protein modelling – genomic modelling – Probabilistic modelling – Bayesian networks – Boolean networks - Molecular modelling

*Computer programs for molecular modelling.*

**Unit IV: Pattern matching and Visualization** **9 hours**

Gene regulation – motif recognition – motif detection – strategies for motif detection – Visualization – Fractal analysis – DNA walk models – one dimension – two dimension – higher dimension – Game representation of Biological sequences – DNA, Protein

*Amino acid sequences*

**Unit V: Microarray Analysis** **9 hours**

Microarray technology for genome expression study – image analysis for data extraction – pre-processing – segmentation – gridding – spot extraction – normalization, filtering – cluster analysis – gene network analysis – Compared Evaluation of Scientific Data Management Systems – Cost Matrix – Evaluation model - Benchmark – Trade-offs

**Text Books**

1. Yi-Ping Phoebe Chen (Ed), “BioInformatics Technologies”, First Indian Reprint, Springer Verlag,2007.

**Reference Books**

1. Bryan Bergeron, “Bio Informatics Computing”, Second Edition, Pearson Education, 2003.
2. Arthur M Lesk, “Introduction to Bioinformatics”, Second Edition, Oxford University Press, 2005

**Web References**

1. https://nptel.ac.in/courses/105/102/105102012/
2. https://onlinecourses.swayam2.ac.in/nou20_cs14/

## Internal Assessment Pattern

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 50 | 50 |
| L2 | 50 | 50 |
| Total (%) | 100 | 100 |

## Sample Short and Long Answer Questions of Various Cognitive Levels

### L1: Remember

1. List out any 4 applications of bio-informatics
2. Draw the warehouse architecture for biological data
3. Describe different data formats to handle biological data

### L2: Understand

1. Explain the neural network models to handle biological data
2. Explain evaluation metrics for biological models

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## PE 20AI008 Fundamentals of Blockchain 3 0 0 3

At the end of the course, students will be able to

| Code | Course Outcomes | Mapping with POs | DoK |
|---|---|---|---|
| 20AI008.1 | Understand and explore the working of Blockchain Technology | - | L1, L2 |
| 20AI008.2 | Understand the blockchain technology on cryptocurrency and bitcoin | | L1, L2 |
| 20AI008.3 | Learn the fundamentals of Ethereum and working of smart contarcts | | L1, L2 |
| 20AI008.4 | Understand and analze the working of Hyperledger | | L1, L2 |
| 20AI008.5 | Know the various application of blockchain in different domains | | L1, L2 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create. DoK: Depth of Knowledge

**Unit I: Introduction of Cryptography and Blockchain** **9 hours**
What is Blockchain, Blockchain Technology Mechanisms & Networks, Blockchain Origins, Objective of Blockchain, Blockchain Challenges, Transactions And Blocks, P2P Systems, Keys As Identity, Digital Signatures, Hashing, and public key cryptosystems, private vs. public Blockchain

*Blockchain Architecture, Knowledge of Decentralized systems*

**Unit II: Bitcoin and Cryptocurrency** **9 hours**
What is Bitcoin, The Bitcoin Network, The Bitcoin Mining Process, Mining Developments, Bitcoin Wallets, Decentralization and Hard Forks, Ethereum Virtual Machine (EVM), Merkle Tree, Double-Spend Problem, Blockchain And Digital Currency, Transactional Blocks, Impact Of Blockchain Technology On Cryptocurrency.

*Encryption key Techniques*

**Unit III: Introduction to Ethereum** **9 hours**
What is Ethereum, Introduction to Ethereum, Consensus Mechanisms, How Smart Contracts Work, Metamask Setup, Ethereum Accounts, Receiving Ether's What's a Transaction?, Smart Contracts

*Benefits of Ethereum Blockchain, Smart Contract fundamnetals*

**Unit IV: Introduction to Hyperledger** **9 hours**
What is Hyperledger? Distributed Ledger Technology & its Challenges, Hyperledger & Distributed Ledger Technology, Hyperledger Fabric, Hyperledger Composer

*Fundameentals of Docker, Types of Blockchains*

**Unit V: Blockchain Applications** **9 hours**
Internet of Things, Medical Record Management System, Domain Name Service and Future of Blockchain, Alt Coins

*Real Time IOT Applications, Ethereum, Hyperledger Fabric*

**Text Books**

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

**Reference Books**

1. Imran Bashir, "Masteering Blockchain", Packt Publishing Ltd.,2017
2. Antonopoulos and G. Wood, "Mastering Ethereum", O'Reilly Media, Inc.,2018

**Web References**

1. https://nptel.ac.in/courses/106/104/106104220/#
2. https://www.udemy.com/course/build-your-blockchain-az/
3. https://eduxlabs.com/courses/blockchain-technologytraining/?tab=tab-curriculum

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 50 | 50 |
| L2 | 50 | 50 |
| Total (%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

1. What is the difference between Bockchain and Hyperledger?
2. What do you mean by blocks in blockchain technology?
3. What is Cryptography role in blockchain?

**L2: Understand**

1. Explain different type of Blockchain
2. How is hash generated
3. What is smart Contract and list some of its applications

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## PE 20AI009 Big Data Analytics 3 0 0 3

At the end of the course, students will be able to

| Code | Course Outcomes | Mapping with POs | DoK |
|---|---|---|---|
| 20AI009.1 | Identify the knowledge of Big Data | - | L1, L2 |
| 20AI009.2 | Identify the architectural concepts of HDFS in Hadoop ecosystem | | L1, L2 |
| 20AI009.3 | Demonstrate MapReduce Framework, HBase and Spark | | L1, L2 |
| 20AI009.4 | Illustrate Big Data stack and technologies | | L1, L2 |
| 20AI009.5 | Demonstrate Analytics on Big Data | | L1, L2 |
| 1. Weakly Contributing \| 2. Moderately Contributing \| 3. Strongly Contributing, for the attainment of respective POs | | | |
| L1: Remember \| L2: Understand \| L3: Apply \| L4: Analyze \| L5: Evaluate \| L6: Create. DoK: Depth of Knowledge | | | |

**Unit I: Fundamentals of Big Data** **9 hours**

Introduction to Big Data, History of Data Management, Evolution of Big Data, Structuring Big Data, Elements of Big Data, Big Data Analytics, Uses of Big Data in Social Networking, Uses of Big Data in Retail Industry, Distributed and Parallel Computing for Big Data, Introducing Hadoop, Cloud Computing and Big Data

*Data Management*

**Unit II: Understanding Hadoop Ecosystem** **9 hours**

Hadoop Distributed File System (HDFS), MapReduce, Introducing HBase, HBase architecture, Regions, Storing Big Data with HBase, Interacting with Hadoop Ecosystem, Combining HBase and HDFS, Hive, Pig and Pig Latin

*Data Integrity in HBase*

**Unit III: Understanding MapReduce Fundamentals, HBase and Spark** **9 hours**

MapReduce Framework, Techniques to Optimize MapReduce Jobs, Uses of MapReduce, Role of HBase in Big Data Processing, Characteristics of HBase, Introduction to Data Analysis with Spark, Spark Core, Spark SQL, Spark Streaming, MLlib, GraphX, Storage Layers for Spark

*Fundamental Role of Spark*

**Unit IV: Understanding Big Data Technology Foundations** **9 hours**

Exploring the Big Data Stack, Data Sources Layer, Ingestion Layer, Storage Layer, Physical Infrastructure Layer, Platform Management Layer, Security Layer, Monitoring Layer, Analytics Engine, Visualization Layer, Big Data Applications, Virtualization and Big Data, Virtualization Approaches

*Data and Storage Virtualization*

**Unit V: Understanding Analytics and Big Data** **9 hours**

Comparing Reporting and Analysis, Types of Analytics, Points to Consider during Analytics, Developing an Analytic Team, Understanding Text Analytics, Analytical Approaches and Tools to Analyze Data, Analytical Approaches, History of Analytical Tools

*Data Visualization Tools*

**Text Books**

1. DT Editorial Services, "Big Data – Hadoop2, MapReduce, Hive, YARN, Pig, R and Data Visualization" Black Book, DreamTech Publications, 2019
2. Sridhar Alla, "Big Data Analytics with Hadoop 3", Packt Publications, 2018
3. Holden Karau, Andy Konwinski, Patrick Wendell & Matei Zaharia, "Learning Spark", O'Reilly Publications, 1st Edition, 2015

**Reference Books**

1. Balamurugan Balusamy, Nandhini Abirami R, Seifedine Kadry, Amir H. Gandomi, "Big Data: Concepts, Technology and Architecture", Wiley Publications, 1st Edition, 2021
2. Thomas Erl, Wajid Khattak, Paul Buhler, "Big Data Fundamentals: Concepts, Drivers & Techniques", The Pearson Service Technology Publications,1st Edition, 2016

**Web Resources**

1. https://www.edureka.co/blog/what-is-big-data/
2. https://hadoop.apache.org/

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 50 | 50 |
| L2 | 50 | 50 |
| Total (%) | 100 | 100 |

## Sample Short and Long Answer Questions of Various Cognitive Levels

### L1: Remember

1. What is Big Data and its characteristics?
2. What is Pig and Pig Latin?
3. List out the techniques to optimize MapReduce jobs.
4. List out various Analytical Approaches.

### L2: Understand

1. Discuss uses of Big Data in Retail Industry.
2. Explain HDFS with neat diagram.
3. Explain Stack of Layers in Big Data architecture.
4. Explain Text Data Analysis

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## PE 20AI010 Soft Computing 3 0 0 3

### Pre-requisite

At the end of the course, students will be able to

| Code | Course Outcomes | Mapping with POs | DoK |
|---|---|---|---|
| 20AI010.1 | Identify soft computing techniques and their roles | - | L1, L2 |
| 20AI010.2 | Describe soft computing techniques and their roles in building intelligent machines | | L1, L2 |
| 20AI010.3 | Recognize the feasibility of applying a soft computing methodology for a particular problem | | L1, L2 |
| 20AI010.4 | Describe the neuro fuzzy models | | L1, L2 |
| 20AI010.5 | Identify modern software tools to solve real problems using a soft computing approach and evaluate various soft computing approaches for a given problem | | L1, L2 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create. DoK: Depth of Knowledge

**Unit I: Review of ANN** **9 hours**
Basic-concepts-single layer perception-Multi layer perception-Supervised and unsupervised learning back propagation networks, Application.

*Reinforcement learning*

**Unit II: Fuzzy Systems** **9 hours**
Fuzzy sets and Fuzzy Reasoning-Fuzzy Matrices-Fuzzy functions-decomposition-Fuzzy automata and languages- Fuzzy control methods-Fuzzy decision making

*Washing machines and AC applications*

**Unit III: Neuro-fuzzy models** **9 hours**
Adaptive networks based Fuzzy Interfaces-Classification and Representation Trees-Data dustemp algorithm –Rule base structure identification-Neuro-Fuzzy controls.

*Application of fuzzy control system*

**Unit IV: Genetic Algorithm** **9 hours**
Survival of the fittest-pictures computations-cross over mutation-reproduction-rank method-rank space method, Application

*Bio-inspired algorithms*

**Unit V: Review of AI** **9 hours**
AI Search Algorithm-Predicate calculus rules of interface – Semantic networks-frames-objects-Hybrid models, applications

*Adverseral search*

**Text Books**

1. E – Neuro Fuzzy and Soft computing – Jang J.S.R., Sun C.T and Mizutami, Prentice hall New Jersey, 1998
2. Fuzzy Logic Engineering Applications – Timothy J.Ross, McGraw Hill, NewYork, 1997.
3. Fundamentals of Neural Networks – Laurene Fauseett, Prentice Hall India, New Delhi, 1994.

**Reference Books**

1. Introduction to Artificial Intelligence – E Charniak and D McDermott, Pearson Education

2. Artificial Intelligence and Expert Systems – Dan W. Patterson, Prentice Hall of India

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 50 | 50 |
| L2 | 50 | 50 |
| Total (%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

1. Define fuzzy logic
2. Give examples for fuzzy functions
3. Define fuzzy relations
4. What are genetic operators
5. Define survival of fittest

**L2: Understand**

1. Explain neuro fuzzy models
2. Describe the process of fuzzification

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## PE 20AI011 Cyber Threat Analysis 3 0 0 3

At the end of the course, students will be able to

| Code | Course Outcomes | Mapping with POs | DoK |
|---|---|---|---|
| 20AI011.1 | Understand the General Cryptography Knowledge, wireless encryption and security, and virtual private network | - | L1, L2 |
| 20AI011.2 | Know the knowledge on information systems security management | | L1, L2 |
| 20AI011.3 | Know the knowledge of IT risk and security management | | L1, L2, L3 |
| 20AI011.4 | Understand the using of various tools in vulnerability assessment and management | | L1, L2, L3 |
| 20AI011.5 | Identify threats and fully exploring on threat scenarios for analysis | | L1, L2, L3, L4 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create. DoK: Depth of Knowledge

**Unit I: Information Assurance/Encryption** **9 hours**
General Crytography Knowledge, Ancient Ciphers-The Caeser Cipher, ROT 13, Atbash Cipher, Wireless Encryption and Security, Obfuscation, Digital Signatures, Digital Certificates, Device and File Encryption, Virtaul Private Networks

*Symmetric Ciphers, Security attacks, Security Mechanisms*

**Unit II: Information Systems and Security Management** **9 hours**
Knowledge of Cyber Threats and Vulnerabilities, Knowledge of Information Technology (IT) Security Principles and Methods, Knowledge of Local Area and Wide Area Networking Principles

*Different types of Cyber Attacks, Planning of attacks*

**Unit III: IT Risk and Security Management** **9 hours**
Knowledge of Risk Management Process, Knowledge of Risk Management Framework, Knowledge of Organisation's Risk Tolerance, Knowledge of Risk / Threat Assessment, Knowledge of Confidentiality, Integrity, and Aaiabiity Principles, Knowledge of Collectio / Analysing Techniques and Tools for Chat List, VOIP, WebMail etc.

*IT Risk Policies, Procedures, Methods*

**Unit IV: Vulnerability Assessment and Management** **9 hours**
Introduction- Tools, Shodan,Maltego, Nessus, OWASP ZAP, OpenVAS, Metasploit- SMB Scanner, SQL Server Scan, SSH Server Scan, Responding Vulnerability

*OWASP 10 Tools*

**Unit V: Threat Analysis** **9 hours**
Introduction, Threat Modelling- STRIDE, DREAD, SQUARE, VAST, PASTA, Business Impact Analysis, Characterizing and Analyzing Network Traffic, Forensic Handling of Incidents

*Confidentiality, Integrity, and Availability*

**Text Books**

1. Izzat Alsmadi, Chuck Easttom, Lo'ai Tawalbeh, "The NICE Cyber Security Security Framework" Springer Nature Switzerland AG 2020.

**Reference Books**

1. Aaron Roberts, "Cyber Threat Intelligence" APress Media, LLC part of Springer Nature, 2021

2. Richard Forward, "Infosecurity 2008 Threat Analysis", Syngress Publishing, Inc.,Elsevier, Inc.2008

**Web References**

1. https://nptel.ac.in/courses/106106129
2. https://onlinecourses.nptel.ac.in/noc22_cs23/w

## Internal Assessment Pattern

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 20 | 20 |
| L2 | 40 | 30 |
| L3 | 40 | 50 |
| Total (%) | 100 | 100 |

## Sample Short and Long Answer Questions of Various Cognitive Levels

### L1: Remember

1. What is Cryptogrraphy?
2. What is difference between symmetric and asymmetric encryption?
3. What is the difference between IDS and IPS?

### L2: Understand

1. Explain CIA triad
2. What is the difference between VA(Vulnerability Assessment) and PT(Penetration Testing)?
3. What is a three-way handshake?

### L3: Apply

1. Illustrate Privilege Escalation using Nmap
2. Analyze the Network Traffic using Wireshark
3. Apply your knowledge on Threat Modelling using various tools

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## PE 20AI012 Distributed Computing 3 0 0 3.0

At the end of the course, students will be able to

| Code | Course Outcomes | Mapping with POs | DoK |
|---|---|---|---|
| 20AI012.1 | Design and implement distributed parallel computing and assessing models for distributed systems | - | L1, L2 |
| 20AI012.2 | Design and implement distributed algorithms | | L1, L2 |
| 20AI012.3 | Experiment with mechanisms such as client/server and P2P algorithms, remote procedure calls(RPC/RMI),and consistency for programming parallel systems | | L1, L2 |
| 20AI012.4 | Differentiate between the major classes of parallel processing systems | | L1, L2 |
| 20AI012.5 | Analyze the efficiency of parallel processing systems and evaluate types of application for which parallel programming | | L1, L2 |
| 1. Weakly Contributing \| 2. Moderately Contributing \| 3. Strongly Contributing, for the attainment of respective Pos | | | |
| L1: Remember \| L2: Understand \| L3: Apply \| L4: Analyze \| L5: Evaluate \| L6: Create. DoK: Depth of Knowledge | | | |

**Unit I: Parallel architecture** **9 hours**

Key concepts and challenges, overview of parallel computing, Flynn's Taxonomy, Multi core processors, Shared Vs Distributed memory, Introduction to openMP Programming, Instruction level support for parallel computing, SIMD, Vector processing, GPU Architecture

*CPU Architecture*

**Unit II: Parallel Algorithms and Design** **9 hours**

Preliminaries, Decomposition Techniques, Characteristics of tasks and interactions, mapping Techniques for load balancing

**Unit III: Distributed Mutex & Deadlock** **9hours**

Distributed mutual exclusion algorithms- Introduction – Preliminaries – Lamport's algorithm, Ricart-Agrawala algorithm, Maekawa's algorithm, Suzuki–Kasami's broadcast algorithm. Deadlock detection in distributed systems- Introduction – System model, Preliminaries – Models of deadlocks – Knapp 's classification – Algorithms for the single resource model, the AND model

*Algorithm for OR model*

**Unit IV: Recovery & Consensus** **9hours**

Check pointing and rollback recovery-Introduction, Background and definitions, Issues in failure recovery, Checkpoint-based recovery, Log-based roll back recovery, coordinated check pointing algorithm – Algorithm for asynchronous check pointing and recovery. Consensus and agreement algorithms- Problem definition, Overview of results, Agreement in a failure - Agreement in synchronous systems with failures.

*Agreement in free systems*

**Unit V: Peer-to-peer computing and overlay graphs** **9 hours**

Introduction – Data indexing and overlays, Chord, Content addressable networks – Tapestry. Distributed shared memory- Abstraction and advantages, Memory consistency models, Shared memory Mutual Exclusion.

*Differences between memory consistency and inconsistency model*

**Text Books**

1.Distributed Systems Concepts and Design, George Coulouris, Jean Dollimore and Tim Kindberg, Fifth Edition, Pearson Education, 2012.

2. Distributed computing: Principles, algorithms, and systems, Ajay D Kshemkalyani and Mukesh Singhal, Cambridge University Press, 2011

**Reference Books**

1.Distributed Operating Systems: Concepts and Design, Pradeep K Sinha, Prentice Hall of India, 2007.
2.Advanced concepts in operating systems. Mukesh Singhal and Niranjan G. Shivaratri, McGraw-Hill, 1994.

**Web Resources**

https://nptel.ac.in/courses/106/106/106106168/

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 40 | 40 |
| L2 | 40 | 40 |
| L3 | 20 | 20 |
| Total (%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

1. What are the models that are followed in distributed systems?
2. Discuss various challenges in distributed systems
3. List the characteristics of a distributed system.
4. Mention any five security mechanisms used in distributed computing?
5. What is network transparency?
6. Define marshaling

**L2: Understand**

1. Define Inter Process Communication
2. Identify system call trap and how it is implemented?
3. Statethe requirements of consensus algorithm to hold for execution
4. Write ashort note on Chandy Misra Haas Algorithm
5. What do you understand by logical time and logical clocks? What is Lamport's contribution?for it?

