

**ACADEMIC REGULATIONS
COURSE STRUCTURE
AND
DETAILED SYLLABUS
(Choice Based Credit System)**



ROBOTICS

For
B.TECH. FOUR YEAR DEGREE COURSE
(Applicable for batches admitted from 2020-2021)



SWARNANDHRA
COLLEGE OF ENGINEERING & TECHNOLOGY
(AUTONOMOUS)

SEETHARAMAPURAM, NARSAPUR-534 280, W.G.DT., A.P.

ACADEMIC REGULATIONS

1. INTRODUCTION

Swarnandhra College of Engineering & Technology (**Subsequently referred to as SCET**) will be followed the norms of Jawaharlal Nehru Technological University Kakinada and Govt. of Andhra Pradesh.

All Academic Programme rules and regulations are approved by the Academic Council, which is the highest Academic body of the Institute. It is applicable for all Bachelor of Technology (B. Tech) degree programme from academic year 2020-21.

2. ADMISSIONS

2.1 Regular Admission

(Join in first year B. Tech Programme)

Admissions in the Institution are classified into **CATEGORY – A**, through convener, EAMCET and **CATEGORY- B** filled by the college management.

2.2 Lateral Entry Admission

(Join in the Second year/third semester of B. Tech Programme)

Eligibility: Diploma in Engineering / B.Sc Degree with Mathematics as one course .

Based on the rank secured by the candidate at Engineering Common Entrance Test (ECET) conducted by APSCHE, Government of Andhra Pradesh.

2.3 Advance standing Admission

(Transfer from other Colleges/ Re-admission due to dis-continuation)

These may arise in the following cases:

- a) When a student seeks transfer from other colleges to SCET and desirous to pursue the study at SCET in an eligible branch of study.
- b) When students of SCET get transferred from one regulation to another regulation.

In all such cases, approval is mandatory from the statutory bodies

3. UNDER GRADUATE (UG) PROGRAMMES OFFERED

The College is offering the following programmes:

- Computer Science and Engineering (CSE)
- Electronics and communication Engineering (ECE)
- Electrical and Electronics Engineering (EEE)
- Information Technology (IT)
- Mechanical Engineering (ME)
- Civil Engineering (CE)
- Artificial Intelligence and Machine Learning (AI&ML)
- Robotics (ROBO)

3.1 Structure of the Programme:

i) Preamble:

It is emphasized in UGC Guidelines on Choice Based Credit System (CBCS), that the important measures taken to enhance academic standards and quality in higher education include innovation and improvements in curriculum, teaching-learning process, examination and evaluation systems, besides governance and other matters. It is adopted grading system in place of conventional system of marks and percentages.

CBCS provides flexibility in designing curriculum and assigning credits based on the course content and hours of teaching. The students can register any course of their choice, learn at their own pace, undergo additional courses and acquire more than the required credits, and adopt an interdisciplinary approach through open electives.

Key words CBCS, such as Course, credit, credit point, CGPA, SGPA, Grade Point, Letter Grades as given in the UGC guidelines are used the same definitions.

Each Programme consists of:

- Foundation courses in Basic Sciences, Engineering Sciences, Humanities and social science including management courses.
- Professional core Courses to impart broad knowledge.
- Professional Elective Courses from the discipline or interdisciplinary areas / industry related opted by the student based on their interest in specialization.
- Open Elective Courses from the interdisciplinary areas opted by the students based on their interest in specialization.
- Mandatory Courses, Internship, Seminar, Project work.
- Skill Oriented Courses to upskilling the graduates on the skills relevant to the need and demands of the industry.

Each Programme designed to have 35-40 theory courses, 20-25 laboratory courses and 05 Skill Oriented Courses. The categories of courses are indicated in the following table.

A three-week induction program is mandatory for all first year UG students and shall be conducted as per AICTE/UGC/APSCHE guidelines.

TABLE-1 CATEGORY OF COURSES

S.No	Category	Code
1	Humanities and social science including Management courses	HSMC
2	Basic Science courses	BSC
3	Engineering courses science	ESC
4	Professional core Courses	PCC
5	Open Elective Courses	OEC
6	Professional Elective Courses	PEC
7	Internship, seminar, project work	PROJ
8	Skill Oriented Courses	SC
9	Laboratory Courses	LC
10	Mandatory courses	MC

Note: All components prescribed in the curriculum will be conducted and evaluated.

MOOCs: A student shall be permitted to pursue up to a maximum of two elective courses under MOOCs during the Programme. Each of the courses must be of minimum 12 weeks in duration. Attendance will not be monitored for MOOC courses. Student has to pursue and acquire a certificate for a MOOC course only from the organizations/agencies approved by the BoS in order to earn the 3 credits. The Head of the department shall notify the list of such courses at the beginning of the semester.

ii) **Contact hours:** Depending on the complexity and volume of the course, the number of contact hours per week will be determined.

iii) **Credits:**

TABLE-2 CREDITS BASED ON CONTACT HOURS

Course type	No. of Contact Hours	No. of Credits
Theory	1	1
Practical	2	1

TABLE-3 CREDITS FOR DIFFERENT COURSES

Course type	Lecture method			Credits
	L	T	P	
Theory/Elective	2	1	0	3
	3	0	0	3
	2	0	2	3
	2	0	0	2
Laboratory	0	0	2	1
	0	0	3	1.5
	0	0	4	2
Skill Oriented Courses	1	0	2	2

3.2 Curriculum for each Programme:

- All Four year B. Tech Programme of study is formulated based on the guidelines mentioned in 3.1 and recommended by the concerned Board of Studies (BoS) and approved by the Academic Council (AC).
- The same curriculum will be applicable for lateral entry students from 3rd semester onwards.
- For advance standing admission, the equivalent curriculum will be prepared by BoS and approved by AC.

4 DURATION OF THE PROGRAMME:

The duration of the B. Tech. Programme is four academic years consisting of eight semesters. Students, who fail to fulfill all the academic requirements for the award of the degree within the prescribed duration as per article 4.1, will forfeit their admission in B. Tech.