**L3: Apply**

1. Point out whether byzantine agreement algorithm can be reached for three generals with one of them faulty, if their generals digitally signed their messages
2. Discriminate the synchronization process with physical and logical clocks

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## OE 20CEO03 Disaster Risk Mitigation and Management 3 0 0 3

At the end of the course, students will be able to

| Code | Course Outcomes | Mapping with POs | DoK |
|---|---|---|---|
| | | | |
| 20CEO03.1 | Identify various types of disasters, their causes, effects & mitigation measures | - | L1, L2 |
| 20CEO03.2 | Understand various phases of disaster management cycle and create vulnerability and risk maps | | L1, L2 |
| 20CEO03.3 | Understand the approaches of risk and vulnerability | | L1, L2 |
| 20CEO03.4 | Explain the concept of disaster management and emerging approaches | | L1, L2 |
| 20CEO03.5 | Understand the mitigation measures | | L1, L2 |
| 1. Weakly Contributing \| 2. Moderately Contributing \| 3. Strongly Contributing, for the attainment of respective Pos | | | |
| L1: Remember \| L2: Understand \| L3: Apply \| L4: Analyze \| L5: Evaluate \| L6: Create. DoK: Depth of Knowledge | | | |

### UNIT I: Natural Disasters 9 Hours

Natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, volcanic eruptions, Heat and cold waves, Climatic change: global warming, Sea level rise, ozone depletion.
Man Made Disasters - Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation.

*Ozone Depletion*

### Unit II: Disaster Management Principles 9 Hours

Evolution of disaster risk management concept Disaster management cycle – Prevention, Preparedness, Mitigation, Rescue and Recovery Integrated and Comprehensive disaster risk reduction approach, Strategies and Policies.

*Disaster management cycle*

### Unit III: Risk and vulnerability 9 Hours

Hazard, risk and vulnerability: Physical, social and economic dimensions, Vulnerability in changing climate, Climate change and Disasters, Risk Analysis Techniques, Risk: Identification, reduction and transfer, Approaches to mapping social vulnerability, Participatory disaster risk assessment, Action plans, Strategy for survival.

*Vulnerability in changing climate*

### UNIT IV: Disaster Management 9 Hours

Preparedness through (IEC) Information, education & communication, pre-disaster stage (mitigation), Effect to mitigate natural disaster at national and global levels. International strategy for disaster reduction.
Emerging approaches in Disaster Management-Concept of disaster management, national disaster management framework, financial arrangements, role of NGOs, community –based organizations and media.

*National disaster management framework*

### UNIT-V: Risk Mitigation 9 Hours

Definition, Concept, Importance, Guiding Principles, Tools, Approaches, Strategies Sustainable Development, Sustainable Land Use Planning, Technology and the Environment. Emerging Technologies in Disaster Mitigation, Remote Sensing, GIS, Disaster Mapping, Aerial Photography, Land Use Zoning

*Emerging technologies in disaster mitigation*

### Text Books

1. Khanna, B. K., “Disasters: All you wanted to know about”, New India Publishing Agency,New Delhi, 2005
2. Edwards, B., “ Natural Hazards”, Cambridge University Press, U.K., 2005
3. Chakraborty, S. C., “Natural Hazards and Disaster Management”, Pargatishil Prokashak,Kolkata, 2007

**Reference Books**

1. Sahni, P., "Disaster Mitigation Experiences and Reflections", Prentice Hall of India, NewDelhi, 2002
2. Prashant K. Srivastava, Sudhir Kumar Singh, Mohanty, U. C., Tad Murty, "Techniques for Disaster Risk Management and Mitigation", 2020

**Web References**

1. https://books.google.com
2. http://cbseacademic.nic.in

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 50 | 50 |
| L2 | 50 | 50 |
| Total (%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

1. Define climatic change
2. List any four effects of natural disasters
3. Define disaster Managemrnt

**L2: Understand**

1. Explain about risk assessment
2. Outline the principles of disaster management
3. Differentiate between hazard, risk and vulnerability

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## OE 20CS404 Operating Systems 3 0 0 3

At the end of the course, students will be able to

| Code | Course Outcomes | Mapping with POs | DoK |
|---|---|---|---|
| 20CS404.1 | Describe the structure, components and functionalities of operating system | - | L1, L2 |
| 20CS404.2 | Describe the process management activities of operating system | | L1, L2 |
| 20CS404.3 | Illustrate the use of process synchronization tools | | L1, L2 |
| 20CS404.4 | Describe the various memory management and allocation techniques | | L1, L2 |
| 20CS404.5 | Demonstrate different secondary storage management strategies and file system | | L1, L2 |
| 1. Weakly Contributing \| 2. Moderately Contributing \| 3. Strongly Contributing, for the attainment of respective Pos | | | |
| L1: Remember \| L2: Understand \| L3: Apply \| L4: Analyze \| L5: Evaluate \| L6: Create. DoK: Depth of Knowledge | | | |

**Unit I: Introduction to Operating System Concepts** **9 Hours**

What Operating System Do, Operating System Operations, Process Management, Memory Management, Storage Management, Protection and Security, Computing Environments, Operating Systems Services, System Call, Types of System Call, Operating System Generation, System Boot

*The Shell, Mobile Operating System, Choice of Interface*

**Unit II: Process Management** **9 Hours**

Process Concept: The Process, Process State, Process Control Block, Threads, Process Scheduling: Scheduling Queues, Schedulers, Context Switch, Operations on Processes, Inter Process Communication, Multithread Programming: Overview, Benefits, Multithreading Models, Process Scheduling: Basic Concepts, Scheduling Criteria, Scheduling Algorithms.

*Process Termination, Multiprocess Architecture*

**Unit III: Synchronization** **9 Hours**

Background, The Critical-section problem, Peterson's Solution, Synchronization hardware, Semaphores, Classic Problems of Synchronization, Monitors, Deadlocks: System Model, Deadlock Characterization, Methods for Handling Deadlock, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock.

*Transactional Memory, Two Phase Locking*

**Unit IV: Memory Management** **9 Hours**

Background, Swapping, Contiguous Memory Allocation, Segmentation, Paging, Structure of the Page Table, Virtual Memory Management: Background, Demand paging, Page replacement, Thrashing, Mass-Storage Structure: Overview of Mass-Storage Structure, Harddisk Drives, Volatile Memory, HDD Scheduling-FCFS Scheduling, SCAN Scheduling of a Disk-Scheduling Algorithm.

*Buddy System, Prepaging*

**Unit V: File system Interface** **9 Hours**

File Concept, Access Methods, Directory and Disk Structure, File System Mounting, File Sharing, Protection, Implementing File Systems: File System Structure, File System Implementation, Directory Implementation, Allocation Methods, Free-Space Management.

*Consistency Checking, Malware, Denial of service*

### Text Books

1. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, "Operating System Concepts", Tenth Edition, John Wiley and Sons Inc., 2018
2. William Stallings, "Operating Systems - Internals and Design Principles", Ninth Edition, Pearson, 2018

### Reference Books

1. Andrew S. Tanenbaum, "Modern Operating Systems", Fourth Edition, Pearson, 2015
2. Charles Crowley, "Operating Systems: A Design-Oriented Approach", First Edition, Tata McGraw Hill

Education, 2001
3. Dhananjay M. Dhamdhere, "Operating Systems: A Concept-Based Approach", Third Edition, McGraw Hill Higher Education, 2017

### Web Resources

1. http://nptel.ac.in/downloads/106108101/
2. https://www.coursera.org/learn/iot/lecture/MrgxS/lecture-3-1-operating-systems
3. https://www.geeksforgeeks.org/operating-system-introduction-operating-system-set-1/
4. https://www.unf.edu/public/cop4610/ree/Notes/PPT/PPT8E/CH12-OS8e.pdf
5. https://in.udacity.com/auth?next=/course/introduction-to-operating-systems--ud923

### Internal Assessment Pattern

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 50 | 40 |
| L2 | 50 | 60 |
| Total (%) | 100 | 100 |

### Sample Short and Long Answer Questions of Various Cognitive Levels

### L1: Remember

1. Define Operating System
2. What are operating system services?
3. List any four types of system calls
4. What is a process? List any four fields of process control block
5. What are the necessary conditions for a deadlock?
6. Differentiate between binary and counting semaphore.
7. What are the various attributes that are associated with an opened file?

### L2: Understand

1. Discuss the essential properties of operating systems -Batch, Interactive, Timesharing Real time and Distributive
2. Explain how multiprogramming increases the utilization of CPU
3. Why system calls are needed in operating system?
4. Distinguish between logical address and physical address
5. What is the difference between a process and thread?
6. How does the system detect thrashing? What can the system do to eliminate this problem?
7. Consider the following four processes represented as (Process, Arrival Time, Burst Time) with the length of CPU burst in milliseconds.
   { ( P1, 0, 10), (P2, 1, 7), (P3, 2, 13), (P4, 3, 11) }. Using preemptive SJF scheduling: (i) Draw Gantt chart
   (ii) Calculate average waiting time.
8. Why semaphores are important? Suggest the solution for bounded buffer problem with semaphores
9. Explain the steps involved in handling a page fault with a neat sketch

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## OE 20AIO03 Fundamentals of AI 3 1 0 3

At the end of the course, students will be able to

| Code | Course Outcomes | Mapping with POs | | PO12 | DoK |
|---|---|---|---|---|---|
| | | PO1 | PO2 | | |
| 20AIO03.1 | Describe the foundational principles of artificial intelligence | 3 | 2 | 1 | L1, L2 |
| 20AIO03.2 | Formalise the given problem using different AI methods | 3 | 2 | 1 | L1, L2 |
| 20AIO03.3 | Explain different concepts of logic | 3 | 2 | 1 | L1, L2 |
| 20AIO03.4 | Describe the different methods of knowledge representation | 3 | 2 | 1 | L1, L2 |
| 20AIO03.5 | Explain the priciples and applications of expert systems | 3 | 2 | 1 | L1, L2 |
| 1. Weakly Contributing \| 2. Moderately Contributing \| 3. Strongly Contributing, for the attainment of respective Pos | | | | | |
| L1: Remember \| L2: Understand \| L3: Apply \| L4: Analyze \| L5: Evaluate \| L6: Create. DoK: Depth of Knowledge | | | | | |

**Unit 1: Introduction to Artificial Intelligence** **9+3 Hours**

Introduction – History - Intelligent systems - Foundations of AI – Applications – Tic-Tac-Tie game playing - Development of AI languages - Current trends in AI

*Online agents*

**Unit II: Problem Solving** **9+3 Hours**

Problem solving: State-Space search and Control strategies: Introduction - General problem solving - Characteristics of problem - Exhaustive searches - Heuristic search techniques - Iterativedeepening A* - Constraint satisfaction - Problem reduction and game playing: Introduction - Problem reduction - Game playing - Alphabeta pruning - Two-player perfect information games

*Unknown environment*

**Unit III: Logic concepts** **9+3 Hours**

Introduction - Propositional calculus - Proportional logic - Natural deduction system - Axiomatic system - Semantic tableau system in proportional logic - Resolution refutation in proportional logic

*Predicate Logic*

**Unit IV: Knowledge Representation** **9+3 Hours**

Introduction - Approaches to knowledge representation - Knowledge representation using semantic network - Extended semantic networks for KR - Knowledge representation using frames - Advanced knowledge representation techniques: Introduction - Conceptual dependency theory - Script structure - Cyc theory - Case grammars

*Semantic web*

**Unit V: Expert Systems** **9+3 Hours**

Expert system and applications: Introduction - Phases in building expert systems - Expert system versus traditional systems - Rule-based expert systems - Blackboard systems - Truth maintenance systems - Application of expert systems

*List of shells and tools*

**Text Books**

1. Stuart Russel and Peter Norvig, “Artificial Intelligence: A Modern Approach”, Fourth Edition, Pearson Education, 2020
2. Dan W. Patterson, “Introduction to AI and ES”, Pearson Education, 2007

**Reference Books**

1. Kevin Night, Elaine Rich, and Nair B., “Artificial Intelligence”, McGraw Hill, 2008
2. Patrick H. Winston, "Artificial Intelligence", Third edition, Pearson Edition, 2006
3. Deepak Khemani, “Artificial Intelligence”, Tata McGraw Hill Education, 2013

Web Resources

1. https://nptel.ac.in

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 50 | 50 |
| L2 | 50 | 50 |
| Total (%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

1. State the tasks which are associated with A.I.
2. Give an example of script-arithmetic problem.
3. Define Script
4. Recall Intelligence

**L2: Understand**

1. Explain Turing Test.
2. Explain the characteristics of production system.
3. Write A* algorithm in detail and explain its functionality to solve 8-puzzle problem.
4. Explain the semantic analysis phase done through case grammars in Natural Language understanding

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## OE 20DSO03 Introduction to Big Data 3 0 0 3

At the end of the course, students will be able to

| Code | Course Outcomes | Mapping with POs | DoK |
|---|---|---|---|
| 20DSO03.1 | Identify the Knowledge of Big Data | - | L1, L2 |
| 20DSO03.2 | Demonstrate Hadoop Framework for handling Big Data | | L1, L2 |
| 20DSO03.3 | Illustrate the Architectural Concepts of HDFS in Hadoop Ecosystem | | L1, L2 |
| 20DSO03.4 | Illustrate MapReduce Framework | | L1, L2 |
| 20DSO03.5 | Explain Spark & RDD | | L1, L2 |
| 1. Weakly Contributing \| 2. Moderately Contributing \| 3. Strongly Contributing, for the attainment of respective Pos | | | |
| L1: Remember \| L2: Understand \| L3: Apply \| L4: Analyze \| L5: Evaluate \| L6: Create. DoK: Depth of Knowledge | | | |

### Unit I: Introduction to Big Data 9 Hours

What is Big Data, Evolution of Big Data, Types of Big Data, Sources of Big Data,5Vs of Big Data, Big Data Analytics, Big Data Applications, Google File System

*Uses of Big Data in Retail Industry*

### Unit II: Introduction to Hadoop 9 Hours

Introducing Hadoop, Hadoop History, Hadoop-definition,Comparing SQL Databases and Hadoop, Hadoop Cluster, Hadoop Modes, Hadoop Features, The building blocks of Hadoop, NameNode, DataNode, Secondary NameNode, Job Tracker, Task Tracker

*Hadoop Cluster*

### Unit III: Hadoop Ecosystem &HDFS 9 Hours

Hadoop and its Ecosystem, Hadoop Ecosystem Components, Hadoop Ecosystems Tools, Hadoop Distributed File System, Concept of Block in HDFS Architecture, Features of HDFS, HDFS Read and Write Mechanism, Rack awareness in HDFS, Introducing HBase, Hive, Pig

*HDFS Read/Write*

### Unit IV: Introduction to MapReduce 9 Hours

Hadoop MapReduce Framework, Architecure, Phases, Mapreduce Job Types, Uses of MapReduce, Techniques to Optimize MapReduce Jobs, Limitations of MapReduce.

*MapReduce Phases*

### Unit V: Introduction to Spark and RDD 9 Hours

Introduction to Spark, Dataframes - Dataframes role in Spark, Introduction to RDD, RDD operations, Creating RDDs, RDD Operations, Working with Key/Value Pairs.

*Dataframes*

### Text Books

1. DT Editorial Services, “Big Data – Hadoop2, MapReduce, Hive, YARN, Pig, R and Data Visualization”, Black Book, DreamTech Press, 2019.
2. Sridhar Alla, “Big Data Analytics with Hadoop 3” - Packt Publications, 2018.
3. Holden Karau, Andy Konwinski, Patrick Wendell &MateiZaharia, “Learning Spark” O’reilly Publications, 2015.

### Reference Books

1. Chuck Lam, “Hadoop in Action”, 1st Edition, MANNING Publications, 2016.
2. Balamurugan Balusamy, Nandhini Abirami R, SeifedineKadry, Amir H. Gandomi, “Big Data: Concepts, Technology, and Architecture” 1st Edition, Wiley Publications, 2021.
3. Thomas Erl, Wajid Khattak, Paul Buhler, “Big Data Fundamentals: Concepts, Drivers &Techniques”, 1st Edition, Pearson Publications, 2016.

### Web Resources

1. https://hadoop.apache.org/
2. https://spark.apache.org/

### Internal Assessment Pattern

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 50 | 50 |
| L2 | 50 | 50 |
| Total (%) | 100 | 100 |

### Sample Short and Long Answer Questions of Various Cognitive Levels

### L1: Remember

1. Define Big Data.
2. List the characteristics of Big Data.
3. Define Hadoop.
4. What are Hadoop components?
5. What are RDD operations?

### L2: Understand

1. Explain HDFS Read & Write mechanism.
2. Explain Rack awareness in HDFS.
3. Explain MapReduce workflow in detail.
4. Describe the working with Key/value pairs in RDDs.

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## OE 20ECO03 Privacy and Security in IoT 3 0 0 3

**Pre- Requisite** Embedded Systems, IoT

At the end of the course, students will be able to

| Code | Course Outcomes | Mapping with POs | DoK |
|---|---|---|---|
| 20ECO03.1 | Understand the basic knowledge of cryptography, networking and web security | - | L1, L2, L3 |
| 20ECO03.2 | Explain Architecture of IoT and its Applicaations | | L1, L2, L3 |
| 20ECO03.3 | Understand the Attacks against IoT system | | L1, L2, L3 |
| 20ECO03.4 | Explain Secure Bootstrapping for IoT Sytem | | L1, L2, L3 |
| 20ECO03.5 | Understand the IoT system security and Trust zone | | L1, L2, L3 |
| 1. Weakly Contributing \| 2. Moderately Contributing \| 3. Strongly Contributing, for the attainment of respective Pos | | | |
| L1: Remember \| L2: Understand \| L3: Apply \| L4: Analyze \| L5: Evaluate \| L6: Create. DoK: Depth of Knowledge | | | |

**Unit I: Introduction to Cryptography and Network Securitys** **09 Hours**

Cryptography , networking, Web Security: Secure socket layer and transport layer security, System Security: Intruders , Viruses and related threads, trusted systems.

*Secure Shell (SSH)*

**Unit II: Introduction to IoT** **09 Hours**

Internet of Things (IoT) ,Need of IoT,Applications,Architecture,Enabling technologies, IoT security and privacy.

*IoT protocols*

**Unit III: Attacks against IoT** **09 Hours**

Attacks against IoT system (hardware + software) ,Aattacks against IoT network protocols ,Attacks against industry IoT

*Attacks against Web systems*

**Unit IV: Secure Bootstrapping for secure IoT system** **09 Hours**

Ttrusted boot,Secure boot,TPM and its usages,Remote attestation ,tamper resistant-proof-response hardware and its usage

*Bootatraping for IoT*

**Unit V: IoT System Security and TrustZone** **09 Hours**

System security , TrustZone hardware architecture, TrustZone software architectures.

*Web security*

### Text Books

1. Syed Rameem Zahra, Mohammad Ahsan Chishti ,"Security and Privacy in the Internet of Things " 1st Edtion ,Chapman & Hall, 2020
2. Fei Hu ,"Security and Privacy in Internet of Things (IoTs) Models, Algorithms, and Implementations", 1st Edition CRC Press

### Reference Books

1. Ravi Ramakrishnan, Loveleen Gaur "Internet of Things Approach and Applicability in Manufacturing " , 1st Edtion ,Chapman & Hall, 2019
2. Vijay Madisetti, Arshdeep Bahga, Internet of Things, "A Hands on Approach", UniversityPress,2015

### Web Resources

1. https://lss.at.ufl.edu/help.shtml
2. http://cms.uflib.ufl.edu/ask

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 20 | 20 |
| L2 | 40 | 30 |
| L3 | 40 | 50 |
| Total (%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

1. What is cryptography ?
2. List the applications of IoT
3. What is Attacks against IoT system ?

**L2: Understand**

1. Explain about networking
2. Explain Enabling technologies of IoT
3. Explain Aattacks against IoT network protocols

**L3: Apply**

1. Discus about web security
2. Write about Architecture of IoT
3. Explain Attacks against industry IoT

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**Board of Studies(ECE)**

## OE 20EEO03 Low Cost Automation 3 0 0 3.0

At the end of the course, students will be able to

| Code | Course Outcomes | Mapping with PO's | | DoK |
|---|---|---|---|---|
| | | PO 1 | PO 2 | |
| 20EEO03.1 | Understanding automation of assembly lines | 2 | 2 | L2 |
| 20EEO03.2 | Automation Using Hydraulic Systems | 2 | 2 | L2 |
| 20EEO03.3 | Describe Automation Using Pneumatic Systems | 2 | 2 | L2 |
| 20EEO03.4 | Explain Automation Using Electronic Systems | 2 | 2 | L2 |
| 20EEO03.5 | Explain Assembly Automation | 2 | 2 | L2 |
| 1. Weakly Contributing \| 2. Moderately Contributing \| 3. Strongly Contributing, for the attainment of respective Pos | | | | |
| L1: Remember \| L2: Understand \| L3: Apply \| L4: Analyze \| L5: Evaluate \| L6: Create, DoK:Depth of Knowledge | | | | |

**UNIT I : Automation Of Assembly Lines** **12 Hours**

Concept of automation-mechanization and automation - Concept of automation in industry - mechanization and automation - classification, balancing of assembly line using available algorithms -Transfer line-monitoring system (TLMS) using Line Status - Line efficiency - Buffer stock Simulation in assembly line

*Transfer line-monitoring system (TLMS) using Line Status ,Line efficiency*

**UNIT II: Automation Using Hydraulic Systems** **12 Hours**

Design aspects of various elements of hydraulic systems such as pumps, valves, filters, reservoirs, accumulators, actuators, intensifiers etc. - Selection of hydraulic fluid, practical case studied on hydraulic circuit design and performance analysis - Servo valves, electro hydraulic valves, proportional valves and their applications.