4.1 Maximum duration of study.

Maximum duration permitted for completion of the B. Tech. Programme of study will be:

Regular Admission: Eight academic years in sequence from the year of admission for a student admitted into first year of any Programme.

Lateral Entry Admission: Six academic years in sequence from the year of admission for a student admitted into second year of any Programme.

Advanced standing Admission: The maximum time for completion of Programme of study, will be twice the period in terms of academic years in sequence, with prescribed curriculum.

TABLE- 4 MAXIMUM DURATION OF STUDY

Admitted year of study	Maximum duration
First year	8 Academic years in sequence
Second year (Lateral entry)	6 Academic years in sequence
Advanced standing	Twice the period in terms of academic years in sequence

4.2 Cancellation of Admission :

In case candidate fails the above conditions for the award of degree, admission stands cancelled.

5 MEDIUM OF INSTRUCTION :

The medium of instruction and examinations are in English.

6 **MINIMUM INSTRUCTION DAYS**: Each semester will consist of 22 weeks duration with minimum of 110 working days which includes instruction days, internal tests and End examinations.

7 **TRANSITORY REGULATIONS** (Admitted under advance standing):

The following regulations will be followed the operandi. At the time of such admission, based on the Programme pursued (case by case)

- Discontinued or detained candidates are eligible for re-admission in subsequent years in the same semester.
- The re-admitted candidate will be governed by the rules & regulations under which the candidate has been admitted.

In case of transferred students from other colleges, credits shall be transferred to SCET as per the academic regulations and course structure of SCET.

8 **DISTRIBUTION AND WEIGHTAGE OF MARKS**:

Each semester consists of 4/5/6 theory courses and 4/3/2 Laboratory courses. However, in the 8th semester there will be only project work / internship in industry.

(a). **Theory Courses**:

- Each course consists of five units.
- All courses will be evaluated with a maximum of 100 marks.
- Marks distribution will be 30 marks for internal evaluation and 70 marks for the end semester examination.
- The internal evaluation of 30 marks consists of Two Mids for 20 marks and Five class tests for 10 marks.

- Mid Examination: Each mid examination will be conducted for 20 marks with the duration of 75 Minutes. Internal test paper consists of three questions (8M+8M+4M) from two and half units and all are to be answered.
- **Weighted average of two Mids** performance will be considered, weightage of 80% for the best Mid marks and 20% for the second.
- **Class tests for 10 marks calculation:** There will be one class test conducted in each unit. Average of **Best three** will be considered.
- The **end semester** examination will be conducted for 70 marks which covers full syllabus. In end examination pattern, **Part – A** consists of five short questions from all units (Brainstorming/Thought provoking/Case study) for 10 marks. **Part – B** has **5 questions** with internal choice from each unit and valued for 60 marks.
- Internal Marks will be considered for three academic years only if the candidates will not completed the concern course because of less than 12 internal marks. Thereafter the candidate writes external examination for 70 which will be converted to 100 but the candidate must get minimum 40 %.

(b). **Practical Courses:**

- All courses will be evaluated with a maximum of 100 marks.
- Marks distribution will be 30 marks for internal evaluation and 70 marks for the end semester examination.
- End practical examination will be conducted by the internal and external examiner appointed by COE.
- Internal evaluation will be a continuous assessment during the semester for 30 marks with 15 marks for day-to-day work, including record valuation and 15 marks for internal test.

(c). **Design or Engineering Drawing Marks Distribution:** For the courses of design or drawing such as Engineering Graphics, etc., the distribution will be 30 marks for internal evaluation with 10 marks for day-to-day work, and 20 marks from two internal test (80% of first best + 20% of second best). End examination will be conducted for 70 marks.

(d) **Summer Internship:** It can be carried out with a minimum of Six weeks and maximum Eight weeks duration at end of 4th semester and 6th semester. The internship can be done by the students at local industries, Govt. Organizations, construction agencies, Industries, Hydel and thermal power projects and also in software MNCs. It will be evaluated internally by an internal evaluation committee comprising of Head of the Department and two faculty of the department. A student will be required to submit a summer internship report to the concerned department and appear for an oral presentation before the departmental committee. The report and the oral presentation shall carry 40% and 60% weightage respectively. A minimum of 50% of maximum marks shall be obtained to earn the corresponding credits

(e) **Full Internship and Project Work:** The 8th Semester Project Work with full internship will be evaluated for 200 Marks. The project work is evaluated for internal assessment of 60 and external Examination for 140. At the end of the semester the candidate shall submit an internship completion certificate and a project report. A student shall also be permitted to submit project report on the work carried out during the internship. Completion of internships is mandatory, if any student fails to complete internship, he/she will not be eligible for the award of degree. In such cases, the student shall repeat and complete the internship.

i) **Internal Assessment:** Internal Assessment will be monitored by Project Review Committee

consists of Head of the Department , Supervisor and Senior faculty member on the basis of two seminars and the internal marks will be awarded by Project Supervisor with recommendation of PRC.

ii) External Examination: External Examination will be conducted by Project external examination committee consists of Head of the Department, Supervisor and External examiner appointed by CoE , through presentation / viva - voce by the student.

9. Community Service Project (Experiential Learning through Community

Engagement):

Community Service Project is an experiential learning strategy that integrates meaningful community service with instruction, participation, learning and community development. Community Service Project is meant to link the community with the college for mutual benefit. Community Service Project is an integral part of the curriculum with 4 Credits and evaluated internally for 100 marks.

Objectives:

- ❖ To sensitize the students to the living conditions of the people who are around them,
- ❖ To bring about an attitudinal change in the students and help them to develop societal consciousness, sensibility, responsibility and accountability
- ❖ To make students aware of their inner strength and help them to find new /out of box solutions to the social problems.
- ❖ To make students socially responsible citizens who are sensitive to the needs of the disadvantaged sections.
- ❖ To help students to initiate developmental activities in the community in coordination with public and government authorities.
- ❖ To develop a holistic life perspective among the students by making them study culture, traditions, habits, lifestyles, resource utilization, wastages and its management, social problems, public administration system and the roles and responsibilities of different persons across different social systems.