*Servo valves, electro hydraulic valves, proportional valves and their applications.*

**UNIT-III: Automation Using Pneumatic Systems** **12 Hours**

Pneumatic fundamentals - control elements, position and pressure sensing -logic circuits - switching circuits - fringe conditions modules and these integration - sequential circuits - cascade methods - mapping methods – step counter method - compound circuit design - combination circuit design. Pneumatic equipments - selection of components - design calculations -application - fault finding – hydro pneumatic circuits - use of microprocessors for sequencing - PLC, Low cost automation - Robotic circuits.

*Low cost automation - Robotic circuits.*

**UNIT-IV : Automation Using Electronic Systems** **12 Hours**

Introduction - various sensors – transducers - signal processing - servo systems - programming of microprocessors using 8085 instruction - programmable logic controllers

*programming of microprocessors using 8085 instruction - programmable logic controllers*

**UNIT-V: Assembly Automation** **12 Hours**

Types and configurations - Parts delivery at workstations - Various vibratory and non vibratory devices for feeding - hopper feeders, rotary disc feeder, centrifugal and orientation - Product design for automated assembly.

*Product design for automated assembly.*

### Text Books

1. Anthony Esposito, "Fluid Power with applications", Prentice Hall international, 2009.
2. Mikell P Groover-"Automation, Production System and Computer Integrated Manufacturing", Prentice Hall Publications, 2007.

### Reference Books

1. Kuo .B.C, “Automatic control systems”, Prentice Hall India, New Delhi, 2007.
2. Peter Rohner, “Industrial hydraulic control”, Wiley Edition, 1995.
3. Mujumdar.S.R, “Pneumatic System”, Tata McGraw Hill 2006.

**Web References**

1. https://nptel.ac.in/courses/112102011

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 50 | 50 |
| L2 | 50 | 50 |
| Total (%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

1. What is automation?
2. What is Pneumatic fundamentals?
3. What is transducers?
4. What is switching circuits?
5. What is Buffer stock Simulation?

**L2: Understand**

1. Explain Line efficiency.
2. Explain Selection of hydraulic fluid.
3. Explain Pneumatic equipments
4. Explain programmable logic controllers.
5. Explain Parts delivery at workstations.

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**Board of Studies (EEE)**

## OE 20MEO03 Industrial Automation 3 0 0 3

At the end of the course, students will be able to

| Code | Course Outcomes | Mapping with POs | DoK |
|---|---|---|---|
| 20MEO03.1 | Identify various concepts of automation and work part transport mechanisms. | - | L2 |
| 20MEO03.2 | Illustrate the assembly systems and their applications. | - | L3 |
| 20MEO03.3 | Describe the importance of handling systems and identification systems. | - | L3 |
| 20MEO03.4 | Apply the concepts of part families and machine cells into various production systems | - | L2 |
| 20MEO03.5 | Recognize the importance of automated inspection and to distinguish the various control systems | - | L2 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective POs
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create,DoK: Depth of Knowledge

**Unit I: Manufacturing and Automation-Over View** **11+1 Hours**

Production systems, Automation in production systems, Automation principles and strategies, Reasons for Automation, Manufacturing operations, Functions in Manufacturing, Information processing in Manufacturing plant layout, production facilities. Basic elements of an automated system, levels of automation; Hardware components for automation and process control, programmable logic controllers and personal computers. Automation for machining operations.

**Unit II: Assembly Systems and Line Balancing** **11+1 Hours**

Process-Assembly lines-manual single stations assembly, Manual assembly line, automated assembly system-Line balancing. Automated Assembly Systems – Design for automated assembly-Types of automated assembly systems-Parts feeding devices

**Unit III: Automated Material Handling Systems** **11+1 Hours**

Automated Material Handling and storage system: Material Handling and Identification Technologies: Material handling, equipment, Storage systems, performance and location strategies, Automated storage systems, AS/RS, types. Functions, material handling equipment-Conveyors, AGVS, Industrial Robots-Anatomy, Robot configurations, work volume-AS/RS. Automatic identification methods, Barcode technology, RFID

**Unit IV: Manufacturing Cells** **11+1 Hours**

Manufacturing Systems and Automated Production Lines: Manufacturing systems: components of a manufacturing system, Single station manufacturing cells, Automated production lines, Applications, Transfer lines

**Unit V: Control Systems** **11+1 Hours**

Control Systems-Process Industries Versus Discrete Manufacturing Industries, Continuous Versus Discrete Control: Continuous Control Systems, Discrete Control Systems, Computer Process Control: Control Requirements, Capabilities of Computer Control.

.

**Text Books**

1. Milkell P. Groover, Automation, Production Systems and Computer Integrated Manufacturing, Kindle Edition, Prentice Hall of India, 2016.

**Reference Books**

1. C. Roy, “Robots and Manufacturing Automation”, Asfahl John Wiley & Sons. 2. Krishna Kant, “Computer Based Industrial Control”, EEE-PHI, 2nd edition, 2010

**Web References**

1. www.nptel.iitm.ac.in
2. www.btechguru.com

**Internal Assessment Pattern**

| Cognitive Level | InternalAssessment#1(%) | InternalAssessment#2(%) |
|---|---|---|

| | | |
|---|---|---|
| L1 | 40 | 30 |
| L2 | 40 | 30 |
| L3 | 20 | 40 |
| Total(%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

1. What is industrial automation?
2. What are the different costs included in industry in designing the particular product ?
3. What is production volume?
4. List the categorization of production system.
5. What are the types of automation?
6. What are the features of Flexible Automation?
7. What is factory type of Integral automation?
8. Define process.
9. What are process variables?
10. What is meant by control system in automation?

**L2: Understand**

1. Explain Automation principles and strategies
2. Compare Manual assembly line, automated assembly system
3. Illustrate Material handling, equipment, Storage systems, performance and location strategies
4. Demonstrate components of a manufacturing system
5. Compare Continuous Control Systems, Discrete Control Systems

**L3: Apply**

1. Apply the basic elements of an automated system for industrial automation
2. Apply different types of automated assembly systems for moderate plants
3. Apply the Barcode technology, RFID for industrial automation
4. Discuss Automated production lines, Applications, Transfer lines
5. Design the capabilities of computer control systems

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**Board of Studies (ME)**

## OE 20SHO02 Design Innovations 3 0 0 3

At the end of the course, students will be able to

| Code | Course Outcomes | DoK |
|---|---|---|
| 20SHO02.1 | Explain the fundamentals of Design Thinking and innovation | L2 |
| 20SHO02.2 | Empathize and analyse model action plan | L2 |
| 20SHO02.3 | Describe the principles of innovation and idea generation for product design | L2 |
| 20SHO02.4 | Apply design thinking techniques for given tasks | L2 |
| 20SHO02.5 | Apply the design thinking techniques for solving problems in various sectors | L3 |
| L1: Remember \| L2: Understand \| L3: Apply \| L4: Analyze \| L5: Evaluate \| L6: Create, DoK: Depth of Knowledge | | |

### Unit I: Introduction to Design Thinking 12 Hours

Introduction to elements and principles of Design, basics of design-dot, line, shape, form as fundamental design components. Principles of design. Introduction to design thinking, history of Design Thinking, New materials in Industry

### Unit II: Design Thinking 12 Hours

Design thinking process (empathize, analyze, idea & prototype), implementing the process in driving inventions, design thinking in social innovations. Tools of design thinking - person, costumer, journey map, brain storming, product development

### Unit III: Innovation 12 Hours

Art of innovation, Difference between innovation and creativity, role of creativity and innovation in organizations. Creativity to Innovation. Teams for innovation, Measuring the impact and value of creativity. Product Design: problem formation, introduction to product design, Product strategies, Product value, Product planning, product specifications

### Unit IV: Design Thinking for Strategic Innovation 12 Hours

An exercise in design thinking – implementing design thinking for better process. Implement design thinking process in various Industries. Design thinking for Start-ups

### Unit V: Design thinking in Various Sectors 12 Hours

Case studies in Information Technology, Finance, Education, Management and Retail sector. Analyze and Prototyping, Usability testing, Organizing and interpreting results

**Case study learning outcomes:**

1. Make use of practical design thinking methods in every stage of problem with the help of method templates
2. Apply design thinking to a problem in order to generate innovative and user-centric solutions
3. Empathize with end user and initiate a new working culture based on user-centric approach
4. Prototype and run usability tests for unbiased examination of the product in order to identify problem

### Text Books

1. Tim Brown, Harper Bollins, Change by Design, 2009
2. David Lee, Design Thinking in the Class Room, Ulysses Press

### Reference Books

1. Design the Future, Shrrutin N Shetty, Norton Press
2. William Lidwell, Kritina Holden, Jill Butter, Universal Principles of Design
3. Chesbrough H., The Era of Open Innovation
4. Chitale A. K. and Gupta R. C., Product Design and Manufacturing, Prentice Hall

### Web References


1. https://nptel.ac.in/courses/110106124
2. https://onlinecourses.nptel.ac.in/noc19_mg60/preview
3. www.tutor2u.net/business/presentations/. /productlifecycle/default.html
4. https://docs.oracle.com/cd/E11108_02/otn/pdf/. /E11087_01.pdf
5. www.bizfilings.com › Home › Marketing › Product Development
6. https://www.mindtools.com/brainstm.html
7. https://www.quicksprout.com/. /how-to-reverse-engineer-your-competit
8. www.vertabelo.com/blog/documentation/reverse-engineering https://support.microsoft.com/en-us/kb/273814
9. https://support.google.com/docs/answer/179740?hl=en
10. https://www.youtube.com/watch?v=2mjSDIBaUIM
11. thevirtualinstructor.com/foreshortening.html
12. https://dschool.stanford.edu/.../designresources/.../ModeGuideBOOTCAMP2010L.pdf
13. https://dschool.stanford.edu/use-our-methods/ 6.
14. https://www.interactiondesign.org/literature/article/5-stages-in-the-design-thinking-process 7.
15. https://www.nngroup.com/articles/design-thinking/ 9.
16. https://designthinkingforeducators.com/design-thinking/ 10.
17. www.designthinkingformobility.org/wp-content/.../10/NapkinPitch_Worksheet.pdf


### Activity Based Learning (Suggested Activities in Class) / Practical Based learning

http://dschool.stanford.edu/dgift/

### Internal Assessment Pattern

| Cognitive Level | Internal Assessment # 1 (%) | Internal Assessment # 2 (%) |
|---|---|---|
| L1 | 20 | 20 |
| L2 | 50 | 50 |
| L3 | 30 | 30 |
| Total (%) | 100 | 100 |

### Sample Short and Long Answer Questions of Various Cognitive Levels

### L1: Remember

1. What do you mean by design thinking?
2. How design thinking works within a product development process

### L2: Understand

1. Explain the elements and principles of design
2. Differentiate between creativity and innovation

### L3: Apply

1. How design thinking helped financial sector to gain the consumer 'trust'?

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**Board of Studies**

## HS 20HSX04 Professional Ethics 3 0 0 3

At the end of the course, students will be able to

| Code | Course Outcomes | Mapping with POs | | DoK |
|---|---|---|---|---|
| | | PO8 | PO12 | |
| 20HSX04.1 | Understand the ethics and apply ethics in society | 3 | 1 | L1, L2, L3 |
| 20HSX04.2 | Discuss the ethical issues related to engineering and realize the responsibilities and rights in the society | 3 | 1 | L1, L2, L3 |
| 20HSX04.3 | Know the code of ethics and industrial standards | 3 | 1 | L1, L2, L3 |
| 20HSX04.4 | Understand the rights and responsibilities of an employee at workplace | 3 | 1 | L1, L2, L3 |
| 20HSX04.5 | Understand environmental ethics and CSR of companies | 3 | 1 | L1, L2, L3 |
| 1. Weakly Contributing \| 2. Moderately Contributing \| 3. Strongly Contributing, for the attainment of respective Pos | | | | |
| L1: Remember \| L2: Understand \| L3: Apply \| L4: Analyze \| L5: Evaluate \| L6: Create. DoK: Depth of Knowledge | | | | |

### Unit I: Introduction to Ethics 10 Hours

Need and importance of ethics, objectives, morals, values and ethics – integrity – work ethic – service learning – civic virtue – respect for others – living peacefully – honesty – courage – valuing time – cooperation – commitment – empathy – self-confidence.

### Unit II: Engineering Ethics 10 Hours

Senses of 'engineering ethics' – variety of moral issues – types of inquiry – moral dilemmas – moral autonomy – consensus and controversy – models of professional roles – self-interest – self respect - customs and religion.

### Unit III: Engineering as Social Experimentation 10 Hours

Engineering as experimentation – engineers as responsible experimenters – codes of ethics – industrial standards - a balanced outlook on law.

### Unit IV: Safety, Responsibilities and Rights 10 Hours

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis - Safety lessons from Challenge - Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights.

### UnitV: Global Issues 10 Hours

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers–Moral Leadershi p– Code of Conduct– Corporate Social Responsibility.

### Text Books

1. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2003
2. Govindarajan M., Natarajan S., Senthil Kumar V. S., "EngineeringEthics", Prentice Hall of India, New Delhi, 2004

### Reference Books

1. Laura P. Hartman and Joe Desjardins, "Business Ethics: Decision Making for PersonalIntegrity and Social Responsibility" McGraw Hill Education, India Pvt. Ltd., New Delhi, 2013, Web References
2. World Community Service Centre, ' Value Education', Vethathiri Publications, Erode, 2011
3. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, "Engineering Ethics – Concepts and Cases", Cengage Learning, 2009

### Web References

1. www.onlineethics.org
2. www.nspe.org
3. www.globalethics.org
4. www.ethics.org

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 20 | 20 |
| L2 | 40 | 30 |
| L3 | 40 | 50 |
| Total (%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

1. List the human values and explain
2. Give an overview of Engineering Ethics
3. What is meant by Professional Responsibility?
4. What are the safety lessons one can learn in the Challenger case?
5. What are employee rights?
6. What is the engineer's role in weapon development?

**L2: Understand**

1. Illustrate the ethical aspect principle of caring or sharing, with an example
2. Explain various actions of an engineer leading to dishonesty
3. Justify the safety and other obligations of professional engineers
4. Discuss the problems with law in engineering practice
5. Explain in detail about the effect of information on risk assessments
6. Explain the role of engineers as 'expert witness' and 'advisors'

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| | | | | | |
|---|---|---|---|---|---|
| IN | **Summer Internship #2** | **0** | **0** | **0** | **1.5** |

At the end of the course, students will be able to

| No. | Course Outcomes |
|---|---|
| 1 | Demonstrate the theoretical learning outcomes |
| 2 | Integrate theory and practice during graduation |
| 3 | Comprehend the industry practices in the relevant and allied field of study |
| 4 | Develop communication skills in terms of oral, written, and graphical communications |
| 5 | Develop problem solving skills |
| 6 | Develop work habits and teamwork in a multidisciplinary setting for a successful career after graduation |
| **Note:** All the above course outcomes are relatively mapped to all POs as it caters to all program outcomes | |

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SC **20AIS04 Datasets and Packages for ML Engineer - 1** 1 0 2 2.0

At the end of the course, students will be able to

| Code | Course Outcomes | Mapping with POs | | DoK |
|---|---|---|---|---|
| | | PO4 | PO5 | |
| 20AIS05.1 | Interpret and use different types of data sets for computer vision problem | 2 | 2 | L1, L2, L3 |
| 20AIS05.2 | Interpret and use different types of data sets for NLP applications | 2 | 2 | L1, L2, L3, |
| 20AIS05.3 | Interpret and use different types of data sets for prediction | 2 | 2 | L1, L2, L3 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos

L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create. DoK: Depth of Knowledge

Study of Keras – TensorFlow – Implementation of Deep Neural Network models – Implementation of CNN – Implementation of RNN

**Resources**

1. https://data.mendeley.com/
2. https://deepmind.com/
3. https://www.kaggle.com
4. https://machinelearningmastery.com/

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**Full Semester Internship** **0 0 0 6**

At the end of the course, students will be able to

| No. | Course Outcomes |
|---|---|
| 1 | Recognizes and articulates the conceptual knowledge involved in the task undertaken |
| 2 | Search and professionally use the appropriate resources required to accomplish the task |
| 3 | Demonstrate the theoretical learning outcomes of the domain in task undertaken |
| 4 | Communicate well in various forms appropriately |
| 5 | Demonstrate a professional behaviour with improved inter-personal skills |
| 6 | Coordinate with people from inter and multi-disciplinary setting |
| **Note:** All the above course outcomes are relatively mapped to all POs as it caters to all program outcomes | |

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**Capstone Project/Interdisciplinary Project** **0 0 0 6**

At the end of the course, students will be able to

| No. | Course Outcomes |
|---|---|
| 1 | Demonstrate the application of theoretical concepts of domain |
| 2 | Identify the appropriate tools and methodologies for accomplishing the project |
| 3 | Illustrate the use of project management principles |
| 4 | Demonstrate the various forms of communication |
| 5 | Exhibit professional behaviour with inter and multi-disciplinary settings |
| **Note:** All the above course outcomes are relatively mapped to all POs as it caters to all program outcomes | |

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**HO 20DSH01 Text Analytics** **4 0 0 4.0**

At the end of the course, students will be able to

| Code | Course Outcomes | Mappingwith POs | DoK |
|---|---|---|---|
| 20DSH01.1 | Understand the basic concepts of Natural Language Processing | | L1, L2 |
| 20DSH01.2 | Understand the text analytics framework. | | L1, L2 |
| 20DSH01.3 | Understand the concepts of Text Summarization. | | L1, L2 |
| 20DSH01.4 | Apply different techniques on Text Similarity | | L1, L2, L3 |
| 20DSH01.5 | Analysing the concepts of Semantic and Sentiment Analysis | | L1, L2, L3 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create. DoK: Depth of Knowledge

**Unit I: Natural Language Basics** **9 hours**
Natural Language: Philosophy of Language,Acquisition and Usage, Language Syntax and Structure,Language Semantics, Natural Language Processing: Machine Translation,Speech Recognition Systems,Question Answering Systems,Contextual Recognition and Resolution,Text Categorization, Text Summarization,Text Analytics

*Speech Recognition System versus Contextual Recognition system*

**Unit II: Text Classification** **9hours**
Automated Text Classification,Classification Algorithms: Multinomial Naïve Bayes,Support Vector Machines, Evaluating Classification Models,Building a Multi-Class Classification System,Applications and Uses,Feature Extraction:Bag of Words Model, TF-IDF Mode, Advanced Word Vectorization Models, Understanding Text Syntax and Structure:Parts of Speech (POS) Tagging,Dependencybased Parsing,Shallow Parsing,Constituency-based Parsing

*Decision tree*

**Unit III: Text Summarization** **9 hours**
TextSummarization and Information Extraction:Text Normalization,Feature Extraction:Keyphrase Extraction,Weighted Tag–Based Phrase Extraction, Topic Modelling:Latent Semantic Indexing,Latent Dirichlet Allocation, Matrix Factorization, Automated Document Summarization, Latent Semantic Analysis

*Non-negative Matrix Factorization*

**Unit IV: Text Similarity and Clustering9 hours**
Information Retrieval (IR), Feature Engineering,Similarity Measures: Analysing Term Similarity,Manhattan Distance,Euclidean Distance, Analyzing Document Similarity: Cosine Distance and Similarity,Document Clustering:K-means Clustering,Ward's Agglomerative Hierarchical Clustering

*Hamming Distance, K-NN Clustering*

**Unit V: Semantic and Sentiment Analysis9 hours**
Semantic Analysis:Analyzing Lexical Semantic Relations,Word Sense Disambiguation,Named Entity Recognition, Propositional Logic,First Order Logic.Sentiment Analysis:Supervised Machine Learning Technique, Unsupervised Lexicon-based Techniques,Comparing Model Performances

*Semantic Representations*

**Text Books**

1. Dipanjan Sarkar, "Text Analytics with Python : A Practitioner's Guide to Natural Language", 2nd Edition,Apress, 2019
2. Akshay Kulkarni, Adarsha Shivananda, "Natural Language Processing Recipes: Unlocking Text Data with Machine Learning and Deep Learning Using Python", 1stEdition,Apress, 2019

**Reference Books**

1. Birds.,KlienE. and E.Loper, "Natural Language Processing with python", 1st Edition ,O 'Reilly Media Inc, 2009

**Web Resources**

1. https://www.tutorialspoint.com/big_data_analytics/text_analytics.htm
2. https://towardsdatascience.com/getting-started-with-text-analysis-in-python-ca13590eb4f7

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 40 | 35 |
| L2 | 40 | 35 |
| L3 | 20 | 30 |
| Total (%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

1. What is Natural Language Processing?
2. List out the three phases of transfer model in Machine Translation.
3. What is POS tagging?
4. Define k-means clustering
5. What do you mean by natural language and computer language?

**L2: Understand**

1. Explain the process of multi-document summarization.
2. Discuss about NLP and NLU
3. Describe twoevaluation metrics available for text classification
4. Explain text summarization and multiple document text summarization withneat diagram
5. Explain about Ward's Agglomerative Hierarchical Clustering

**L3: Apply**

1. Apply the naive Bayes classifier approach to Word Sense Disambiguation inNLP
2. Apply the significance of Word Sense Disambiguation in NLP
3. Evaluate the architecture of an Information Retrieval system with a neatdiagram

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## HO 20AIH02 Advanced Data Structures and Algorithms 4 0 0 4

At the end of the course, students will be able to

| Code | Course Outcomes | Mapping with POs | DoK |
|---|---|---|---|
| 20AIH02.1 | Understand the importance of algorithms in computing | - | L1, L2 |
| 20AIH02.2 | Design efficient algorithms for the given problem | | L1, L2 |
| 20AIH02.3 | Choose appropriate data structures for the given problem | | L1, L2 |
| 20AIH02.4 | Apply graph algorithms to solve real-time problems | | L1, L2 |
| 20AIH02.5 | Choose and implement appropriate design strategy | | L1, L2 |
| L1: Remember \| L2: Understand \| L3: Apply \| L4: Analyze \| L5: Evaluate \| L6: Create. DoK: Depth of Knowledge | | | |

**Unit 1: Role of algorithms in Computing** **9 hours**
Algorithms – Algorithms as a Technology- Insertion Sort – Analysing Algorithms – Designing Algorithms- Growth of Functions: Asymptotic Notation – Standard Notations and Common Functions- Recurrences: The Substitution Method – The Recursion-Tree Method

**Unit 2: Hierarchical Data Structures** **9 hours**
Binary Search Trees: Basics – Querying a Binary search tree – Insertion and Deletion- Red-Black trees: Properties of Red-Black Trees – Rotations – Insertion – Deletion -B-Trees: Definition of Btrees – Basic operations on B-Trees – Deleting a key from a B-Tree- Fibonacci Heaps: structure – Mergeable-heap operations- Decreasing a key and deleting a node-Bounding the maximum degree

**Unit 3: Algorithm Design Strategies** **9 hours**
Dynamic Programming: Matrix-Chain Multiplication – Elements of Dynamic Programming – Longest Common Subsequence- Greedy Algorithms: An Activity-Selection Problem – Elements of the Greedy Strategy – Activity Selection Problem

**Unit 4: String Matching algorithms** **9 hours**
Naive String Matching, Rabin-Karp algorithm, matching with finite Automata, Knuth- Morris - Pratt algorithm

**Unit 5: NP Complete and Hard** **9 hours**
NP-Completeness: Polynomial Time – Polynomial-Time Verification – NP- Completeness and Reducability – NP-Completeness Proofs – NP-Complete Problems

**Text Books**

1. Cormen T. H., Leiserson C.E., Rivest R. L. and Stein. C., “Introduction to Algorithms”, Third Edition, PHI

**Reference Books**

1. Ellis Horowitz, Satraj Sahni and Rajasekharam, “Fundamentals of Computer Algorithms”, Galgotia publications pvt. Ltd.
2. Parag Himanshu Dave, Himanshu Bhalchandra, “Design and Analysis Algorithms”, Dave Publisher, Pearson
3. Goodrich M. T., and Tomassia R., “Algorithm Design: Foundations, Analysis and Internet examples “, John Wiley and sons.

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 50 | 50 |
| L2 | 50 | 50 |
| Total (%) | 100 | 100 |

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## HO 20AIH03 Game Theory 4 0 0 4

At the end of the course, students will be able to

| Code | Course Outcomes | Mapping with POs | DoK |
|---|---|---|---|
| 20AIH03.1 | Understand the fundamentals of game theory | - | L1, L2 |
| 20AIH03.2 | Describe the principles of computer graphics | | L1, L2 |
| 20AIH03.3 | Explain the basic principles of game designing | | L1, L2 |
| 20AIH03.4 | Explain game engine design methods | | L1, L2 |
| 20AIH03.5 | Design and develop simple games | | L1, L2, L3 |
| L1: Remember \| L2: Understand \| L3: Apply \| L4: Analyze \| L5: Evaluate \| L6: Create. DoK: Depth of Knowledge | | | |

**Unit 1: Introduction** **9 hours**
Elements of Game Play – Artificial Intelligence – Getting Input from the Player - Sprite Programming – Sprite Animation - Multithreading – Importance of Game Design – Game Loop

**Unit 2: 3D Graphics for Game Programming** **9 hours**
Coordinate Systems, Ray Tracing, Modelling in Game Production, Vertex Processing, Rasterization, Fragment Processing and Output Merging, Illumination and Shaders, Parametric Curves and Surfaces

**Unit 3: Game Design Principles** **9 hours**
Character Development, Story Telling, Narration, Game Balancing, Core mechanics, Principles of level design, Genres of Games, Collision Detection, Game Logic, Game AI, Path Finding, Case study : Tetris

**Unit 4: Game Engine Design** **9 hours**
Renderers, Software Rendering, Hardware Rendering, and Controller Based Animation, Spatial Sorting, Level of Detail, Collision Detection, Standard Objects

**Unit 5: Game Development** **9 hours**
Developing 2D and 3D Interactive Games Using OpenGL, DirectX – Isometric and Tile Based Games, Puzzle Games, Single Player Games, Multi-Player Games

**Text Books**

1. David H. Eberly, "3D Game Engine Design: A Practical Approach to Real-Time Computer Graphics", Second Edition, Morgan Kaufmann, 2010.
2. 2. Jung Hyun Han, "3D Graphics for Game Programming", First Edition, Chapman and Hall/CRC, 2011

**Reference Books**

1. Jonathan S. Harbour, "Beginning Game Programming", Course Technology, Third Edition PTR, 2009.
2. Ernest Adams and Andrew Rollings, "Fundamentals of Game Design", Third Edition, Pearson Education, 2014.
3. Scott Rogers, "Level Up: The Guide to Great Video Game Design", First Edition, Wiley, 2010.
4. Jim Thompson, Barnaby Berbank-Green, and Nic Cusworth, "Game Design: Principles, Practice, and Techniques - The Ultimate Guide for the Aspiring Game Designer", First Edition, Wiley, 2008

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 50 | 50 |
| L2 | 50 | 50 |
| Total (%) | 100 | 100 |

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## HO 20DSH04 Recommender Systems 4 0 0 4.0

At the end of the course, students will be able to

| Code | Course Outcomes |
|---|---|
| 20DSH04.1 | Design recommendation system for a particular application domain. |
| 20DSH04.2 | Evaluate recommender systems on the basis of metrics such as accuracy, rank accuracy,diversity, product coverage, and serendipity. |
| 20DSH04.3 | Explain User-based recommendation, knowledge-based recommender system. |
| 20DSH04.4 | Define Opportunities for hybridization, Monolithic hybridization. |
| 20DSH05.5 | Identify hybridization design, Weighted, Switching, Mixed, Pipelined hybridization. |
| 1. Weakly Contributing \| 2. Moderately Contributing \| 3. Strongly Contributing, for the attainment of respective Pos | |
| L1: Remember \| L2: Understand \| L3: Apply \| L4: Analyze \| L5: Evaluate \| L6: Create. DoK: Depth of Knowledge | |

**Unit I:Introduction** **9 + 3 hours**

Overview of Information Retrieval, Retrieval Models, Search andFiltering Techniques: Relevance Feedback, User Profiles, Recommender system functions,Matrix operations, covariance matrices, Understanding ratings, Applications of recommendationsystems, Issues with recommender system.

*Information Retrieval*

**Unit II: Content-based Filtering** **9 + 3 hours**

High level architecture of content-based systems,Advantages and drawbacks of content-based filtering, Item profiles, Discovering features ofdocuments, pre-processing and feature extraction, Obtaining item features from tags, Methods for learning user profiles, Similarity based retrieval, Classification algorithms.

*Pre-processing*

**Unit III: Collaborative Filtering** **9+ 3 hours**

User-based recommendation, Item-based recommendation,Model based approaches, Matrix factorization, Attacks on collaborative recommender systems.Types of Recommender Systems: Recommender systems in personalized web searchknowledge-based recommender system, Social tagging recommender systems, Trust-centricrecommendations, Group recommender systems

*Matrix factorization*

**Unit IV: Hybrid Approaches** **9+ 3 hours**

opportunities for hybridization, Monolithic hybridizationdesign: Feature combination, Feature augmentation, Parallelized hybridization design: Weighted,Switching, Mixed, Pipelined hybridization design: Cascade, Meta-level, Limitations ofhybridization strategies.

*Feature augmentation*

**Unit V: Evaluating Recommender System** **9+ 3 hours**

Introduction, General properties of evaluationresearch, Evaluation designs: Accuracy, Coverage, confidence, novelty, diversity, scalability,serendipity, Evaluation on historical datasets, Offline evaluations

*Evaluation on historical datasets*

**Text Books**

1.Jannach D., Zanker M. and FelFering A., Recommender Systems: An Introduction,Cambridge University Press (2011), 1st ed.
2. Charu C. Aggarwal, Recommender Systems: The Textbook, Springer (2016), 1st ed.

**Reference Books**

1.Ricci F., Rokach L., Shapira D., Kantor B.P., Recommender Systems Handbook,Springer(2011), 1st ed.

2. Manouselis N., Drachsler H., Verbert K., Duval E., Recommender Systems ForLearning, Springer (2013), 1st ed.

**Web Resources**

1. www.geeksforgeeks.com
2. www.sanfoundary.com

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HO **20AIH05 Video Analytics** **4 0 0 4.0**

At the end of the course, students will be able to

| Code | Course Outcomes |
|---|---|
| 20AIH05.1 | Understand the need for video Analytics |
| 20AIH05.2 | Understand the basic configuration |
| 20AIH05.3 | Understand the functional block of a video analytics |
| 20AIH05.4 | Get exposed to the various applications of video analytics |
| 20AIH05.5 | Design custom made video analytics system for the given target application |
| 1. Weakly Contributing \| 2. Moderately Contributing \| 3. Strongly Contributing, for the attainment of respective Pos | |
| L1: Remember \| L2: Understand \| L3: Apply \| L4: Analyze \| L5: Evaluate \| L6: Create. DoK: Depth of Knowledge | |

**Unit I: Video Analytic components** **9 hours**

Need for Video Analytics-Overview of video Analytics- Foreground extraction- Feature extraction- classifier - Preprocessing-edge detection- smoothening- Feature space-PCA-FLD-SIFT features

*Edge detection*

**Unit II: foreground extraction** **9hours**

Background estimation-Averaging-Gaussian Mixture Model-Optical Flow based-Image Segmentation-Region growing-Region splitting -Morphological operations-erosion-Dilation Tracking in a multiple camera environment

*Morphological operations*

**Unit III: Classifiers** **9 hours**

Neural networks (back propagation)- Deep learning networks-Fuzzy classifier-Bayesian classifier-HMM based classifier

*Fuzzy classifier*

**Unit IV: Video analytic for security** **9 hours**

Abandoned object detection- human behavioral analysis -human action recognition- perimeter security- crowd analysis and prediction of crowd congestion

*Human action recognition*

**Unit V: Video Analytics for business intelligence and Traffic Monitiring and assistance** **9 hours**

Customer behavior analysis- people counting- Traffic rule violation detection- traffic congestion identification for route planning-driver assistance – lane change warning

*Traffic congestion identification*

**Text Books**

1. Graeme A. Jones (Editor), Nikos Paragios (Editor), Carlo S. Regazzoni (Editor) Video-Based Surveillance Systems: Computer Vision and Distributed Processing , Kluwer academic publisher, 2001
2. Caifeng Shan (Editor), Fatih Porikli (Editor), Tao Xiang (Editor), Shaogang Gong (Editor) Video Analytics for Business Intelligence, Springer, 2012

**Reference Books**

1. Nilanjan Dey (Editor), Amira Ashour (Editor) and Suvojit Acharjee (Editor), Applied Video Processing in Surveillance and Monitoring Systems (IGI global) 2016

2. Zhihao Chen (Author), Ye Yang (Author), Jingyu Xue (Author), Liping Ye (Author), Feng Guo (Author), The Next Generation of Video Surveillance and Video Analytics: The Unified Intelligent Video Analytics Suite, CreateSpace Independent Publishing Platform, 2014

**Web Resources**

1. https://docs.opencv.org/3.4/d8/d83/tutorial_py_grabcut.html
2. https://www.sciencedirect.com/topics/computer-science/video-analytics
3. https://www.sciencedirect.com/topics/computer-science/video-analytics

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 40 | 35 |
| L2 | 40 | 35 |
| L3 | 20 | 30 |
| Total (%) | 100 | 100 |

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## HO 20AIH06 Game Programming 4 0 0 4

At the end of the course, students will be able to

| Code | Course Outcomes |
|---|---|
| 20AIH06.1 | Explain the game logic and game theory |
| 20AIH06.2 | Discuss the concepts of Game design and development |
| 20AIH06.3 | Explain the Core architectures of Game Programming |
| 20AIH06.4 | Explain the Concepts of software and hardware rendering |
| 20AIH06.5 | Create interactive Games |

**Unit 1: Introduction** **9 hours**
Introduction, Game Logic, Game AI, Path Finding, Game Theory, Character development, Story Telling, Narration, Game Balancing, Core mechanics, Principles of level design, Genres of Games, Collision Detection

**Unit 2: 3D Graphics for Game Programming** **9 hours**
Coordinate Systems, Ray Tracing, Modelling in Game Production, Vertex Processing, Rasterization, Fragment Processing and Output Merging, Illumination and Shaders, Parametric Curves and Surfaces

**Unit 3: Game Engine Design** **9 hours**
Game engine architecture, Engine support systems, Resources and File systems, Game loop and real-time simulation, Human Interface devices, Collision and rigid body dynamics, Game profiling

**Unit 4: Game Programming** **9 hours**
Renderers, Software Rendering, Hardware Rendering, and Controller Based Animation, Spatial Sorting, Level of Detail, Collision Detection, Standard Objects

**Unit 5: Game Development** **9 hours**
Developing 2D and 3D Interactive Games Using OpenGL, DirectX – Isometric and Tile Based Games, Puzzle Games, Single Player Games, Multi-Player Games

**Text Books**

1. Mike Mc Shaffrfy and David Graham, "Game Coding Complete", Fourth Edition, Cengage Learning, PTR, 2012.
2. Jason Gregory, "Game Engine Architecture", CRC Press / A K Peters, 2009.
3. David H. Eberly, "3D Game Engine Design, Second Edition: A Practical Approach to Real-Time Computer Graphics" 2 nd Editions, Morgan Kaufmann, 2006.

**Reference Books**

1. Ernest Adams and Andrew Rollings, "Fundamentals of Game Design", 2 nd Edition Prentice Hall / New Riders, 2009.
2. Eric Lengyel, "Mathematics for 3D Game Programming and Computer Graphics", 3 rd Edition, Course Technology PTR, 2011.
3. Jesse Schell, The Art of Game Design: A book of lenses, 1 st Edition, CRC Press, 2008.

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 50 | 50 |
| L2 | 50 | 50 |
| Total (%) | 100 | 100 |

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## HO 20DSH07 Data Analysis with MATLAB 4 0 0 4.0

At the end of the course, students will be able to

| Code | Course Outcomes |
|---|---|
| 20DSH07.1 | Identify how to prepare the data for analysis |
| 20DSH07.2 | Describelinear regression analysis |
| 20DSH07.3 | Apply the Fourier analysis and calculate FFT |
| 20DSH07.4 | Illustrate about time series objects and methods |
| 20DSH07.5 | Demonstrate time series tools |
| 1. Weakly Contributing \| 2. Moderately Contributing \| 3. Strongly Contributing, for the attainment of respective Pos | |
| L1: Remember \| L2: Understand \| L3: Apply \| L4: Analyze \| L5: Evaluate \| L6: Create. DoK: Depth of Knowledge | |

**Unit I Preparing Data for Analysis:** **9 hours**
MATLAB for Data Analysis: Introduction, Calculations on Vectors and Matrices, MATLAB GUIs for Data Analysis Related Toolboxes, Importing and Exporting Data, Plotting Data: Introduction, Example-Loading and Plotting Data, Removing and Interpolating Missing Values: Representing Missing Data Values, Calculating with NaNs, ,Removing NaNs from the Data, Interpolating Missing Data, Removing Outliers

*Example-Using MATLAB Data Statistics*

**Unit II Linear Regression Analysis**: **9 hours**
Linear Regression: Introduction, Residuals and Goodness of Fit, When to Use the Curve Fitting Toolbox, Correlation Analysis: Introduction, Covariance, Correlation Coefficients, Interactive Fitting: The Basic Fitting GUI, Preparing for Basic Fitting, Opening the Basic Fitting GUI, Programmatic Fitting: MATLAB Functions for Polynomial Models

*Example-Data Fitting Using MATLAB Functions*

**Unit III Fourier Analysis:** : **9 hours**
Fourier Analysis-Introduction: Function Summary, Calculating Fourier Transforms, Example-Using FFT to Calculate Sunspot, Magnitude and Phase of Transformed Data

*FFT Length versus Performance*

**Unit IV Time Series Objects and Methods:** **9 hours**
Time Series Objects: Introduction: Time Series Data Sample **,**Example — Using Time Series Objects and Methods: Creating Time Series Objects, Viewing Time Series Objects, Modifying Time Series Units and Interpolation Method, Defining Events, Time Series Methods**:** General Methods, Data and Time Manipulation Methods, Event Methods

*Statistical Methods*

**Unit V Time Series Tools:** **9 hours**
Introduction **:**Opening Time Series Tools, Getting Help, Time Series Tools Window **,** Time Series Tools Workflow, Generating Reusable M-Code, Importing and Exporting Data: Types of Data You Can Import, How to Import Data , Changes to Data Representation During Import,Importing Data with Missing Values, Plotting Time Series :Types of Plots in Time Series Tools, Creating a Plot

*Histograms, XY Plots*

**Text Books**

1. " Matlab 7 Data Analysis",The MathWorks 2007

**Reference Books**

1. Irfan Turk, "Practical MATLAB", Apress 2019
2. ArashKarimpour,"Fundamentals of Data Science with MATLAB", ArashKarimpour 2020

**Web Resources**

1. https://in.mathworks.com/videos/matlab-for-data-analytics-1525861909298.html

2. https://in.mathworks.com/products/matlab/data-analysis.html
3. https://in.mathworks.com/videos/data-analytics-with-matlab-99066.html?s_tid=vid_pers_recs

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 30 | 20 |
| L2 | 35 | 40 |
| L3 | 35 | 40 |
| Total (%) | 100 | 100 |

L1: Remembering
1. Give steps to import and export data inMATLAB?
2. How do you perform operations on vectors in MATLAB?
3. How do you represent missing values in MATLAB?
4. Explain classical time series forecasting method Moving Average

L2: Understanding
1. How MATLAB is used in data analytics?
2. Discuss briefly about removing outliers and filtering data with an example
3. Explain how FFT can be used to calculate sunspot
4. How to create time series objects in MATLAB?
5. Describe in detail about time series methods

L3: Applying
1. How do you analyze time series data in MATLAB?
2. Consider the following sample of ordered pairs (x,y) where y = the purity of oxygen produced in a chemical distillation process, and x = the percentage of hydrocarbons that are present in the main condenser of the distillation unit.

| Observation Number | Hydrocarbon Level x (in %) | Purity y (in %) | Observation Number | Hydrocarbon Level x (in %) | Purity y (in %) |
|---|---|---|---|---|---|
| 1 | 0.99 | 90.01 | 11 | 1.19 | 93.65 |
| 2 | 1.02 | 89.05 | 12 | 1.15 | 92.52 |
| 3 | 1.15 | 91.43 | 13 | 0.98 | 90.56 |
| 4 | 1.29 | 93.74 | 14 | 1.01 | 89.54 |
| 5 | 1.46 | 96.73 | 15 | 1.11 | 89.85 |
| 6 | 1.36 | 94.45 | 16 | 1.2 | 90.39 |
| 7 | 0.87 | 87.59 | 17 | 1.26 | 93.25 |
| 8 | 1.23 | 91.77 | 18 | 1.32 | 93.41 |
| 9 | 1.55 | 99.42 | 19 | 1.43 | 94.98 |
| 10 | 1.4 | 93.65 | 20 | 0.95 | 87.33 |

(i) Enter above data either as a single 20x2 matrix or as two 20x1 vectors. Be sure to preserve the ordering of the pairs
(ii)Create a scatterplot of this data. Label both the x and y axis and title the graph “scatterplot”. Labels can be added on the graph itself.
(iii) Determine the correlation coefficient.