Implementation of Community Service Project:

1. Every student should put in a minimum of 180 hours for the Community Service Project during the summer/ Semester vacation.
2. Each class/section should be assigned with a mentor
3. Specific Departments could concentrate on their major areas of concern.
4. A log book has to be maintained by each of the student, where the activities undertaken / involved to be recorded.
5. The log book has to be countersigned by the concerned mentor/faculty incharge.
6. Evaluation to be done based on the active participation of the student and grade could be awarded by the mentor/faculty member.
7. The final evaluation to be reflected in the grade memo of the student.

8. The Community Service Project should be different from the regular programmes of NSS / NCC / Green Corps / Red Ribbon Club, etc.
9. Minor project report should be submitted by each student. An internal Viva shall also be conducted by a committee constituted by the principal of the college.
10. The Project Log-, Project Implementation, Project report and Presentation shall carry 20%, 30%, 25% and 25% weightage respectively. A minimum of 50% of maximum marks shall be obtained to earn the corresponding credits.

TABLE- 5 MARKS ALLOCATION

Course type	Marks Allocation			
	Internal		End Semester	Total
	Internal test	Class Test/ Day to day work		
Theory course	20	10	70	100
Laboratory course	15	15	70	100
Design or Drawing course	20	10	70	100
Skill Oriented Courses	15	15	70	100
Summer Internship	50		-	50
Community Service Project	100		-	100
Project Work	60		140	200

(f) Mandatory Courses:

These courses are compulsory with zero credits. Only internal examination will be conducted and student has to secure minimum 40% of the marks in the evaluation for passing the course. The minimum attendance requirement is 75 %.

- (g) **Open Electives:** Students are to choose Open Elective – I during 5th Semester, Open Elective–II during 6th Semester and Open Elective – III and IV during 7th Semester from the list of Open Electives given in the Course Structure. However, students cannot opt for an Open Elective Subject offered by their own (parent) Department, if it is already listed under any category of the courses offered by the parent Department in any Semester.

(h) Skill Oriented Courses:

- i) A pool of interdisciplinary and job-oriented mandatory skill courses which are relevant to the industry are integrated into the curriculum of concerned branch of engineering.
- ii) For these courses, one theory and two practical hours may be allotted as approved by the concerned BOS.
- iii) The student shall be given an option to choose either the skill courses being offered by the college or to choose a certificate course being offered by industries/Professional bodies/APSSDC or any other accredited bodies as approved by the concerned BoS.

- iv) Every year the concerned BoS review the skill oriented courses based on industrial demand which are offered by the eligible external agencies and college.
- v) Marks distribution will be 30 marks for internal evaluation and 70 marks for the end semester examination. End examination will be conducted by the internal and external examiner appointed by COE. Internal evaluation will be a continuous assessment during the semester for 30 marks with 15 marks for day-to-day work, including record valuation and 15 marks for internal test.
- vi) If a student chooses a Certificate Course offered by industries/Professional bodies/APSSDC or any other accredited bodies, in lieu of the skill advanced course offered by the Department, the credits shall be awarded depends on the Course Completion Certificate.
- vii) College academic committee evaluates the grades/marks given for a course by external agencies and convert to the equivalent marks/grades.
- viii) There are five (05) skill-oriented courses shall be offered during III to VII semesters.
- ix) Out of the five skill courses two shall be skill-oriented courses from the same domain and shall be completed in second year. Of the remaining 3 skill courses, one shall be necessarily be a soft skill course and the remaining 2 shall be skill-advanced courses either from the same domain or Job oriented skill courses, which can be of inter disciplinary nature.

10. ATTENDANCE REQUIREMENTS

- (i) A student will be eligible to appear for end semester examinations, if he/she acquired a minimum of 75% of attendance in aggregate of all the courses.
- (ii) Condonation of shortage of attendance in aggregate up to 10% on medical grounds (Above 65% and below 75%) in any semester may be granted by the College Academic Committee.
- (iii) Shortage of Attendance below 65% in aggregate shall not be condoned.
- (iv) Students with less than 65% of attendance in any semester are not eligible to take up their end examination of that particular semester and their registration for previous semesters examinations shall be allowed.
- (v) Attendance may also be condoned for those who participate in Inter Collegiate/university sports, co- and extracurricular activities provided their attendance is in the minimum prescribed range for the purpose (>65%) and recommended by the concerned authority. He/ She shall pay the prescribed Condonation fee.
- (vi) Prescribed Condonation fee shall be payable by the student to appear for the end examination.
- (vii) A Student will not be promoted to the next semester unless he/she satisfies the attendance requirement of the present semester as applicable. They may seek re-admission for that semester as and when offered consecutively.
- (viii) A student will be condoned only four times for regular student and three times for lateral entry students during entire course of study.
- (ix) For induction programme attendance shall be maintained as per AICTE norms.

TABLE-6 ATTENDANCE REQUIREMENT

Attendance Percentage	Condonation fee	Appear End Exams
Above 75 %	Nil	Eligible
65 % -75%	Yes (on medical grounds)	Eligible
Below 65 %	Nil	Not Eligible (Seek re-admission to that semester when offered)

11. MINIMUM ACADEMIC REQUIREMENTS:

The following academic requirements have to be satisfied in addition to the attendance requirements mentioned in **S.No.10**.

- (i) A student will be deemed to have satisfied the minimum academic requirements and earned the credits allotted to each theory or practical or design or drawing subject or project if he/she secures not less than a minimum of 35% of marks exclusively in the end semester examinations in each of the courses, for which the candidate had appeared. However, the candidate should have secured a minimum of 40% marks in both external and internal components put together to declare eligible for pass..
- (ii) A student will be promoted from first semester to second semester, second semester to third and third to fourth semester, if he/she satisfies the minimum attendance requirement.
- (iii) A student will be promoted from 4th to 5th Semester (2nd year to 3rd year), if he/she fulfills the academic requirements of 40% of the credits up to either 3rd or 4th Semester from all the examinations (Regular and supplementary) whether or not the candidate takes the examinations.
- (iv) A student will be promoted from 6th to 7th Semester (3rd year to 4th year), only if he/she fulfills the academic requirements of 40% of the credits up to either 5th or 6th Semester from, all the examinations (regular and supply) whether or not the candidate takes the examinations.
- (v) When a student is detained for lack of credits/shortage of attendance, he may be re-admitted into the same semester/year in which he has been detained. However, the academic regulations under which he was first admitted shall continue to be applicable to him.