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## HO 20AIH08 Natural Language Preocessing 4 0 0 4

At the end of the course, students will be able to

| Code | Course Outcomes |
|---|---|
| 20AIH08.1 | Understand of the field of natural language processing. |
| 20AIH08.2 | model linguistic phenomena with formal grammars |
| 20AIH08.3 | Design, implement and test algorithms for NLP problems |
| 20AIH08.4 | Understand the mathematical and linguistic foundations underlying approaches to the various areas in NLP |
| 20AIH08.5 | Apply NLP techniques to design real world NLP applications |

**UNIT I INTRODUCTION**
Origins and challenges of NLP – Language Modeling: Grammar-based LM, Statistical LM – Regular Expressions, Finite-State Automata – English Morphology, Transducers for lexicon and rules, Tokenization, Detecting and Correcting Spelling Errors, Minimum Edit Distance

**UNIT II WORD LEVEL ANALYSIS**
Unsmoothed N-grams, Evaluating N-grams, Smoothing, Interpolation and Backoff – Word Classes, Part-of-Speech Tagging, Rule-based, Stochastic and Transformation-based tagging, Issues in PoS tagging – Hidden Markov and Maximum Entropy models.

**UNIT III SYNTACTIC ANALYSIS**
Context-Free Grammars, Grammar rules for English, Treebanks, Normal Forms for grammar – Dependency Grammar – Syntactic Parsing, Ambiguity, Dynamic Programming parsing – Shallow parsing – Probabilistic CFG, Probabilistic CYK, Probabilistic Lexicalized CFGs – Feature structures, Unification of feature structures

**UNIT IV SEMANTICS AND PRAGMATICS**
Requirements for representation, First-Order Logic, Description Logics – Syntax-Driven Semantic analysis, Semantic attachments – Word Senses, Relations between Senses, Thematic Roles, selectional restrictions – Word Sense Disambiguation, WSD using Supervised, Dictionary & Thesaurus, Bootstrapping methods – Word Similarity using Thesaurus and Distributional methods.

**UNIT V DISCOURSE ANALYSIS AND LEXICAL Resources**
Discourse segmentation, Coherence – Reference Phenomena, Anaphora Resolution using Hobbs and Centering Algorithm – Coreference Resolution – Resources: Porter Stemmer, Lemmatizer, Penn Treebank, Brill's Tagger, WordNet, PropBank, FrameNet, Brown Corpus, British National Corpus (BNC)

*Reference Books:*

1. Siddiqui and Tiwary U.S., Natural Language Processing and Information Retrieval, Oxford University Press (2008).
2. Daniel M Bikel and Imed Zitouni Multilingual natural language processing applications Pearson, 2013
3. Alexander Clark (Editor), Chris Fox (Editor), Shalom Lappin (Editor) The Handbook of Computational Linguistics and Natural Language Processing ISBN: 978-1-118-
4. Steven Bird, Ewan Klein, Natural Language Processing with Python, OReilly
5. Brian Neil Levine, An Introduction to R Programming
6. Niel J le Roux, Sugnet Lubbe, A step by step tutorial : An introduction into R application and programming

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 50 | 50 |
| L2 | 50 | 50 |
| Total (%) | 100 | 100 |

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## HO 20AIH09 3D Graphics and Animation 4 0 0 4

At the end of the course, students will be able to

| Code | Course Outcomes |
|---|---|
| 20AIH09.1 | Design three-dimensional graphics |
| 20AIH09.2 | Apply three dimensional transformations |
| 20AIH09.3 | Design animation sequences |
| 20AIH09.4 | Explain the computer graphics realism |
| 20AIH09.5 | State the applications of animation |

**Unit 1: Introduction to 3D Graphics** **9 hours**
Three dimensional Concepts, Three Dimensional Object Representations – Polygon Surfaces- Polygon Tables- Plane Equations - Polygon Meshes, Curved Lines and Surfaces, Quadratic Surfaces, Blobby Objects

**Unit 2: 3D Transformation and Viewing** **9 hours**
Three Dimensional Geometric and Modeling Transformations – Translation, Rotation, Scaling, Composite Transformations; Three-Dimensional Viewing – Viewing Pipeline, Viewing Coordinates, Projections, Clipping; Visible Surface Detection Methods

**Unit 3: Animation** **9 hours**
Design of Animation Sequence – Animation Function – Raster Animation – Key Frame Systems – Motion Specification – Morphing – Tweening – Types of Animation – Fractals – Tools for Animation Creation

**Unit 4: Animations and Realism** **9 hours**
Tiling the plane – Recursively Defined Curves – Koch curves – C curves – Dragons – Space filling Curves – fractals – Grammar Based Models – Fractals – Turtle Graphics – Ray Tracing

**Unit 5: Applications of Animation** **9 hours**
3D Computer Animation for Applications Such as Games and Virtual Environments – Character Animation Techniques Such as Synthesizing their Body Movements – Facial Expressions and Skin Movements – Behaviors in Crowded Scenes.

**Text Books**

1. Donald Hearn and Pauline Baker M, —Computer Graphics", Prentice Hall, New Delhi, 2007
2. F.S. Hill, Jr., Stephen M. Kelley, Jr., “Computer graphics using OpenGL”, Pearson Prentice Hall, Third Edition, 2007

**Reference Books**

1. Alan Watt, “3D Computer Graphics”, Third Edition, Pearson Addison Wesley,2000
2. Alan Watt, Mark Watt, “Advanced Animation and Rendering Techniques: Theory and Practice”, Addison Wesley, 1992.

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 40 | 40 |
| L2 | 30 | 50 |
| L3 | 30 | 10 |
| Total (%) | 100 | 100 |

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HO **20DSH10 Data Preparing and Cleaning** **4 0 0 4.0**

At the end of the course, students will be able to

| Code | Course Outcomes |
|---|---|
| 20DSH10.1 | Describe the basic concepts of Data Preparation |
| 20DSH10.2 | Identify Data Preparation Techniques |
| 20DSH10.3 | Able to Handle Messy Data |
| 20DSH10.4 | InterpretFeature Selection on different types of Data |
| 20DSH10.5 | Able to apply Data Transformation & Data Reduction Techniques |
| 1. Weakly Contributing \| 2. Moderately Contributing \| 3. Strongly Contributing, for the attainment of respective Pos | |
| L1: Remember \| L2: Understand \| L3: Apply \| L4: Analyze \| L5: Evaluate \| L6: Create. DoK: Depth of Knowledge | |

**Unit I: Data Preparation Basics** **9 hours**

Introduction to Data Preparation, Choosing correct Data Preparation Techniques, Importance of Data Preparation, Preparation of Raw Data, Predictive Modeling, Real-time & Scalability Issues in Data Preparation

*Feature Engineering*

**Unit II: Data Preparation Techniques** **9hours**

Data Preparation Techniques, Common Data Preparation Tasks, Data Cleaning, Feature Selection, Data Transforms, Feature Engineering, Dimensionality Reduction, Data Preparation without Leakage, Problems with Naïve Data Preparation, Data Preparation with Train & Test Sets, Data Preparation with Cross-Validation

*Cross Validation*

**Unit III: Data Cleaning** **9 hours**

Data Cleaning Introduction, Messy Datasets, Identify & Delete Columns that contains a single value, Consider Columns that have very few values, Removing Columns that have low variance, Identify & remove rows that contain a duplicate value, Outlier Identification & Removal, Handling Missing Data, KNN Imputation

*Handling Missing Data*

**Unit IV: Feature Selection** **9 hours**

Feature Selection Introduction, Statistics for Feature Selection, Feature Selection for any Datatype, Selecting Categorical Input Features, Selecting Numerical Input Features, Selecting Features for Numerical Output

*Feature Selection for any Datatypes*

**Unit V: Data Transformation& Dimensionality Reduction** **9 hours**

Scaling Numerical Data, Scaling Data with Outliers, Encoding Categorical Data, Transforming Numerical Data to Categorical Data, Problems with many Input Variables, Dimensionality Reduction, Techniques for Dimensionality Reduction, PCA Dimensionality Reduction

*Dimensionality Reduction*

**Text Books**

1. Jason Brownlee, “Data Preparation for Machine Learning- Data Cleaning, Feature Selection & Data Transforms in Python”, Edition v1.1, Machine Learning Mastery Publications, 2020

**Reference Books**

1. Tamraparni Dasu, Theodore Johnson, “Exploratory Data Mining & Data Cleaning”, Edition 1, Wiley Publications, 2003.

**Web Resources**

1. https://www.techtarget.com/searchbusinessanalytics/definition/data-preparation
2. https://www.techtarget.com/searchdatamanagement/definition/data-scrubbing

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## HO 20AIH11 Digital Forensics 4 0 0 4

At the end of the course, students will be able to

| Code | Course Outcomes |
|---|---|
| 20AIH11.1 | Understand the essential elements of forensic analysis |
| 20AIH11.2 | Describe the security issues in forensic analysis |
| 20AIH11.3 | Explain the intrusion detection system |
| 20AIH11.4 | Understand the methods of preparing forensic reports |
| 20AIH11.5 | Explore open source tools available |

Unit 1
Introduction to Digital Forensics and Digital Evidences Digital Forensic ,Rules for Digital Forensic The Need for Digital Forensics, Types of Digital Forensics, Ethics in Digital Forensics, Digital Evidences : Types and characteristics and challenges for Evidence Handling 6 CO2

Unit II
Introduction to Computer Security Incident Goals of Incident response, Incident Response Methodology, Formulating Response Strategy, IR Process – Initial Response, Investigation, Remediation, Tracking of Significant, Investigative Information, Reporting Pre Incident Preparation, Incident Detection and Characterization. Live Data Collection : Live Data Collection on Microsoft Windows Systems: Live Data 11 CO3 Collection on Unix-Based Systems

Unit III
Introduction to Intrusion Detection systems, Types of IDS Understanding Network intrusion and attacks , Analyzing Network Traffic, Collecting Network based evidence, Evidence Handling. Investigating Routers

Unit IV
Forensic Investigation Report :Goals of Report, Layout of an Report and Forensic Tools Investigative Report, Guidelines for Writing a Report, sample for writing a forensic report . Computer Forensic Tools : need and types of computer forensic tools, task performed by computer forensic tools

Unit V
Study of open source Tools like SFIT, Autopsy etc. to acquire, search, analyze and store digital evidence 7 CO6

*Reference Books:*

1. Clint P Garrison Digital Forensics for Network, Internet, and Cloud Computing A forensic evidence guide for moving targets and data , Syngress Publishing, Inc. 2010
2. Bill Nelson,Amelia Phillips,Christopher Steuart, Guide to Computer Forensics and Investigations . Cengage Learning, 2014
3. Debra Littlejohn Shinder Michael Cross Scene of the Cybercrime: Computer Forensics Handbook, 2nd Edition Syngress Publishing, Inc.2008.
4. Marjie T. Britz, Computer Forensics and Cyber Crime, Pearson, Third Edition.

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 50 | 50 |
| L2 | 50 | 50 |
| Total (%) | 100 | 100 |

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## HO 20AIH12 Augmented Reality and Virtual Reality 4 0 0 4

At the end of the course, students will be able to

| Code | Course Outcomes |
|---|---|
| 20AIH12.1 | Demonstrate the concepts of augmented reality |
| 20AIH12.2 | Identify augmented reality contents and interactions |
| 20AIH12.3 | Explain the components of virtual reality |
| 20AIH12.4 | Explain the modeling tools of virtual reality |
| 20AIH12.5 | State the applications of virtual and augmented reality |

**Unit 1: Introduction to Augmented Reality** **9 hours**
Introduction, The Relationship Between Augmented Reality and Other Technologies-Media, Applications of Augmented Reality Augmented Reality, Ingredients of an Augmented Reality Experience

**Unit 2: Augmented Reality Content and Interaction** **9 hours**
Content – Creating visual content – 3D objects – 2D images – Visual elements, Interaction in Augmented Reality –Interaction in Real World – Manipulation – Navigation –Multi Person Augmented Reality Application

**Unit 3: Introduction to Virtual reality** **9 hours**
The three I's of virtual reality - Commercial VR technology and the Five Classic Components of a VR System - Input Devices: (Trackers, Navigation, and Gesture Interfaces): Three-dimensional Position Trackers, Navigation and Manipulation-Interfaces and Gesture interfaces-Output Devices: Graphics Displays-Sound Displays & Haptic feedback.

**Unit 4: VR Development Process** **9 hours**
Geometric modeling - kinematics modeling- physical modeling - behaviour modeling - model Management.

**Unit 5: Applications** **9 hours**
Medical applications-Military Applications - Robotics Applications- Advanced Real Time Tracking- Other applications- Games, Movies, Simulations, Therapy

**Text Books**

1. C. Burdea & Philippe Coiffet, "Virtual Reality Technology", Second Edition, Gregory, John Wiley & Sons, Inc.,2008
2. *Jason Jerald, The VR Book: Human-Centred Design for Virtual Reality. Association for Computing Machinery and Morgan & Claypool, New York, NY, USA., 2015*

**Reference Books**

1. Dieter Schmalstieg & Tobias Hollerer, Augmented Reality: Principles and Practice (Usability) by Pearson Education (US), Addison-Wesley Educational Publishers Inc, New Jersey, United States, 2016.
2. Steve Aukstakalnis, Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR (Usability), Addison-Wesley Professional; 1 edition, 2016.

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 50 | 50 |
| L2 | 50 | 50 |
| Total (%) | 100 | 100 |

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## MI 20CSM01 E-Commerce 3 0 0 3.0

At the end of the course, students will be able to

| Code | Course Outcomes | Mapping withPOs | DoK |
|---|---|---|---|
| 20CSM01.1 | Explain the role of new internet economy in E-Commerce | - | L1,L2 |
| 20CSM01.2 | Explain the architecture of World Wide Web | | L1,L2 |
| 20CSM01.3 | Describe the E-Commerce process models and E-Payment System | | L1,L2 |
| 20CSM01.4 | Illustrate the network models in customization and internal commerce | | L1,L2 |
| 20CSM01.5 | Explain the E-commerce models in advertising and marketing of business | | L1,L2 |
| 1. Weakly Contributing \| 2. Moderately Contributing \| 3. Strongly Contributing, for the attainment of respective Pos | | | |
| L1: Remember \| L2: Understand \| L3: Apply \| L4: Analyze \| L5: Evaluate \| L6: Create. DoK: Depth of Knowledge | | | |

**Unit I:Introduction** **9 hours**

Electronic Commerce- Architectural Frame work, anatomy of E-commerce applications, E-Commerce consumer applications, E-commerce organization applications

*E-Commerce and media convergence*

**Unit II: World Wide Web & Network security** **9 hours**

Client-Server Network security, World Wide Web(WWW) as the architecture, Web background: Hypertext Publishing, Technologybehind the web, Security and the web

*Emerging Client-Server Security Threats*

**Unit III: E-Payment Systems** **9 hours**

Consumer Oriented Electronic Commerce- Mercantile Process models, E-Payment systems- Digital Token-Based, smart cards, credit cards, risk and E-Payment systems.

*Designing E-Payment Systems*

**Unit IV:EDI Implementation and Intraorganizational E-Commerce** **9 hours**

Standardization and EDI, EDI Software implementation, Value added networks, Intra organizational E-Commerce- Workflow Automation and Coordination, Customization and Internal Commerce, Supply chain management (SCM).

*EDI Envelope for Message Transport*

**Unit V: Advertising and Marketing on the Internet** **9 hours**

Corporate Digital Library- Document Library, digital document types, corporate data warehouses, Advertising and marketing-Information based marketing, Advertising on Internet, online marketing process, market research.

*Charting the Online Marketing Process*

**Text Books**

1. Ravi Kalakota and Andrew B. Whinston., “Frontiers of electronic commerce”, First Edition, Pearson Education ,2011
2. Jaiswal S.,“ E-Commerce”, Second Edition,Galgotia,2010

**Reference Books**

1. Dave Chaffey., “E-business & E- commerece management- strategy, implementation and Practice”, Fifth edition, Pearson Education, 2015.
2. Kenneth C, “E-Commerce: Business.Technology.Society”, First Edition, Pearson Education, 2008

**Web References**

1. https://www.techopedia.com/definition/18226/corporate-data-warehouse-cdw
2. http://ecmrce.blogspot.com
3. http://data.conferenceworld.in

**Internal Assessment Pattern**

| CognitiveLevel | Internal Assessment #1(%) | Internal Assessment #2(%) |
|---|---|---|
| L1 | 50 | 50 |
| L2 | 50 | 50 |
| Total (%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive LevelsL1: Remember**

1. Write any four important E-Commerce organization Applications
2. Write about any four requirements of EDI
3. Write short notes on Risks in E-Payment systems
4. Write short notes on Market research
5. What are the factors for design of electronic payment system?

**L2: Understand**

1. How enterprise resource planning and supply chain management software differs in their goals and implementations
2. How product or service customization is adopted in intraorganizational commerce?
3. Explain Merchantile's model from the Merchant's perceptive
4. Explain in detail about E-Payment systems
5. Discuss about mercantile transaction using credit cards

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**Board of Studies (CSE)**

MI 20MEM01 Biomaterials **3 0 0 3**

At the end of the course, students will be able to

| Code | Course Outcomes | Mapping withPOs | DoK |
|---|---|---|---|
| 20MEM01.1 | Classify various biomaterials | - | L1,L2 |
| 20MEM01.2 | Identify the Metallic implant materials | | L1,L2, L3 |
| 20MEM01.3 | Describe the failure modes of implant materials | | L1,L2 |
| 20MEM01.4 | Apply Ceramic implant materials | | L1,L2, L3 |
| 20MEM01.5 | Develop the Biocompatibility & Toxicological properties in of biomaterials | | L1,L2, L3 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective POs
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create,DoK: Depth of Knowledge

**Unit I: Introduction** **09 Hours**

Definition of biomaterials, requirements & classification of biomaterials, Comparison of properties of some common biomaterials. Effects of physiological fluid on the properties of biomaterials. Biological responses (extra and intra- vascular system). Surface properties of materials.

*physical properties of materials, mechanical properties.*

**Unit II: Metallic implant materials** **09 Hours**

Stainless steel, Co-based alloys, Ti and Ti-based alloys. Importance of stress-corrosion cracking. Host tissue reaction with bio metal, corrosion behavior and the importance of passive films for tissue adhesion. Hard tissue replacementimplant: Orthopedic implants, Dental implants. Soft tissue replacement implants: Percutaneous and skin implants.

*Vascular implants, Heart valve implants-Tailor made composite in medium.*

**Unit III: Polymeric implant materials** **09 Hours**

Polyolefin's, polyamides, acrylic polymers, fluorocarbon polymers, silicon rubbers, acetyls. (Classification according to thermo sets, thermoplastics and elastomers).Viscoelastic behavior: creep-recovery, stress-relaxation, strain rate sensitivity. Importance of molecular structure, hydrophilic and hydrophobic surface properties, migration of additives (processing aids), aging and environmental stress cracking. Physiochemical characteristics of biopolymers. Biodegradable polymers for medical purposes, Biopolymers in controlled release systems.