TABLE-7 PROMOTION IN TO NEXT HIGHER CLASS

Promotion		Promotion Criteria
From	To	
1 ST Semester	2 nd Semester	Minimum Attendance requirement
2 nd Semester	3 rd Semester	
3 rd Semester	4 th Semester	
4 th Semester	5 th Semester	Minimum Attendance requirement & 40% of credits up to either 3 rd or 4 th semester from all exams
5 th Semester	6 th Semester	Minimum Attendance requirement
6 th Semester	7 th Semester	Minimum Attendance requirement & 40% of credits up to either 5 th or 6 th semester from all exams
7 th Semester	8 th Semester	Minimum Attendance requirement

12. GAP YEAR CONCEPT

Student Entrepreneur in Residence shall be introduced and outstanding students who wish to pursue entrepreneurship are allowed to take a break of one year study, after the 4th Semester with the due recommendations of the GAP committee and approved by the principal. This may be extended to two years at the most which period is not counted for the maximum time for graduation.

13. AWARD OF B.TECH DEGREE:

A student shall be eligible for award of the B.Tech. Degree if he/she fulfills all the following conditions:

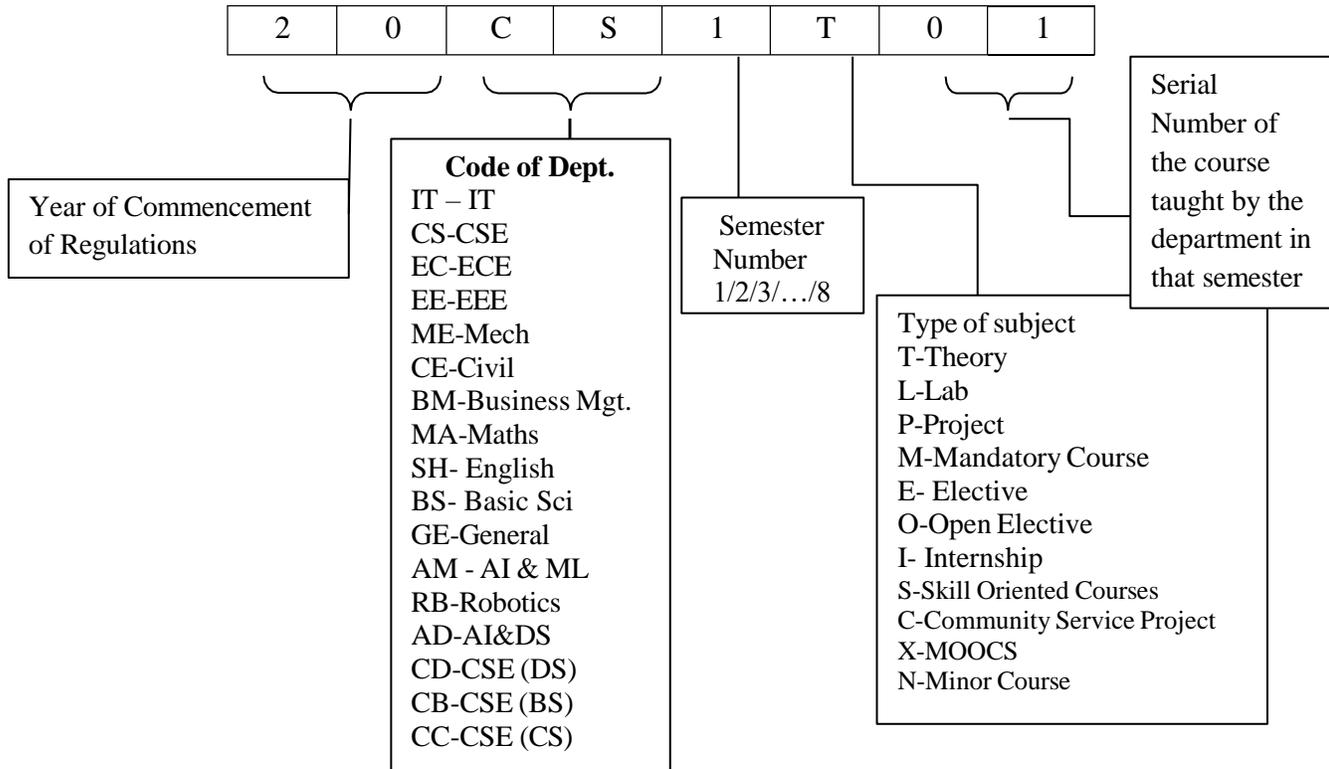
- (i) Pursue the programme of study for a stipulated period of four years and not more than eight years.
- (ii) Register for 160 credits and secure the same.
- (iii) Registered and successfully completed all the components prescribed in the programme of study in which he/she is admitted.
- (iv) All mandatory courses must be completed with satisfactory.
- (vi) Obtained CGPA greater than or equal to 5.0 (minimum requirements for pass).
- (vii) A student shall be eligible for the award of B.Tech degree with Honors or Minor if he/she earns 20 credits in addition to the 160 credits. A student shall be permitted to register either for Honors or for Minor and not for both simultaneously.
- (viii) All students shall register for NCC/NSS activities and will be required to participate in an activity specified by NSS officer during first two years. Grade shall be awarded as Satisfactory or Unsatisfactory in the mark sheet on the basis of participation, attendance, performance and behavior. If a student gets an unsatisfactory Grade, he/she shall repeat the above activity in the subsequent years, in order to complete the degree requirements.
- (ix) Courses like Environmental Sciences, Universal Human Values, Ethics, Indian Constitution, Essence of Indian Traditional Knowledge etc., shall be included in the curriculum as non-credit mandatory courses. Environmental Sciences is to be offered compulsorily as mandatory course for all branches. A student has to secure 40% of the marks allotted in the internal evaluation for passing the course. No marks or letter grade shall be allotted for all mandatory non-credit courses.

14. AWARD OF B. TECH. (HONOR)/B. TECH. (MINOR):

B. Tech. with Honors or a B. Tech. with a Minor will be awarded if the student earns 20 additional credits are acquired as per the regulations/guidelines. Registering for Honors/Minor is optional. (Refer Sl.No 24 & 25)

15. COURSE CODE & COURSE NUMBERING SCHEME:

The subject codes will be given by the department teaching the subject. Each subject code contains 8 characters. The 8 characters for each subject will be filled as per the following guidelines.



16. GRADING SYSTEM:

16.1 Award of Grade:

(i) Semester Grade Point Average (SGPA):

a) The Semester Grade Point Average (SGPA) will be calculated according to the formula

$$SGPA (S_i) = \frac{\sum C_i G_i}{\sum C_i}$$

Where C_i = number of credits for the subject i
 G_i = grade points obtained by the student in the subject.

b) To arrive at Cumulative Grade Point Average (CGPA), the formula is used considering the student's performance in all the courses taken in all the semesters completed up to the particular point of time.

$$CGPA = \frac{\sum C_i S_i}{\sum C_i}$$

where „ S_i “ is the SGPA of the i th semester and C_i is the total number of credits in that semester

- i. Both SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

- ii. Grade Point: It is a numerical weight allotted to each letter grade on a 10-point scale.
- iii. Letter Grade: It is an index of the performance of students in a said course. Grades are denoted by letters A+, A, B, C, D, E and F.
- iv. Equivalent Percentage = $(\text{CGPA} - 0.75) \times 10$

(ii) After a student satisfy the requirements prescribed for the award of B.Tech Programme he/she shall be placed in one of the following four grades. The award of the degree is based on CGPA on a grade point scale of 10 and given in Table 8.

Table -8

CGPA	Award of Division
≥ 7.75	First Class with Distinction (Without any supplementary appearance)
$\geq 6.75 < 7.75$	First Class
$\geq 5.75 < 6.75$	Second Class
$\geq 5.00 < 5.75$	Pass Class

16.2 Award of Grade in Each Semester:

- (i) Based on the student performance during a given semester, a final letter grade will be awarded at the end of the semester for each subject. The letter grades and the corresponding grade points are as given in the Table 10.

Table -9

Percentage of Marks Scored	Letter Grade	Level	Grade Points
≥ 90	A+	Outstanding	10
80 - 89	A	Excellent	9
70-79	B	Very Good	8
60-69	C	Good	7
50-59	D	Fair	6
40-49	E	Satisfactory	5
< 40	F	Fail	0
	Ab	Absent	0

- (ii) A student earns a minimum of 5 grade points in a subject is declared to have successfully completed the subject, and is deemed to have earned the credits assigned to that subject. However, it should be noted that a pass in any subject/Internship/project/ shall be governed by the rules mentioned in **S.No. 13**.
- (iii) Grade Sheet: A grade sheet (memorandum) will be issued to each student indicating his/her performance in all courses taken in that semester and also indicating the grades.
- (iv) Transcripts: After successful completion of the programme of study, a Transcript containing performance of all academic years will be issued as a final record. Duplicate transcripts will also be issued up to any point of study to the student on request and by paying stipulated fee in force.

(v) Candidates shall be permitted to apply for revaluation within the stipulated period with payment of prescribed fee.

(vi) The Academic Council has to approve and recommend to the JNTUK, Kakinada for the award of a degree to any student.

17. ACADEMIC REGULATIONS FOR B.TECH (LATERAL ENTRY SCHEME):

- i. The students have to acquire 121 credits from 3rd Semester to 8th Semester of Program (regular) for the award of the degree.
- ii. Students, who fail to fulfill the requirement for the award of the degree in 6 consecutive academic years from the year of admission, shall forfeit their seat.
- iii. The same attendance regulations are to be adopted as per the rules mentioned in item No.9.
- iv. **Rules for Promotion in to Next Higher Class:** (6th Semester to 7th Semester): A student shall be promoted from 6th Semester to 7th Semester only if he/she fulfills the academic requirements of 40% credits up to either 5th or 6th Semester.

18. SUPPLEMENTARY EXAMINATIONS:

In addition to the Regular Final Examinations held at the end of each semester, a Supplementary Examination will be conducted. A student can appear for any number courses of supplementary examinations till he/she clears the courses. However the maximum stipulated period of programme cannot be relaxed under any circumstance.

19. ADVANCED SUPPLEMENTARY EXAMINATIONS:

Candidate who fails the courses in 7th and 8th Semester can appear for Advanced Supplementary Examinations.

20. ACADEMIC REGULATIONS FOR B.TECH (LATERAL ENTRY SCHEME):

- i. The students have to acquire 121 credits from 3rd Semester to 8th Semester of B. Tech Programme for the award of the degree.
- ii. All mandatory courses must be completed with satisfactory for award of degree.
- iii. Obtained CGPA greater than or equal to 4.5 (minimum requirements for pass).
- iv. The same attendance regulations are to be adopted as per the rules mentioned in item No.09.
- v. **Rules for Promotion from 6th Semester to 7th Semester:** A student shall be promoted from 6th Semester to 7th Semester only if he/she fulfills the academic requirements of 40% credits up to 6th Semester.
- vi. Students, who fail to fulfill the requirement for the award of the degree in six consecutive academic years from the year of admission, shall forfeit their seat.

21. CONDUCT AND DISCIPLINE:

Students admitted in SCET are to be followed the conduct and discipline of the college and which will be updated from time to time.

22. MALPRACTICES:

If any malpractices held in internal assessment tests or Semester-End Examinations, Principal constitute a Malpractice Enquiry Committee to enquire the case. The principal shall take necessary action based on the recommendations of the committee as per stipulated norms.

23. WITHHOLDING OF RESULTS

If the student has not paid the dues, if any, to the institution or if any case of indiscipline is pending against him, the result of the student will be withheld. His degree will be withheld in such cases.