*Synthetic polymeric membranes and their biological applications.*

**Unit IV: Ceramic implant materials** **09 Hours**

Definition of bio ceramics. Common types of bio-ceramics: Aluminum oxides, Glass ceramics, Carbons. Bio resorbable and bioactive ceramics. Importance of wear resistance and low fracture toughness. Host tissue reactions: importance of interfacial tissue reaction (e.g. ceramic/bone tissue reaction).

Composite implant materials: Mechanics of improvement of properties by incorporating different elements. Composite theory of fiber reinforcement (short and long fibers, fibers pull out).

*Polymers filled with osteogenic fillers (e.g. hydroxyapatite). Host tissue reactions.*

**Unit V: Biocompatibility & Toxicological screening of biomaterials** **09 Hours**

Definition of biocompatibility, blood compatibility and tissue compatibility. Toxicity tests: acute and chronic toxicity studies (in situimplantation, tissue culture, haemolysis, thrombogenic potential test, systemic toxicity, intracutaneous irritation test), sensitization.

*carcinogenicity, mutagenicity and special tests.*

**Text Books**

1. Biomaterials Science: An Introduction to Materials in Medicine, By Buddy D. Ratner, et. al. AcademicPress, San Diego, 1996.
2. Sujata V. Bhat, Biomaterials, Narosa Publishing House, 2002.
3. J B Park, Biomaterials – Science and Engineering, Plenum Press, 1984.
4. Comprehensive structural interity, Vol.9: Bioengineering Editors: Mithe, Ritchie and Karihalo, ElsevierAcademic Press, 2003.

**Reference Text books**

1. Biomaterials Science: An introduction to Materials in Medicine, Edited by Ratner, Hoffman, Schoet and Lemons, Second Edition: Elsevier Academic Press, 2004.

**Web References**

1. https://nptel.ac.in/content/syllabus_pdf/113104009.pdf
2. RBM603 BIOMATERIALS Syllabus free download
3. UP Technical University BE BM Syllabus
4. RBM603 Syllabus, BM Unit-wise Syllabus – BE 6th Semester

**Internal Assessment Pattern**

| CognitiveLevel | InternalAssessment#1(%) | InternalAssessment#2(%) |
|---|---|---|
| L1 | 10 | 10 |
| L2 | 30 | 30 |
| L3 | 60 | 60 |
| Total(%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

1. Write about classification of biomaterials?
2. State the applications of biomaterials?
3. List the advantages and disadvantages biomaterials?
4. Write about Effects of physiological fluid on the properties of biomaterials?
5. Define Importance of stress-corrosion cracking?

**L2: Understand**

1. Surface properties of materials
2. Comparison of properties of some common biomaterials
3. Corrosion behavior and the importance of passive films for tissue adhesion
4. Visco elastic behavior: creep-recovery, stress-relaxation, strain rate sensitivity

**L3: Apply**

1. Mechanics of improvement of properties by incorporating different elements. Composite theory of fiber reinforcement (short and long fibers, fibers pull out). Polymers filled with osteogenic fillers (e.g. hydroxyapatite). Host tissue reactions

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**MI 20EEM01 Basic Control Systems** **3 0 0 3**

At the end of the course, students will be able to

| Code | Course Outcomes | Mapping with PO's | DoK |
|---|---|---|---|
| 20EEM01.1 | Determine time response specifications of second order systems | | L1-L2 |
| 20EEM01.2 | Determine error Constants for different types of input signals | | L1-L2 |
| 20EEM01.3 | Understand various levels of illuminosity produced by differentilluminating sources. | | L1-L3 |
| 20EEM01.4 | Design different lighting systems by taking inputs and constraints in view for different layouts. | | L1-L3 |
| 20EEM01.5 | Understand the speed/time characteristics of different types oftraction motors. | | L1-L3 |
| 1. Weakly Contributing \| 2. Moderately Contributing \| 3. Strongly Contributing, for the attainment of respective Pos | | | |
| L1: Remember \| L2: Understand \| L3: Apply \| L4: Analyze \| L5: Evaluate \| L6: Create, DoK:Depth of Knowledge | | | |

**Unit I: Introduction to Control Systems** **09 Hours**

Classification of control systems, open loop and closed loop control systems and their differences, Feedback characteristics, transfer function of linear system, differential equations of electrical networks, translational and rotational mechanical systems

*Differences between Closed loop and Open Loop Control Systems*

**Unit II: Time Response Analysis** **09 Hours**

Standard test signals time response of first and second order systems time domain specifications, steady state errors and error constants

*Definitions of Time domain Specifications*

**Unit III: Stability** **09 Hours**

The concept of stability, Routh's stability criteria – Limitations of Routh's stability, effect of addition of poles and zeros, introduction to root locus.

*Basics of Routh's Criteria*

**Unit IV: Frequency response** **09 Hours**

Introduction to frequency domain specifications, basics of bode plot, Phase margin, Gain Margin. Introduction to Polar plots, its phase margin and gain margin. Introduction to Nyquist stability criteria

*Definitions of Frequency domain Specifications*

**Unit V: State Space Analysis** **09 Hours**

Concepts of state, state variables and state model, state space representation of transfer function, diagonalization, solving the time invariant state equations, State Transition Matrix and its Properties, concepts of controllability and observability.

*Basics of Matrix operations*

**Text Books**

1. I.J.Nagarath and M.Gopal, "Control Systems Engineering", Newage International Publications, 5th Edition, 2014.
2. Kotsuhiko Ogata, Modern Control Engineering, Prentice Hall of India, 5th edition, 2014

**Reference Books**

1. S.Palani, "Control Systems Engineering", Tata Mc Graw Hill Publications, 3rd Edition, 2012.

**Web References**

1. https://nptel.ac.in/courses/107/106/107106081/
2. https://www.tutorialspoint.com/control_systems/control_systems_introduction.htm

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1(%) | Internal Assessment #2(%) |
|---|---|---|
| L1 | 30 | 30 |
| L2 | 40 | 30 |
| L3 | 30 | 40 |
| Total (%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive LevelsL1: Remember**

1. What are the various standard test signals?
2. Define concept of observability.
3. What is state transition matrix? Write its properties.

**L2: Understand**

1. Explain how Routh Hurwitz criterion can be used to determine the absolute stability of a system
2. Explain about feedback characteristics.
3. Describe the effect of addition of poles and zeros.

**L3: Apply**

1. The characteristic polynomial of a system is.$s^5+2s^6+3s^5+s^4+5s^3+2s^2+s+7=0$. Determine the the stability of thesystem using Routh's stability criteria.
2. Determine range of K for stability of unit feedback system whose open loop transfer function is G(s) = K/s(s+1)(s+2).
3. For a system having G(s) = 25/s(s+10) and units negative feedback, find its time response specifications.

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## MI 20ECM01 Semiconductor Devices and Circuits 3 0 0 3

At the end of the course, students will be able to

| Code | Course Outcomes | Mapping with POs | DoK |
|---|---|---|---|
| 20ECM01.1 | Classify different types of semiconductors with energy band diagrams | - | L1, L2 |
| 20ECM01.2 | Explain the operation and characteristics of PN junction diode and special diodes | | L1, L2 |
| 20ECM01.3 | Classify and Analyze different types of rectifiers | | L1, L2, L3 |
| 20ECM01.4 | Demonstrate the flow of current in different configurations of the transistor & the concept of DC biasing and transistor stabilization | | L1, L2, L3 |
| 20ECM01.5 | Analyze and Design the small signal low frequency amplifiers | | L1, L2, L3 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create. DoK: Depth of Knowledge

**Unit I: Semiconductor Physics** **09 Hours**

Atomic structure, Neil Bohr's atomic theory, definition of conductors, insulators and semiconductors, energy level diagrams. Semiconductors: Classification and types, intrinsic and extrinsic, P-type and N-type semiconductors, majority and minority carriers, recombination, effect of temperature.

*Fermi Level, Charge Densities in Semiconductors*

**Unit II: Semiconductor Diodes and Special Diodes** **09 Hours**

Formation of depletion region, barrier potential, reverse breakdowns, PN junction as diode, symbol, biasing modes, V-I characteristics, diode current equation, effect of temperature on diode current, ideal diode. Special Diodes: Zener diode, Photo Diode, LED - Working, characteristics and applications.

*Diode Switching times, Varactor diode, Tunnel Diode*

**Unit III: Rectifiers and Filters** **09 Hours**

Half wave Rectifier, Full wave rectifier, Bridge Rectifier - Operation, Input and output wave forms. Filters: Inductor filter, Capacitor filter, π filter, Comparison of various filter circuits in terms of ripple factors.

*LC filter, Multi section π filter*

**Unit IV: Transistors and Biasing Techniques** **09 Hours**

Junction transistor, Transistor current components, Transistor configurations, Transistor as an amplifier, characteristics of transistor in CB and CE configurations. Need for biasing, operating point, Load line analysis, fixed bias and self bias, Stabilization against variations in VBE, Ic, and β, Stability factor, Thermistor and Sensistor bias compensation techniques, Thermal runaway.

*Ebers-Moll model of a transistor, Punch through/reach through, Thermal stability*

**Unit V: Small Signal Low Frequency Transistor Amplifier Models** **09 Hours**

**BJT:** Two port network, Transistor hybrid model, Determination of h-parameters, Generalized analysis of transistor amplifier model using h-parameters, Exact and approximate analysis of CB and CE amplifiers, Comparison of transistor amplifiers.

*Effects of emitter bypass capacitor ($C_e$) on low frequency response*

**Textbooks**


1. Lal Kishore K., "Electronic Devices and Circuits", 4th Edition, Bright Sky Publications, 2016
2. Millman J. and Christos C. Halkias, "Electronic Devices and Circuits", 4th Edition, Tata Mc-Graw Hill, 2010
3. David A. Bell, "Electronic Devices and Circuits", 5th Edition, Oxford University Press, 2009
4. Boylestad R. L. and Louis Nashelsky, "Electronic Devices and Circuits", 10th Edition, Pearson Publications,2009

**Reference Books**


1. Salivahanan S., Suresh Kumar and Vallavaraj N. A., "Electronic Devices and Circuits", 2nd Edition, Tata Mc-Graw Hill, 2012
2. Donald A. Neamen, "Electronic Circuit Analysis and Design", 3rd Edition, Tata McGraw Hill, 2010
3. Millman J. and Halkias C., "Integrated Electronics", 2nd Edition, Tata Mc-Graw Hill, 2009
4. Singh B. P. and Rekha, "Electronic Devices and Integrated Circuits", 3rd Edition, Pearson publications, 2009
5. Mittal G. K., "Electronic Devices and Circuits", 3rd Edition, Khannan Publishers, 2008


**Web Resources**

1. www.elprocus.com/p-n-junction-diode-theory-and-working/
2. http://fourier.eng.hmc.edu/e84/lectures/ch4/node3.html
3. http://nptel.ac.in/courses/117103063/11

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 40 | 35 |
| L2 | 40 | 35 |
| L3 | 20 | 30 |
| Total (%) | 100 | 100 |

Sample Short and Long Answer Questions of Various Cognitive Levels

**L1: Remember**

1. Define Semiconductor
2. What is ideal diode?
3. List any three applications of Zener diode
4. What is rectifier?
5. Define ripple factor
6. What is BJT?
7. What is thermal runaway?
8. Define stability

**L2: Understand**

1. Describe the formation of P type semiconductor
2. Draw and explain V-I characteristics of PN junction diode
3. Describe the construction and operation of Photo diode
4. With neat circuit diagram describe the operation of bridge rectifier
5. Explain, why Zener diode is used in reverse bias with the help of characteristics
6. Draw and explain the input and output Characteristics of Common base configuration
7. With neat sketches explain the V-I characteristics of NPN transistor in common emitter configuration
8. Write a short note on Thermal Runaway
9. Explain thermister compensation technique

**L3: Apply**

1. Show that the efficiency of half wave rectifier is 40.6%
2. Show that the efficiency of full wave rectifier is 81.2%
3. Obtain an expression of stability factor for fixed bias
4. With suitable expressions explain self bias of BJT
5. Obtain the expressions for voltage gain and current gain of small signal low frequency common emitter amplifier

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## MI 20AIM01 Fundamentals of Neural Networks 3 0 0 3

At the end of the course, students will be able to

| Code | Course Outcomes | Mapping with POs | DoK |
|---|---|---|---|
| 20AIM01.1 | Describe the concepts of artificial neural networks | - | L1, L2 |
| 20AIM01.2 | Compare functions of biological and artificial neural networks | | L1, L2 |
| 20AIM01.3 | Explain the architecture and functioning of Single Layer feed forward networks | | L1, L2 |
| 20AIM01.4 | Describe architecture and functioning of Multi-layer networks | | L1, L2 |
| 20AIM01.5 | Explain associative memory networks | | L1, L2 |
| L1: Remember \| L2: Understand \| L3: Apply \| L4: Analyze \| L5: Evaluate \| L6: Create. DoK: Depth of Knowledge | | | |

**Unit 1: Introduction to Neural Networks** **9 hours**

Introduction - Humans and Computers - Organization of the Brain – Biological Neuron - Biological and Artificial Neuron Models - Characteristics of ANN - McCulloch-Pitts Model - Historical Developments - Potential Applications of ANN

**Unit 2: Essentials of ANN** **9 hours**

Artificial Neuron Model - Operations of Artificial Neuron - Types of Neuron Activation Function - ANN Architectures - Classification Taxonomy of ANN – Connectivity - Learning Strategy (Supervised, Unsupervised, Reinforcement) - Learning Rules

**Unit 3: Single Layer Feedforward Networks** **9 hours**

Introduction - Perceptron Models: Discrete - Continuous and Multi-Category - Training Algorithms: Discrete and ContinuousPerceptron Networks – Limitations of the Perceptron Model

**Unit 4: Multi - Layer Feedforward Networks** **9 hours**

Generalized Delta Rule - Derivation of Backpropagation (BP) Training - Summary of Backpropagation Algorithm - Kolmogorov Theorem, Learning Difficulties and Improvements

**Unit 5: Associative Memory Networks** **9 hours**

Paradigms of Associative Memory - Pattern Mathematics - Hebbian Learning - General Concepts of Associative Memory - Bidirectional Associative Memory (BAM) Architecture - BAM Training Algorithms: Storage and Recall Algorithm - BAM Energy Function

**Text Books**

1. S. N. Sivanandam, S. Sumathi, S. N. Deepa, "Introduction to Neural Networks Using MATLAB 6.0", Tata McGraw-HillCompanies, 2006
2. Simon Haykin, "Neural Networks: A Comprehensive Foundation", Second Edition, Pearson Education, Asia
3. James A. Freeman, David M. Skapura, "Neural Networks: Algorithms, Applications, and Programming Techniques", Addison-Wesley Publishing Company

**Reference Books**

1. B. YagnaNarayana, "Artificial Neural Networks", Prentice Hall India, 2013
2. Satish Kumar, "Neural Networks: A classroom approach", Tata McGraw Hill, 2004.
3. Laurene Fausett, "Fundamentals of Neural Networks", Pearson Education

**Web Resources**

1. https://www.tutorialspoint.com/artificial_neural_network/index.html

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 50 | 50 |
| L2 | 50 | 50 |
| Total (%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

5. Define Neural Computing
6. Define ANN and Neural Computing
7. List any 4 design parameters in the design of Artificial Neural Network
8. What kinds of transfer functions can be used in each layer?
9. Define Pattern Association
10. What is Adaline Model?
11. What are the types of Learning?
12. What is simple artificial neuron?
13. List any 4 applications of Artificial Neural Network
14. Define Delta Learning rule

**L2: Understand**

4. Describe on the process of assigning and updating weights in a artificial neural network
5. What are the design steps to be followed for using ANN for your problem?
6. Describe least square algorithm with example
7. Why XOR Problem cannot be solved by a single layer perceptron? Write an alternative solution for it
8. Explain Back Propagation Network with necessary diagrams and equations
9. Write the differences between Hetero Associative Memories and Interpolative Associative Memories

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**MI 20DSO03 Introduction to R Programming** **3 0 0 3.0**

At the end of the course, students will be able to

| Code | Course Outcomes | Mapping withPOs | DoK |
|---|---|---|---|
| 20DSO03.1 | Understand the basic concepts of R programming | - | L1, L2 |
| 20DSO03.2 | Understand about Scalars and Vectors | | L1, L2, |
| 20DSO03.3 | Implement Lists and data Frames | | L1, L2, L3 |
| 20DSO03.4 | Implement Tables and Statistical Distributions | | L1, L2 , L3 |
| 20DSO03.5 | Implement Functions in R programming | | L1, L2 |
| 1. Weakly Contributing \| 2. Moderately Contributing \| 3. Strongly Contributing, for the attainment of respective Pos | | | |
| L1: Remember \| L2: Understand \| L3: Apply \| L4: Analyze \| L5: Evaluate \| L6: Create DoK: Depth of Knowledge | | | |

**Unit I: Introduction** **9 Hours**

Overview of R, R data types and objects, reading and writing data, sub setting R Objects, Essentials of the R Language, Installing R, Running R, Packages in R, Calculations, Complex numbers in R, Rounding, Arithmetic, Modulo and integer quotients, Variable names and assignment, Operators, Integers, Factors, Logical operations

*Variable Scope & Default Arguments*

**Unit II: Control Structures And Vectors** **9 Hours**

Control structures, functions, scoping rules, dates and times, Introduction to Functions, preview of Some Important R Data Structures, Vectors, Character Strings, Matrices, Lists, Data Frames, Classes

Vectors: Generating sequences, Vectors and subscripts, Extracting elements of a vector using subscripts, Working with logical subscripts, Scalars, Vectors, Arrays, and Matrices, Adding and Deleting Vector Elements, Obtaining the Length of a Vector, Matrices and Arrays as Vectors Vector Arithmetic and Logical Operations, Vector Indexing, Common Vector Operations

*Higher-Dimensional Arrays*

**Unit III: Lists** **9 Hours**

Lists: Creating Lists, General List Operations, List Indexing Adding and Deleting List Elements, Getting the Size of a List, Extended Example: Text Concordance Accessing List Components and Values Applying Functions to Lists, Data Frames, Creating Data Frames, Accessing Data Frames, Other Matrix-Like Operations

Merging Data Frames

**Unit IV: Factors and Tables** **9 Hours**

Factors and Levels, Common Functions Used with Factors, Working with Tables, Matrix/Array-Like Operations on Tables

, Extracting a Sub table, Finding the Largest Cells in a Table, Math Functions, Calculating a Probability, Cumulative Sums and Products, Minima and Maxima, Calculus, Functions for Statistical Distributions

*Aaggregate () Function, Set Operations*

**Unit V: Functions** **9 Hours**

Scripts to Functions, Making the Script, Transforming the Script, Using the Function, Reduce the number of Lines, Adding more Arguments, Dots, Using Functions as Arguments, Crossing the Boarders, Choices with If-Else Statements, vectorizing Choices, Looping Through Values

*Coping and Scoping of Functions*

**Text Books**

1. Norman Matloff, " The Art of R Programming- A Tour of Statistical Software Design ", 2011
2. Roger D. Peng, " R Programming for Data Science " , 2012

**Reference Books**

1. Garrett Grolemund, Hadley Wickham, "Hands-On Programming with R: Write Your Own Functions andSimulations", 1st Edition, 2014
2. Andrie de Vries, Joris Meys, "R For Dummies", 2nd Edition, 2015

**Web References**

1. https://swayam.gov.in/nd1_noc19_ma33/preview
2. https://data-flair.training/blogs/object-oriented-programming-in-r/
3. http://www.r-tutor.com/elementary-statistics
4. https://www.tutorialspoint.com/r/

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 30 | 20 |
| L2 | 30 | 40 |
| L3 | 40 | 40 |
| Total (%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive LevelsL1: Remember**

1. Write about vectors in R
2. Write any three type conversions in R
3. What is a data structure in R?
4. Write any two Boolean operators in R
5. Write any two linear vector algebra operations

**L2: Understand**

1. Explain the importance of data frame
2. How to apply same functions to all rows and columns of a matrix? Explain with example
3. Explain about Finding Stationary Distributions of Markov Chains
4. Describe R functions for Reading a Matrix or Data Frame from a File
5. Explain different matrix operation function in R

**L3: Apply**

1. Implement binary search tree with R
2. Write R script to create a line graph
3. Create a R language code to generate first n terms of a Fibonacci series
4. Apply R program to implement quicksort
5. Apply R code to the function by using if else commandf(x) = x if
   x<1/2
   = (1-x) if 1/2<x<1
   = 0 otherwise

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## MI 20CEM02 Climate Change Mitigation and Adaptation 3 0 0 3

At the end of the course, students will be able to

| Code | Course Outcomes |
|---|---|
| 20CEM02.1 | Understand the concept of climate change scenarios |
| 20CEM02.2 | Outline the causes for the changes in the climate |
| 20CEM02.3 | Identify the impacts of climate change on various sectors |
| 20CEM02.4 | Adopt the methodologies in finding the changes in climate |
| 20CEM02.5 | Demonstrate the climate change adaptation and mitigation options for securing sustainable development |

**Unit I: Fundamentals of Climate Change** **9 Hours**

Greenhouse gases, radiative forcing potential, carbon dioxide equivalency, natural climate forcing factors, emissions sources and sinks

**Unit II: Observed Changes and its Causes** **9 Hours**

Observation of Climate Change – Changes in patterns of temperature, precipitation and sea level rise – Observed effects of Climate Changes – Patterns of Large Scale Variability – Drivers of Climate Change –-Evidences of Changes in Climate and Environment – on a Global Scale and in India.