24. HONORS PROGRAMME:

- a) Students of a Department/Discipline are eligible to opt for Honors Programme offered by the same Department/Discipline.
- b) A student shall be permitted to register for Honors program at the beginning of 4th semester provided that the student must have acquired a minimum of 7.75 CGPA upto the end of 2nd semester without any backlogs. In case of the declaration of the 3rd semester results after the commencement of the 4th semester and if a student fails to score the required minimum of 8 CGPA, his/her registration for Honors Programme stands cancelled and he/she shall continue with the regular Programme.
- c) Students can select the additional and advanced courses from their respective branch in which they are pursuing the degree and get an honors degree in the same. e.g. If a Mechanical Engineering student completes the selected advanced courses from same branch under this scheme, he/she will be awarded B.Tech. (Honors) in Mechanical Engineering.
- d) In addition to fulfilling all the requisites of a Regular B.Tech Programme, a student shall earn 20 additional credits to be eligible for the award of B. Tech (Honors) degree. This is in addition to the credits essential for obtaining the Under Graduate Degree in Major Discipline (i.e. 160 credits).
- e) Of the 20 additional Credits to be acquired, 16 credits shall be earned by undergoing specified courses listed as pools, with four courses, each carrying 4 credits. The remaining 4 credits must be acquired through two MOOCs, which shall be domain specific, each with 2 credits and with a minimum duration of 8/12 weeks as recommended by the Board of studies.
- f) It is the responsibility of the student to acquire/complete prerequisite before taking the respective course. The courses offered in each pool shall be domain specific courses and advanced courses.
- g) The concerned BoS shall decide on the minimum enrolments for offering Honors program by the department. If minimum enrolments criteria are not met then the students shall be permitted to register for the equivalent MOOC courses as approved by the concerned Head of the department in consultation with BoS.
- h) Each pool can have theory as well as laboratory courses. If a course comes with a lab component, that component has to be cleared separately. The concerned BoS shall explore the possibility of introducing virtual labs for such courses with lab component.
- i) If a student drops or is terminated from the Honors program, the additional credits so far earned cannot be converted into free or core electives; they will remain extra. These additional courses will find

mention in the transcript (but not in the degree certificate). In such cases, the student may choose between the actual grade or a “pass (P)” grade and also choose to omit the mention of the course as for the following: All the courses done under the dropped Honors will be shown in the transcript. None of the courses done under the dropped Honors will be shown in the transcript.

- j) In case a student fails to meet the CGPA requirement for Degree with Honors at any point after registration, he/she will be dropped from the list of students eligible for Degree with Honors and they will receive regular B.Tech degree only. However, such students will receive a separate grade sheet mentioning the additional courses completed by them.
- k) Honors must be completed simultaneously with a major degree program. A student cannot earn Honors after he/she has already earned bachelor’s degree.

25. MINOR PROGRAMME:

- a) i) Students who are desirous of pursuing their special interest areas other than the chosen discipline of Engineering may opt for additional courses in minor specialization groups offered by a department other than their parent department. For example, If Mechanical Engineering student selects subjects from Civil Engineering under this scheme; he/she will get Major degree of Mechanical Engineering with minor degree of Civil Engineering
ii) Student can also opt for Industry relevant tracks of any branch to obtain the Minor Degree, for example, a B.Tech Mechanical student can opt for the industry relevant tracks like Data Mining track, IOT track, Machine learning track etc.
- b) The BOS concerned shall identify as many tracks as possible in the areas of emerging technologies and industrial relevance / demand. For example, the minor tracks can be the fundamental courses in CSE, ECE, EEE,CE,ME etc or industry tracks such as Artificial Intelligence (AI), Machine Learning (ML), Data Science (DS), Robotics, Electric vehicles, VLSI etc.
- c) The concerned BoS shall decide on the minimum enrolments for offering Minor program by the department. If a minimum enrolments criterion is not met, then the students may be permitted to register for the equivalent MOOC courses as approved by the concerned Head of the department in consultation with BoS.
- d) A student shall be permitted to register for Minors program at the beginning of 4th semester subject to a maximum of two additional courses per semester, provided that the student must have acquired 7.75 CGPA (Cumulative Grade Point Average) upto the end of 2nd semester without any history of backlogs. It is expected that the 3rd semester results may be announced after the commencement of the 4th semester. If a student fails to acquire 7.75 CGPA upto 3rd semester or failed in any of the courses, his registration for Minors program shall stand cancelled. An CGPA of 7.75 has to be maintained in the subsequent semesters without any backlog in order to keep the Minors registration active.
- e) A student shall earn additional 20 credits in the specified area to be eligible for the award of B. Tech degree with Minor. This is in addition to the credits essential for obtaining the Under Graduate Degree in Major Discipline (i.e. 160 credits).
- f) Out of the 20 Credits, 16 credits shall be earned by undergoing specified courses listed by the concerned BoS along with prerequisites. It is the responsibility of the student to acquire/complete prerequisite

before taking the respective course. If a course comes with a lab component, that component has to be cleared separately. A student shall be permitted to choose only those courses that he/she has not studied in any form during the Programme.

- g) In addition to the 16 credits, students must pursue at least 2 courses through MOOCs. The courses must be of minimum 8 weeks in duration. Attendance will not be monitored for MOOC courses. Student has to acquire a certificate from the agencies approved by the BOS with grading or marks or pass/fail in order to earn 4 credits. If the MOOC course is a pass/fail course without any grades, the grade to be assigned as decided by the university/academic council.
- h) Student can opt for the Industry relevant minor specialization as approved by the concerned departmental BoS. Student can opt the courses from Skill Development Corporation (APSSDC) or can opt the courses from an external agency recommended and approved by concerned BOS and should produce course completion certificate. The Board of studies of the concerned discipline of Engineering shall review such courses being offered by eligible external agencies and prepare a fresh list every year incorporating latest skills based on industrial demand.
- i) College Academic committee evaluates the grades/marks given by external agencies to a student which are approved by concerned BoS. Upon completion of courses the departmental committee should convert the obtained grades/marks to the maximum marks assigned to that course. The controller of examinations can take a decision on such conversions and may give appropriate grades.
- j) If a student drops (or terminated) from the Minor program, they cannot convert the earned credits into free or core electives; they will remain extra. These additional courses will find mention in the transcript (but not in the degree certificate). In such cases, the student may choose between the actual grade or a “pass (P)” grade and also choose to omit the mention of the course as for the following: All the courses done under the dropped Minors will be shown in the transcript. None of the courses done under the dropped Minor will be shown in the transcript.
- k) In case a student fails to meet the CGPA requirement for B.Tech degree with Minor at any point after registration, he/she will be dropped from the list of students eligible for degree with Minors and they will receive B. Tech degree only. However, such students will receive a separate grade sheet mentioning the additional courses completed by them.
- l) Minor must be completed simultaneously with a major degree program. A student cannot earn the Minor after he/she has already earned bachelor’s degree.

26. GENERAL:

- a) Wherever the words “he”, “him”, “his”, occur in the regulations, they include “she”, “her”, “hers”.
- b) The academic regulation should be read as a whole for the purpose of any interpretation.
- c) In case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Principal is final and which is to be ratified by the Chairman of the Governing Body.
- d) The college may change or amend the academic regulations or syllabi at any time and the changes or amendments made shall be applicable to all the students with effect from the dates notified by the college.

SEMESTER-I

S. No	Code	Course Title	L	T	P	C	IM	EM	TM
1	20MA1T01	Linear Algebra	3	-	-	3	30	70	100
2	20BS1T01	Engineering Physics	3	-	-	3	30	70	100
3	20ME1T01	Engineering Graphics	2	-	2	3	30	70	100
4	20EE1T01	Basic Electrical and Electronics Engineering	3	-	-	3	30	70	100
5	20BS1L01	Engineering Physics Lab	-	-	3	1.5	30	70	100
6	20EE1L01	Basic Electrical and Electronics Engineering Lab	-	-	3	1.5	30	70	100
7	20ME1L02	Basic CAD lab	-	-	3	1.5	30	70	100
8	20HS1L01	English Proficiency Lab	-	-	3	1.5	30	70	100
Total			11	-	14	18	240	560	800

SEMESTER-II

S. No	Code	Course Title	L	T	P	C	IM	EM	TM
1	20MA2T02	Differential Equations and Numerical Methods	3	-	-	3	30	70	100
2	20BS2T02	Engineering Chemistry	3	-	-	3	30	70	100
3	20CS2T01	Problem Solving Programming Using C	3	-	-	3	30	70	100
4	20HS2T01	English	3	-	-	3	30	70	100
5	20ME2T01	Engineering Mechanics	3	-	-	3	30	70	100
6	20ME2L02	Engineering Workshop	-	-	3	1.5	30	70	100
7	20BS2L02	Engineering Chemistry Lab	-	-	3	1.5	30	70	100
8	20CS2L01	C Programming Lab	-	-	3	1.5	30	70	100
9	20HS2L02	English Communications Lab	-	-	3	1.5	30	70	100
Total			15	-	14	21	270	630	900

L-LECTURE HOURS, T- TUTORIAL HOURS, P-PRACTICAL HOURS, C-CREDITS,
IM- INTERNAL MARKS, EM- EXTERNAL MARKS, TM- TOTAL MARKS

SEMESTER-III

S. No	Code	Course Title	L	T	P	C	IM	EM	TM
1	20MA3T03	Vector Calculus and Laplace Transforms	3	-	-	3	30	70	100
2	20ME3T01	Mechanics of solids	3	-	-	3	30	70	100
3	20RB3T01	Fundamentals of Industrial Robotics	3	-	-	3	30	70	100
4	20RB3T02	Engineering Materials	3	-	-	3	30	70	100
5	20RB3T03	Machine Tools	3	-	-	3	30	70	100
6	20RB3L01	Basic Robotics Lab	-	-	3	1.5	30	70	100
7	20RB3L02	Engineering Materials Lab	-	-	3	1.5	30	70	100
8	20RB3L03	Machine Tools Lab	-	-	3	1.5	30	70	100
9	20RB3S01	Mat lab Programming	-	-	4	2	30	70	100
10	20CE3M01	Environmental Science	2	-	-	-	-	-	-
Total			17	-	13	21.5	270	630	900

SEMESTER-IV

S. No	Code	Course Title	L	T	P	C	IM	EM	TM
1	20CS4T04	Python programming	3	-	-	3	30	70	100
2	20ME4T01	Theory of Machines	3	-	-	3	30	70	100
3	20MA4T07	Probability and Statistics	3	-	-	3	30	70	100
4	20RB4T01	Fundamentals of CNC Machines	3	-	-	3	30	70	100
5	20BM4T01	Managerial Economics and Financial Analysis	3	-	-	3	30	70	100
6	20CS4L04	Python programming Lab	-	-	3	1.5	30	70	100
7	20ME4L01	Theory of Machines lab	-	-	3	1.5	30	70	100
8	20RB4L01	CNC Programming Lab	-	-	3	1.5	30	70	100
9	20RB4S01	Robo Analyzer	-	-	4	2	30	70	100
10	20BM4M01	Indian Constitution	2	-	-	-	-	-	-
Total			17	-	13	21.5	270	630	900

L-LECTURE HOURS, T- TUTORIAL HOURS, P-PRACTICAL HOURS, C-CREDITS,
IM- INTERNAL MARKS, EM- EXTERNAL MARKS, TM- TOTAL MARKS

SEMESTER – V

S. No	Code	Course Title	L	T	P	C	IM	EM	TM
1	20RB5T01	Introduction to Microprocessors and Microcontrollers	3	-	-	3.0	30	70	100
2	20RB5T02	Internet of Things	3	-	-	3.0	30	70	100
3	20RB5T03	Control systems	3	-	-	3.0	30	70	100
4		Professional Elective - I	3	-	-	3.0	30	70	100
5		Open Elective - I / Job Oriented Elective - I	3	-	-	3.0	30	70	100
6	20RB5L01	Microprocessors and Microcontrollers Lab	-	-	3	1.5	30	70	100
7	20RB5L02	Internet of Things Lab	-	-	3	1.5	30	70	100
8	20RB5S01	Robot Control Software C-PROG	-	-	4	2.0	30	70	100
9	20BM5M01	Essence of Indian Traditional Knowledge	2	-	-	-	-	-	-
10	20RB5I01	Internship- I	0	0	0	1.5	50	0	50
Total			17	0	10	21.5	290	560	850