**Unit III: Impacts of Climate Change** **9 Hours**

Impacts of Climate Change on various sectors – Agriculture, Forestry and Ecosystem – Water Resources – Human Health – Industry, Settlement and Society – Methods and Scenarios -Projected Impacts for Different Regions- Uncertainties in the Projected Impacts of Climate Change – Risk of Irreversible Changes.

**Unit IV: Clean Technology and Energy** **9 Hours**

Clean Development Mechanism -Carbon Trading- examples of future Clean Technology -Biodiesel – Natural Compost – Eco-Friendly Plastic – Alternate Energy – Hydrogen – Biofuels -Solar Energy – Wind – Hydroelectric Power.

**Unit V: Adaptation and Mitigation Responses** **9 Hours**

Policy, Climate Sensitivity and Feedbacks – The Montreal Protocol – UNFCCC – IPCC, Concept framework of urban adaptation to climate change, Mitigation Efforts in India and Adaptation funding.

### Text Books

1. Jan C. Van Dam, “Impacts of Climate Change and Climate Variability on Hydrological Regimes”, Cambridge University Press, 2003
2. Dash Sushil Kumar, “Climate Change – An Indian Perspective”, Cambridge University Press India Pvt. Ltd, 2007

### Reference Books

1. Pielke, R., “Lifting the taboo on adaptation”, Nature 445 (7128), 597-598, 2007
2. Bulkeley, H., “Cities and Climate Change”, Routledge, London, 2013

### Web References

1. IPCC Fourth Assessment Report – The AR4 Synthesis Report
2. https://www.coursera.org/learn/climate-change-mitigation
3. https://www.usc.edu.au/study/courses-and-programs/courses/course-library/ens/ens204-climate-change-mitigation-and-adaptation

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## MI 20CSM02 Knowledge Discovery and Databases 3 0 0 3

At the end of the course, students will be able to

| Code | Course Outcomes |
|---|---|
| 20CSM02.1 | Illustrates the basic concepts of database management system |
| 20CSM02.2 | Able to summarize mining and preprocessing of data |
| 20CSM02.3 | Outline the functionalities of data mining(characterization) |
| 20CSM02.4 | Able to explain the processes of association analysis |
| 20CSM02.5 | Illustrate the features of various clustering techniques |

### Unit I: Introduction to Database and Data Warehouse 9 Hours

Overview of Data, What is Database and What is Database Management Base System, Meaning of Entity, Relation, Database Design and ER diagrams, Attributes, DMBS Software's available in Market, Structured Query Language (SQL)
What is Data Warehouse, Types of Data Warehouse, On-Line Analytical Processing (OLAP)

### Unit II: Data Mining Introduction 9 Hours

Introduction to Data Mining Systems, Knowledge Discovery Process, Data Mining Techniques, Issues, Data Objects and Attribute Types, Statistical Description of Data, Data Preprocessing – Cleaning, Integration, Reduction, Transformation and Discretization, Data Visualization

### Unit III: Classification 9 Hours

Introduction and Basic Concepts of Classification, What is Training Data, Supervisory Learning and Unsupervisory Learning. Decision Tree Induction, Working of Decision Tree and Building a Decision Tree, Bayes' Theorem, Classification by Back Propagation

### Unit IV: Association 9 Hours

What is Association Analysis, Frequent Item Set Generation, Association Rule Generation using Apriori Algorithm.

### Unit V: Clustering and Outlier Analysis 9 Hours

What is Cluster Analysis, Different Types of Clusters, Partition Method – K-Means Algorithm, Hierarchical Methods – Hierarchical Cluster Algorithm, Density Based Method- DBSCAN and Outlier Analysis, What is Outlier Analysis?

Practicing Tool: SQL, Weka, Python and R

### Text Books

1. Raghurama Krishnan, Johannes Gehrke, "Data base Management Systems", Third Edition, TATA McGraw Hill, 2008.
2. Jiawei Han and MichelineKamber, "Data Mining Concepts and Techniques", Third Edition, Elsevier, 2012.
3. Pang-Ning Tan, Michael Steinbach and Vipin Kumar, "Introduction to Data Mining", Pearson,2016

### Reference Books

1. Alex Berson, Stephen J.Smith, —"Data Warehousing, Data Mining & OLAPII", Tata McGraw – Hill Edition, 35th Reprint 2016.
2. K.P. Soman, ShyamDiwakar and V. Ajay, — "Insight into Data Mining Theory and PracticeII", Eastern Economy Edition, Prentice Hall of India, 2006.
3. Ian H.Witten, Eibe Frank, — "Data Mining: Practical Machine Learning Tools and Techniques", Second Edition, Elsevier.

**Web Resources**

1. https://www.tutorialspoint.com/
2. https://www.coursera.org/learn/

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## MI 20MEM02 Micro Electromechanical Systems 3 0 0 3.0

At the end of the course, students will be able to

| Code | Course Outcomes | DoK |
|---|---|---|
| 20MEM02.1 | Acquire the operation of micro devices, micro systems and their applications | L1, L2 |
| 20MEM02.2 | Ability to design the micro devices, micro systems using the MEMS fabrication process. | L2 |
| 20MEM02.3 | Acquire basic approaches for various sensor design | L2 |
| 20MEM02.4 | Acquire basic approaches for various actuator design | L2 |
| 20MEM02.5 | Gain the technical knowledge required for computer-aided design, fabrication, analysis and characterization of nano-structured materials, micro- and nano-scale devices. | L2, L3 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective POs
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create, DoK: Depth of Knowledge

### Unit I: Basic Concepts 11+1 Hours

Definition of MEMS, MEMS history and development, micro machining, lithography principles & methods, structural and sacrificial materials, thin film deposition, impurity doping, etching, surface micro machining, wafer bonding, LIGA. MECHANICAL SENSORS AND ACTUATORS: Principles of sensing and actuation: beam and cantilever, capacitive, piezo electric, strain, pressure, flow, pressure measurement by micro phone, MEMS gyroscopes, shear mode piezo actuator, gripping piezo actuator, Inchworm technology..

### Unit II: Thermal Sensors And Actuators 11+1 Hours

Thermal energy basics and heat transfer processes, thermisters, thermo devices, thermo couple, micro machined thermo couple probe, peltier effect heat pumps, thermal flow sensors, micro hot plate gas sensors, MEMS thermo vessels, pyro electricity, shape memory alloys (SMA), U-shaped horizontal and vertical electro thermal actuator, thermally activated MEMS relay, micro spring thermal actuator, data storage cantilever.

### Unit III: Micro-Opto-Electro Mechanical Systems 11+1 Hours

Principle of MOEMS technology, properties of light, light modulators, beam splitter, micro lens, micro mirrors, digital micro mirror device (DMD), light detectors, grating light valve (GLV), optical switch, wave guide and tuning, shear stress measurement.
MAGNETIC SENSORS AND ACTUATORS: Magnetic materials for MEMS and properties, magnetic sensing and detection, magneto resistive sensor, more on hall effect, magneto diodes, magneto transistor, MEMS magnetic sensor, pressure sensor utilizing MOKE, mag MEMS actuators, by directional micro actuator, feedback circuit integrated magnetic actuator, large force reluctance actuator, magnetic probe based storage device

### Unit IV: Micro Fluidic Systems 11+1 Hours

Applications, considerations on micro scale fluid, fluid actuation methods, dielectro phoresis (DEP), electro wetting, electro thermal flow, thermo capillary effect, electro osmosis flow, opto electro wetting (OEW), tuning using micro fluidics, typical micro fluidic channel, micro fluid dispenser, micro needle, molecular gate, micro pumps.
RADIO FREQUENCY (RF) MEMS:RF – based communication systems, RF MEMS, MEMS inductors, varactors, tuner/filter, resonator, clarification of tuner, filter, resonator, MEMS switches, phase shifter.

### Unit V: Chemical And Bio Medical Micro Systems 11+1 Hours

Sensing mechanism & principle, membrane-transducer materials, chem.-lab-on-a-chip (CLOC) chemo resistors, chemo capacitors, chemo transistors, electronic nose (E-nose), mass sensitive chemo sensors, fluorescence detection, calorimetric spectroscopy

### Text Books

1. Nitaigour Premchand Mahalik, “MEMS” TMH Publishing co.

### Reference Books

1. Chang Liu ,”Foundation of MEMS”, Prentice Hall Ltd.
2. Sergey Edwrd Lyshevski, “MEMS and NEMS”, CRC Press, Indian Edition.
3. Tai-Ran Hsu, “MEMS and Micro Systems: Design and Manufacture”, TMH Publishers.
4. Thomas M Adams, “Richard A Layton Introductory MEMS”, Springer International Publishers.

**Web References**

1. https://nptel.ac.in/courses/117/105/117105082/

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## MI 20EEM02 Basics of Electrical Machines and Drives 3 0 0 3.0

At the end of the course, students will be able to

| Code | Course Outcomes |
|---|---|
| 20EEM02.1 | Understand the basic concepts of different types of electrical drives |
| 20EEM02.2 | Able to explain the performance characteristics of electrical drives |
| 20EEM02.3 | Study the different methods of starting D.C motors and induction motors |
| 20EEM02.4 | Study the conventional and solid-state D.C. drives |
| 20EEM02.5 | Study the conventional and solid-state A.C. drives |

**Unit I: Introduction** **12 Hours**

Basic Elements – Types of Electric Drives – factors influencing the choice of electrical drives – heating and cooling curves – Loading conditions and classes of duty – Selection of power rating for drive motors with regard to thermal overloading and Load variation factors

*Power electronics, power calculations*

**Unit II: Drive Motor Characteristics** **12 Hours**

Mechanical characteristics – Speed-Torque characteristics of various types of load and drive motors – Braking of Electrical motors – DC motors: Shunt, series and compound – single phase and three phase induction motors

*Principle And Operation of DC Motors And Induction Motors.*

**12 Hours**

**Unit III: Starting Methods**

Types of D.C Motor starters – Typical control circuits for shunt and series motors – Three phase squirrel cage and slip ring induction motors

*Types Of Motors and Starter Operation*

**Unit IV: Conventional and Solid State Speed Control of D.C. Drives** **12 Hours**

Speed control of DC series and shunt motors – Armature and field control, Ward-Leonard control system – Using controlled rectifiers and DC choppers –applications.

*Speed Control Methods - Field Control And Armature Control*

**Unit V: Conventional and Solid State Speed Control of A.C. Drives** **12 Hours**

Speed control of three phase induction motor – Voltage control, voltage / frequency control, slip power recovery scheme Using inverters and AC voltage regulators – applications

*Power Electronics Converters and Operation*

### Textbooks

1. Nagrath .I.J. & Kothari .D.P, “Electrical Machines”, Tata McGraw-Hill, 2006
2. Vedam Subrahmaniam, “Electric Drives (Concepts and Applications)”, Tata McGraw-Hill, 2010

### Reference Books

1. Partab. H., “Art and Science and Utilisation of Electrical Energy”, Dhanpat Rai and Sons, 2017
2. Pillai.S.K “A First Course on Electric Drives”, Wiley Eastern Limited, 2012
3. Singh. M.D., K.B.Khanchandani, “Power Electronics”, Tata McGraw-Hill, 2006.

### Web References

1. https://link.springer.com/book/10.1007/978-3-319-72730-1

2. https://www.routledge.com/Electrical-Machine-Drives-Fundamental-Basics-and Practice/Franchi/p/book/9781138099395

## Internal Assessment Pattern

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 40 | 40 |
| L2 | 60 | 60 |
| Total (%) | 100 | 100 |

## Sample Short and Long Answer Questions of Various Cognitive Levels

**L1: Remember**

1. Define Electric Drives
2. Name the basic elements of Electric Drives
3. Write the classification of Electric Drives
4. Give the necessity of power rating
5. What happens if the motor is selected at highest load handling capacity at continuous duty variable?
6. What is short time rating?

**L2: Understand**

1. Describe the method of estimating equivalent continuous power rating of a motor for short time load applications
2. Explain the advantages of electrical drives
3. Discuss about overload current capability of motor

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## MI 20ECM02 Digital Electronics 3 0 0 3

**Pre- Requisite:** Semiconductor Devices and Circuits

At the end of the course, students will be able to

| Code | Course Outcomes |
|---|---|
| 20ECM02.1 | Utilize theory of Boolean algebra & the underlying features of various number systems |
| 20ECM02.2 | Choose the concepts of Boolean algebra for the minimization of switchingfunctions |
| 20ECM02.3 | Design of various combinational logic circuits using basic gates |
| 20ECM02.4 | Design various simple programmable logic devices to complexprogrammable logic devices & arrays |
| 20ECM02.5 | Develop of various sequential logic circuits |

*Half adder and full adder*

### Text Books

1. Taub, H. and Schilling, D., "Digital Integrated Electronics", McGraw Hill, 1977
2. Hodges, D. A. and Jackson, H. G., "Analysis and Design of Digital Integrated Circuits", International Student Edition, McGraw Hill, 1983
3. Hill, F. J. and Peterson, G. L., "Switching Theory and Logic Design", John Wiley, 1981
4. Anand Kumar, A., "Switching Theory and Logic Design", 3rd Edition, PHI Learning, 2016

### Reference Books

1. Kohavi, Z., "Switching and Finite Automata Theory", McGraw Hill,1970
2. Jain, R. P., "Modern Digital Electronics", 3rd Edition, Tata McGraw Hill, 2003
3. Charles Roth, H. and Larry Kinney, L. Jr., "Fundamentals of Logic Design", 7th Edition, Cengage Learning, 2014

### Web References

1. https://onlinecourses.nptel.ac.in/noc19_ee51/preview
2. https://nptel.ac.in/courses/117/105/117105080/
3. https://gate.iitkgp.ac.in/gate_syllabus.html
4. https://www.ee.iitb.ac.in/web/academics/courses/EE221

### Internal Assessment Pattern

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 33 | 33 |
| L2 | 33 | 33 |
| L3 | 34 | 34 |
| Total (%) | 100 | 100 |

### Sample Short and Long Answer Questions of Various Cognitive Levels

### L1: Remember

1. State De-Morgan's theorem and mention its use.
2. Define 'Minterm' and ' Maxterm'.
3. State Distributive law and Duality principle.
4. Define Flip-Flop.

### L2: Understand

1. Why totem pole outputs cannot be connected together?
2. How to connect NAND gates to get an AND gate and OR gate?
3. Explain the terms Prime Implicant and Essential prime implicants.

4. Explain the working of 8:1 MUX with the help of a combinational logic circuit.

**L3: Apply**

1. Express the function Y= A+ BC in canonical POS.
2. Simplify the following Boolean expression into one literal. W'X(Z'+YZ) + X(W+Y'Z).
3. Convert $(115)_{10}$ and $(235)_{10}$ into hexadecimal numbers.
4. Convert the given decimal numbers to their binary equivalent 108.364, 268.025.

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## MI 20AIM02 Machine Learning with Python 3 0 0 3

At the end of the course, students will be able to

| Code | Course Outcomes<br>At the end of the course, the students will be able to |
|---|---|
| 20AIM02.1 | Solve simple computational problems with python |
| 20AIM02.2 | Identify and use appropriate functions to handle data in python code |
| 20AIM02.3 | Describe the foundational concepts and terminologies of machine learning |
| 20AIM02.4 | Explain various unsupervised learning algorithms |
| 20AIM02.5 | Evaluate the performance of the machine learning algorithm |

**Unit 1: Basics of Python Programming** **9 hours**
Introduction to Python: evolution, features – Python IDE installation – Syntax – Comments – Variables – Data types – Numbers – Strings – Booleans – Operators – Control statements – Data structures: lists, dictionary, tuples, sets, arrays – Functions

**Unit 2: Python modules for ML** **9 hours**
NumPy – Pandas – SciPy – MatPlotLib

**Unit 3: Introduction to Machine Learning** **9 hours**
Machine Learning essentials: data set, mean, median, mode, standard deviation, percentile, data distribution, normal distribution – Types of learning: supervised, unsupervised – Supervised learning: classification and regression – Classification algorithms: KNN, Naïve Bayes classifier, Decision trees, Linear models, SVM

**Unit 4: Unsupervised Learning and Pre-processing** **9 hours**
Types of unsupervised learning – Challenges in unsupervised learning – Pre-processing and Scaling – Dimensionality reduction: Principal Component Analysis – Clustering: k-means, agglomerative, DBSCAN

**Unit 5: Data representation and Model evaluation** **9 hours**
Categorical variables: one-hot encoding – Binning – Discretization – Automatic feature selection – Model evaluation: cross-validation – Grid search – Evaluation metrics and scoring

**Text Books**

1. Andreas C. Miller and Sarah Guido, "Introduction to Machine Learning with Python – A guide for Data Scientist", O.Reilly Publisher, 1st edition, 2016
2. Peter Flach, "Machine Learning – The art and science of algorithms that make sense of data", Cambridge Press, 2012
3. Tom Michell, "Machine Learning", McGraw Hill, 2014

**Reference Books**

1. Peter Harington, "Machine Learning in Action", Cengage Publications, 2012
2. Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar "Foundations of Machine LearningII, MIT Press, 2012

**Web Resources**

1. https://www.tutorialspoint.com/python
2. https://www.w3schools/python

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 20 | 30 |
| L2 | 20 | 40 |
| L3 | 60 | 30 |
| Total (%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

1. Define data set
2. List any 4 types of data
3. What are tuples? Give examples
4. What are dictionaries? Give examples
5. Define classification
6. Define clustering
7. What is regression?
8. What is cross-validation?
9. What is meant by training?
10. Define testing

**L2: Understand**

1. Describe the overall process involved in supervised learning
2. Explain liner regression with appropriate example
3. Explain decision tree algorithm
4. Describe the unsupervised learning process
5. Explain about any 2 dimensionality reduction techniques

**L3: Applying**

1. Write a python script to illustrate use of for loop
2. Write a python script to print prime numbers within the given range
3. Write a python script to illustrate the use of NumPy functions
4. Write a python script to add 2 matrices
5. Write python script to illustrate the use of MatPlotLib functions

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## MI 20DSM02 Data Management and Analysis 3 0 0 3

At the end of the course, students will be able to

| Code | Course Outcomes |
|---|---|
| 20DSM02.1 | Understand database and be familiar with relational database concepts |
| 20DSM02.2 | Demonstrate knowledge of terms, methods of ER Modelling |
| 20DSM02.3 | Demonstrate knowledge of trends in data management in Entity Clustering |
| 20DSM02.4 | Demonstrate how to acquire, transform, analyse in SQL |
| 20DSM02.5 | Demonstrate how to solve problems in accounting using Transactions |

**Unit I: Database Concepts and Design Concepts** **9 Hours**

Why Databases? Data Versus Information, Why Database Design is Important? Evolution of File System Data Processing, Problems with File System Data Processing, Database Systems.

Relational Database Model- A Logical View of Data, Keys, Integrity Rules, Relational Algebra, Relationships within the Relational Database, Data Redundancy

**Unit II: Entity Relationship (ER) Modeling** **9 Hours**

Entities, Attributes, Relationships, Connectivity and Cardinality, Existence Dependence, Relationship Strength, Weak Entities, Relationship Participation, Relationship Degree, Recursive Relationships, Associative Entities, Developing an ER diagram

**Unit III: Entity Clustering** **9 Hours**

Entity Integrity: Selecting Primary Keys, Natural Keys and Primary Keys, Primary Key guidelines, when to use Composite Primary Keys, when to use Surrogate Primary Keys, Design Cases: Learning Flexible Database Design

**Unit IV: Introduction to SQL** **9 Hours**

Data Definition Commands, Data Manipulation Commands, SELECT Queries, Additional Data Definition Commands, Additional SELECT Query Keywords, Creating VIEW, Joining Database Tables

**Unit V: Transaction Management and Concurrency Control** **9 Hours**

What is Transaction? Concurrency Control, Concurrency Control with Locking Methods, Concurrency Control with Time Stamping Methods, Concurrency Control with Optimistic Methods

**Text Books**

1. Carlos Coronel and Steven Morris," Database Systems: Design, Implementation, & Management", 13th Edition, Cengage Learning, 2019
2. Sholom M. Weiss, Nitin Indurkhya, Tong Zhang, and Fred Damerau, "Text Mining: Predictive Methods for Analyzing Unstructured Information", 1st Edition, Springer, 2020

**Reference Books**

1. Hector Garcia-Molina, Jeffrey Ullman D, and Jennifer Widom, "Database Systems: The Complete Book", 2nd Edition, Pearson, 2001
2. Jiawei Han, Micheline Kamber and Jian Pei, "Data Mining: Concepts and Techniques", 3rd Edition, Elsevier, 2006

**Web Resources**

1. https://www.niti.gov.in/verticals/data-management-and-analysis
2. https://searchdatamanagement.techtarget.com/definition/data-management
3. https://nptel.ac.in/courses/110/104/110104094/

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## MI 20CEM03 Sustainability and Pollution Prevention Practices 3 0 0 3

At the end of the course, students will be able to

| Code | Course Outcomes |
|---|---|
| 20CEM03.1 | Concept of sustainability and its goals |
| 20CEM03.2 | Sources and effects of environmental pollution |
| 20CEM03.3 | Identify the prevention measures for environmental protection |
| 20CEM03.4 | Approach for analysis and assessment of developmental activities and their impacts on environment |
| 20CEM03.5 | Objectives and components of environmental management |

**Unit -I Concept of sustainability and development** **9 Hours**

Sustainability and its goals, Growth and development, Development and environment, Causes for industrialization, Changing life styles, Regulatory aspects of industrialization, Overall impact of industrialization and Urbanization on quality of human life , Global environmental issues

**Unit -II Pollution, Monitoring and Control** **9 Hours**

Definition, types and sources of pollution, Quality standards for air, water, soil; types of pollutants; Methods of monitoring and control of air, water, soil Pollution (Physicochemical and bacteriological sampling and analysis); effects of pollution on plants, animals and Human beings.

**Unit-III Measures for Environmental Protection** **9 Hours**

Formal and informal environmental education, awareness for nature conservation and protection, environmental ethics and morality, conservation of natural habitats, National parks and wild life sanctuaries, role of youth and women, role of NGO's, urban planning and land-use pattern

**Unit-IV Environmental Impact Assessment** **9 Hours**

Definition, significance and scope of impact assessment, Need & objective, types of environmental impacts, methods of environmental impacts, major steps in impact assessment procedure, generalised approach to impact analysis

**Unit-V Environmental Management** **9 Hours**

Objectives and components of environmental management need for training, Environmental Impact Statement and Environment Managemental Plan, Role of remote sensing in environmental management, Sustainable use of natural resources, management of soil, wildlife and its methods, agriculture management, Public participation in resource management

### Text Books

1. Lars F. Niklasson, "Improving the Sustainable Development Goals: Strategies and the Governance Challenge", 2009
2. Herman Koren, "Best Practices for Environmental Health: Environmental Pollution, Protection, Quality and Sustainability", 21 April, 2017
3. McCully, P, "Rivers no more: the environmental effects of dams (pp. 29-64)", Zed Books, 1996
4. McNeill, John R, "Something New Under the Sun: An Environmental History of the Twentieth Century", 2000

### Reference Books

1. Environmental Chemistry - A.K. De, New Age Int. Pub. Co., New Delhi, 1990
2. Lave, L.B and Upton, "Toxic Chemicals, Health and the Environment", The Hopkins Press Ltd., London, 1987
3. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. "Environmental and Pollution Science. Academic Press", 2011

### Web References

1. http://mcic.ca
2. https://www.drishtiias.com
3. https://www.jica.go.jp

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## MI 20CSM03 Database Security 3 0 0 3

At the end of the course, students will be able to

| Code | Course Outcomes |
|---|---|
| 20CSM03.1 | Explain the Cossets DBMS |
| 20CSM03.2 | Explain the Constrains in Database |
| 20CSM03.3 | Describe different Database Schemas |
| 20CSM03.4 | Illustrate Desecrate Data Models and Water Marking Processes |
| 20CSM03.5 | Explains Geospatial Data Models and Access Methods |

**Unit I: Database Introduction** **9 Hours**

Introduction to Database – Relational Database & Management System, Data Abstraction (Physical Level, Logical Level & View Level) - Multi-level Database, Distributed Database, Database Architecture.

**Unit II: Database Securities** **9 Hours**

Security issues in Database – Integrity constraints, Access Control (Grant & Revoke Privileges) - Statistical Database, Differential Privacy. Distributed Database Security.

**Unit III: Schema Models** **9 Hours**

Security in Data Warehouse & OLAP – Introduction, Fact table, Dimensions, Star Schema, Snowflake Schema, Multi-Dimension Range Query, Data Cubes.

**Unit IV: Data Mining Introduction** **9 Hours**

Data Mining – Introduction - Randomization methods, Data Swapping, Database Watermarking – Basic Watermarking Process - Discrete Data, Multimedia, and Relational Data, Different Data Migration Techniques.

**Unit V: Geospatial Database** **9 Hours**

Geospatial Database Security – Geospatial data models – Geospatial Authorization, Access Control Models: Geo-RBAC, Geo-LBAC

### Text Books

1. Michael Gertz, Sushil Jajodia, “Handbook of Database Security: Applications and Trends”, ISBN-10: 0387485325, Springer, 2007
2. Osama S. Faragallah, El-Sayed M. El-Rabaie, Fathi E. Abd El-Samie, Ahmed I. Sallam, and Hala S. El-Sayed, “Multilevel Security for Relational Databases”, ISBN 978-1-4822- 0539-8, CRC Press, 2014.

### Reference Books

1. Bhavani Thuraisingham, “Database and Applications Security: Integrating Information Security and Data Management”, CRC Press, Taylor & Francis Group, 2005.
2. Elmasri navrate, “Fundamentals of Database Systems”, Seventh Edition, Pearson Education, 2016.
3. Peter Rob & Carlos Coronel, “Database Systems Design, Implementation and Management,” Tenth Edition, Pearson Education, 2013.

**Web Resources**

1. http://www.nptelvideos.in/2012/11/database-managementsystem.html
2. https://www.ibm.com/in-en/cloud/learn/database-security
3. http://data.conferenceworld.in

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## MI 20MEM03 Surface Engineering 3 0 0 3

At the end of the course, students will be able to

| Code | Course Outcomes |
|---|---|
| 20MEM03.1 | Decide the surface preparation methods suitable for different substrate materials. |
| 20MEM03.2 | Apply knowledge on properties offered by different Coatings based on the application requirement. |
| 20MEM03.3 | Interpret the testing &evaluation of metallic coatings. |
| 20MEM03.4 | Explain the effect of process parameters on the properties & microstructure of the surface coating processes. |
| 20MEM03.5 | Explain the importance & role of surface modifications to achieve several technological properties. |

**Unit I: Fundamentals of Surface Engineering** **9 Hours**

Introduction to surface engineering, Scope of surface engineering for different engineering materials, Surface Preparation methods such as Chemical, Electrochemical, Mechanical: Sand Blasting, Shot peening, Shot blasting, Hydro-blasting, Vapor Phase Degreasing etc.,
Coatings: Classification, Properties and applications of Various Coatings

**Unit II: Chemical Conversion Coating** **9 Hours**

Chromating, Phosphating, and Anodizing, Thermochemical processes: Methodology used, mechanisms, important reactions involved, Process parameters and applications.

**Unit III: Coating from Vapor Phase** **9 Hours**

PVD, and CVD: Various Methods used, mechanisms, important reactions involved, Process parameters and applications.

**Unit IV: Metallic coating** **9 Hours**

Hot Dipping, Galvanizing, Electrolytic and Electro less plating: Methodology used, mechanisms, important reactions involved, Process parameters and applications. Testing/ evaluation of metallic coatings.

**Unit V: Thermal spray coatings** **9 Hours**

Processes, Types of spray guns, Comparison of typical thermal spray processes, Surface Preparation, Finishing Treatment, Coating Structures and Properties, Applications.

### Text Books

1. J. R. Davis, “Surface Engineering for Corrosion and Wear Resistance”, 1st Edtion, 1997.
2. George J, “Rudzki -Surface Finishing Systems metal and non-metal finishing handbook-guide”, 1st Edition, Metals Park: ASM, 1983.
3. James A. Murphy, “Surface Preparation and Finishes for Metal, McGraw-Hill”, New York 1971.
4. P. G. Sheasby and R. Pinner, “Surface treatment and finishing of Aluminium and its alloy”, 1st Edition, ASM, Metals Park, 1987.

### Reference Books

1. Friction Stir Welding and Processing, Rajiv Sharan Mishra, Partha Sarathi De, Nilesh Kumar, International 2006.
2. Friction Stir Welding and Processing, R.S. Mishra and M.W. Mahoney, ASM International, 2007.
3. Advances in Friction-Stir Welding and Processing, M-K Besharati-Givi and P. Asadi, ASM International 2008.

**Web References**

1. www.nptel.iitm.ac.in
2. www.btechguru.com
3. www.ocw.mit.edu
4. www.corrosion-doctors.org

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## MI 20EEM03 Electrical Engineering Material Science 3 0 0 3

At the end of the course, students will be able to

| Code | Course Outcomes |
|---|---|
| 20EEM03.1 | Understand the phenomena of metal conductivity |
| 20EEM03.2 | Explain the properties of di-electric properties |
| 20EEM03.3 | Understand the magnetic properties of materials |
| 20EEM03.4 | Explain the types of semi-conductors |
| 20EEM03.5 | Understand the modern techniques used for studying the material science |

**Unit I: Conductivity of Metal** **9 Hours**

Introduction, factors affecting the resistivity of electrical materials, motion of an electron in an electric field, Equation of motion of an electron, current carried by electrons, mobility, energy levels of a molecule, emission of electrons from metals, thermionic emission, photo electric emission, field emission, effect of temperature on electrical conductivity of metals, electrical conducting materials

**Unit II: Dielectric Properties** **9 Hours**

Introduction, effect of a dielectric on the behavior of a capacitor, polarization, the dielectric constant of monatomic gases, frequency dependence of permittivity, dielectric losses, significance of the loss tangent, dipolar relaxation, frequency and temperature dependence of the dielectric constant, dielectric properties of polymeric system,

**Unit III: Magnetic Properties of Materials** **9 Hours**

Introduction, Classification of magnetic materials, diamagnetism, paramagnetism, ferromagnetism, the hysteresis loop, factors affecting permeability and hysteresis loss, common magnetic materials

**Unit IV: Semiconductors** **9 Hours**

Energy band in solids, conductors, semiconductors and insulators, types of semiconductors, Intrinsic semiconductors, impurity type semiconductor, diffusion, thermal conductivity of semiconductors, electrical conductivity of doped materials

**Unit V: Modern Techniques for Materials Studies** **9 Hours**

Optical microscopy – Electron microscopy – Photo electron spectroscopy – Atomic absorption spectroscopy – Introduction to Biomaterials and Nanomaterials

**Text Books**

1. Joseph Le Roy Hayde Proteus Steinmetz, “Radiation, Light and Illumination: A Series of Engineering Lectures Delivered at Union College”, BiblioLife, 2019
2. Jack L. Lindsey,, “Applied Illumination Engineering”, 4th Edition, PHI, 2011
3. John Matthews, “Introduction to the Design and Analysis of Building Electrical Systems”, 2nd Edition, Springer, 2013.

**Reference Books**

1. M.A. Cayless, “Lamps and Lighting”, 5th Edition, Routledge, 2016.
2. Leopold Bloch, “Science of Illumination: An Outline Of The Principles Of Artificial Lighting”, Kessinger Pub, 2018.

**Web References**

1. https://nptel.ac.in/courses/108/105/108105060/

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## MI 20ECM03 Analog Electronic Circuits 3 0 0 3

At the end of the course, students will be able to

| Code | Course Outcomes |
|---|---|
| 20ECM03.1 | Demonstrate the concept of DC biasing and transistor stabilization leading to the design of amplifiers |
| 20ECM03.2 | Classify, analyze types of multistage amplifiers |
| 20ECM03.3 | Classify, analyze and design different types of feedback amplifiers and Oscillators |
| 20ECM03.4 | Analyze the response of different signals for linear and Nonlinear wave shaping circuits |
| 20ECM03.5 | Understand the internal operation of Op-Amp and its Applications |

### Unit I: Transistor Biasing 9 Hours

Need for biasing, operating point, BJT biasing methods, basic stability, fixed bias, collector to base bias, self-bias, Stabilization against variations in VBE, Ic, and β, Stability factors, (S, S', S'').

### Unit II: BJT and Multistage Amplifiers 9 Hours

BJT: Transistor at high frequencies, Hybrid- π common emitter transistor model, Hybrid π conductance, Hybrid π capacitances, Multistage Amplifiers: Classification of amplifiers, methods of coupling, cascaded transistor amplifier.

### Unit III: Feedback Amplifiers and Oscillators 9 Hours

Feedback Amplifiers: Feedback principle and concept, types of feedback, classification of feedback amplifiers. Oscillators: Oscillator principle, condition for oscillations, types of oscillators, RC-phase shift and Wien bridge oscillators with BJT, generalized analysis of LC Oscillators, Hartley and Colpitt's oscillators using BJT.

### Unit IV: Linear Wave Shaping 9 Hours

Linear wave shaping: High pass, low pass RC circuits, response for sinusoidal, step, pulse, square, ramp and exponential inputs. RC network as differentiator and integrator; Attenuators, Diode clippers.

### Unit V: Linear Applications of Op-Amp 9 Hours

Internal Block Diagram of various stages of Op-Amp and Roll of each Stage, Characteristics of Op-Amp, Ideal and Practical Op-Amp specifications, Inverting and Non-inverting amplifier, Integrator and differentiator, Difference amplifier, Instrumentation amplifier.

### Text Books

1. Robert, L. Boylestad and Louis Nashelsky, "Electronic Devices and Circuits Theory", 10th Edition, Prentice Hall of India, 2009.
2. Millman, J, TaubH, Mothiki Surya Prakash Rao and Millman's, "Pulse Digital and Switching Waveforms", 2nd Edition, Tata McGraw-Hill, 2008.
3. Ramakanth A. Gayakwad, "Op-Amps & Linear ICs", Prentices Hall of India, 1987.

### Reference Books

1. Donald A. Neaman, "Electronic Circuit Analysis and Design", 3rd Edition, Tata Mc Graw-Hill, 2010
2. Paul Gray, Hurst, Lewis and Meyer, "Analysis and Design of Analog Integrated Circuits", 4th Edition, John Willey &Sons, 2005
3. Anand Kumar, A., "Pulse and Digital Circuits", 2nd Edition, Prentice Hall of India, 2005
4. Sanjay Sharma, "Operational Amplifiers & Linear Integrated Circuits", 2nd Edition, S. K. Kataria & Sons, 2010.

### Web Resource

1. https://nptel.ac.in/courses/108102112
2. https://www.udemy.com/course/analog-electronics-basic-concepts/

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## MI 20AIM03 Interpretable Machine Learning 3 0 0 3

At the end of the course, students will be able to

| Code | Course Outcomes |
|---|---|
| 20AIM03.1 | Introduction to interpretability |
| 20AIM03.2 | Different interpretable models |
| 20AIM03.3 | Explain the software's for interpretable models. |
| 20AIM03.4 | Illustrate plotting of prediction changes. |
| 20AIM03.5 | Explains individual predictions of any black box classification model. |

**Unit I: Introduction** **9 Hours**

Importance of Interpretability, Taxonomy of Interpretability Methods, Scope and evaluation of Interpretability, Properties of Explanations, Human-friendly Explanations

**Unit II: Interpretable Models-I** **9 Hours**

Data Sets-Regression, Text Classification. Interpretable Models -Linear Regression, Logistic Regression, Decision Tree, Decision Rules, Decision Rule Fit

**Unit III: Interpretable Models-II** **9 Hours**

Generalized Linear Models (GLM) - Non-Gaussian Outcomes, Advantages; Generalized Additive Models (GAM) - Nonlinear Effects, Advantages and software; Other interpretable Models: Naive Bayes Classifier, K-Nearest Neighbors

**Unit IV: Model Agnostic Methods** **9 Hours**

Partial Dependence Plot (PDP), Accumulated Local Effects (ALE) Plot, Feature Interaction, Functional Decomposition, Permutation Feature Importance, Global Surrogate.

**Unit V: Local Model Agnostic Methods** **9 Hours**

Individual Conditional Expectation (ICE), Local Surrogate (LIME), Counterfactual Explanations, Scoped Rules (Anchors), Shapley Values.

### Text Books

1. "Interpretable Machine Learning, A Guide for Making Black Box Models Explainable", By Christoph Molnar · 2020
2. "Interpretable Machine Learning with Python, Learn to Build Interpretable High-performance Models with Hands-on Real-world", By Serg Masís · 2021

### Reference Books

1. "Explainable AI: Interpreting, Explaining and Visualizing Deep Learning", By Andrea Vedaldi, Grégoire Montavon, Klaus-Robert Müller, Lars Kai Hansen, Wojciech Samek,2019.
2. "Interpreting Machine Learning Models, Learn Model Interpretability and Explainability Methods", By Anirban Nandi, Aditya Kumar Pal · 2021

### Web References

1. https://christophm.github.io/interpretable-ml-book/index.html
2. https://ai.googleblog.com/2021/12/interpretable-deep-learning-for-time.html
3. https://arxiv.org/abs/2103.10689

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## MI 20DSM03 Data Governance 3 0 0 3

At the end of the course, students will be able to

| Code | Course Outcomes |
|---|---|
| 20DSM03.1 | Understanding of the role computation can play in solving problems and optimization techniques |
| 20DSM03.2 | Understanding the usage of computational techniques. |
| 20DSM03.3 | Understanding Stochastic programming and statistical thinking |
| 20DSM03.4 | Identify the problem using Monte Carlo simulations |
| 20DSM03.5 | Plotting with the pylab package |

**Unit I: Introduction, Data Literacy and Concepts** **9 Hours**

Data is an asset, Data governance and governance, Data management, The governance "V", Solutions Other terms, Some final core concepts

**Unit II: Overview: A Day in the life of a Data Governance Program and its Capabilities** **9 Hours**

What does it look like? - The scope of data governance and data management, Business model, Content, Development methods -Federation, Elements of data governance programs, Principles, Policies, Metrics, The critical success factors for data governance

**Unit III: The Data Governance Business Case** **9 Hours**

The business case, Objectives of the business case for data governance, Components of the business case - The big picture (vision), Program risks, Business alignment, Costs of data quality issues, Costs of missed opportunities, Data debt, Obstacles, impacts, and changes, Presentation of the case. The process to build the business case - Fully understand business direction, identify possible opportunities, identify usage opportunities, define business benefits, confirm business benefits, quantify costs, Prepare the business case documentation, Approach considerations

**Unit IV: Overview of Data Governance Development and Deployment** **9 Hours**

Types of approaches, The data governance delivery framework, Process overview, Engagement, Strategy, Architecture and design, Implementation, Operation, and changes

**Unit V: Engagement** **9 Hours**

Initiation- Obtain program approval, Develop DG rollout team structure. Definition- Define DG for your organization, identify business units (subject to DG), Identify business capabilities that need data governance (and don't have it). Scope- Define scope and constraints with the initial plan for DG, Approve scope and constraints. Assessment- Information maturity, Change capacity, Data environment

### Text Books

1. John Ladley, "Data Governance", Academic Press, Second Edition, 2012.

### Reference Books

1. EvrenEryuek, Uri Gilad, "Data Governance: The Definitive Guide", O'Reilly Media, Inc., 2021.

### Web Resources

1. https://nptel.ac.in/courses/110/106/110106072/
2. https://nptel.ac.in/courses/110/104/110104094/

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