SEMESTER – VI

S. No	Code	Course Title	L	T	P	C	IM	EM	TM
1	20RB6T01	Artificial Intelligence In Robotics	3	-	-	3.0	30	70	100
2	20RB6T02	Programmable Logic Controllers	3	-	-	3.0	30	70	100
3	20RB6T03	Mobile Robots	3	-	-	3.0	30	70	100
4		Professional Elective-II	3	-	-	3.0	30	70	100
5		Open Elective-II / Job Oriented Elective-II	3	-	-	3.0	30	70	100
6	20RB6L01	Robot Programming Lab	3	-	-	1.5	30	70	100
7	20RB6L02	Artificial Intelligence Based Programming Lab	-	-	3	1.5	30	70	100
8	20RB6L03	PLC Lab	-	-	3	1.5	30	70	100
9	20HS6S01	Advanced Communication Skills Lab	-	-	4	2.0	30	70	100
10	20RB6C01	Community Service Project	-	-	-	4.0	100	-	100
11	20BM6M01	Professional Ethics and Intellectual Property Rights	2	-	-	-	0	0	0
Total			17	0	10	25.5	370	630	1000

L-LECTURE HOURS, T- TUTORIAL HOURS, P-PRACTICAL HOURS, C-CREDITS,
IM- INTERNAL MARKS, EM- EXTERNAL MARKS, TM- TOTAL MARKS

SEMSTER-VII

S.No.	Course Code	Course Title	L	T	P	C	IM	EM	TM
1		Professional Elective-III	3	-	-	3	30	70	100
2		Professional Elective-IV	3	-	-	3	30	70	100
3		Professional Elective-V	3	-	-	3	30	70	100
4		Open Elective-III / Job Oriented Elective-III	3	-	-	3	30	70	100
5		Open Elective-IV / Job Oriented Elective-IV	3	-	-	3	30	70	100
6	20HS7T01	Universal Human Values : Understanding Harmony	3	-	-	3	30	70	100
7	20RB7S01	Robostudio	-	-	4	2	30	70	100
8	20RB7I01	Internship-II	-	-	-	3	50	-	50
Total			18	-	4	23	260	490	750

SEMSTER-VIII

S.No.	Course Code	Course Title	L	T	P	C	IM	EM	TM
1	20RB8P01	Project work, seminar and internship in industry	-	-	-	8	60	140	200
Total			-	-	-	8	60	140	200

PROFESSIONAL ELECTIVE - I

S.No	Course Code	Course Title	Semester
1	20RB5E01	Humanoid Robotics	V
2	20RB5E02	Machine Vision	V
3	20RB5E03	Hydraulics And Pneumatics	V
4	20RB5E04	Sensors For Engineering Applications	V
5	20ME5E04	Production Planning And Control	V

OPEN ELECTIVE - I

S. No	Course Code	Course Title	Offering Dept.
1	20EE5001	Non-conventional Energy sources	EEE
2	20ME5001	Waste to Energy Conversion	ME
3	20CS5001	Internet of Things and Applications	CSE
4	20CS5002	Data Engineering	CSE
5	20BM5001	Innovations and Entrepreneurship	MBA
6	20BM5003	Digital Marketing	MBA
7	20BM5004	Business Environment	MBA
8	20IT5J01	Linux Administration	IT
9	20CS5J01	Full Stack with JAVA	CSE

JOB ORIENTED ELECTIVE - I

S. No	Course Code	Course Title	Offering Dept.
1	20IT5J01	Linux Administration	IT
2	20CS5J01	Full Stack with JAVA	CSE

PROFESSIONAL ELECTIVE - II

S.No	Course Code	Course Title	Semester
1	20ME6E01	Industrial Engineering and Management	VI
2	20RB6E01	Machine Learning For Robotics	VI
3	20RB6E02	Drone Technology	VI
4	20RB6E03	Automation In Manufacturing	VI
5	20RB6E04	Linear Integrated Circuits	VI

OPEN ELECTIVE - II

S. No	Course Code	Course Title	Offering Dept.
1	20CE6001	Environmental Pollution and Control	CE
2	20CE6002	Disaster Management	CE
3	20EE6001	Fundamentals of Electrical Vehicle	EEE
4	20EC6001	Mobile Communication and its Applications	ECE
5	20ME6001	Basics of 3D Printing	MECH
6	20ME6002	Farm Machinery	MECH
7	20CS6001	Fundamentals of Software Engineering	CSE
8	20CS6002	Fundamentals of Computer Networks	CSE
9	20BM6001	Stress and Work Life Management	MBA
10	20BM6002	Banking and Insurance	MBA
11	20MA6001	Operation Research	S&H
12	20IT6001	Introduction to Cloud Computing	IT
13	20IT6002	E-Commerce	IT

JOB ORIENTED ELECTIVE - II

S. No	Course Code	Course Title	Offering Dept.
1	20CS6J01	AWS Cloud Practitioner	CSE
2	20CS6J02	Software Testing Tools	CSE
3	20IT6J01	Full Stack Development	IT
4	20IT6J02	Block Chain Technology	IT

PROFESSIONAL ELECTIVE - III

S.No	Course Code	Course Title	Semester
1	20RB7E01	Robot Operating Systems	VII
2	20RB7E02	Cloud Robotics	VII
3	20RB7E03	Neural Networks and Fuzzy Systems	VII
4	20ME7E01	Mechanical Vibrations	VII
5	20ME7E02	Total Quality Management	VII

PROFESSIONAL ELECTIVE - IV

S.No	Course Code	Course Title	Semester
1	20RB7E04	Medical Robotics	VII
2	20RB7E05	Micro Robotics	VII
3	20RB7E06	Automotive Embedded Systems	VII
4	20RB7E07	Supply Chain Management	VII
5	20ME7E09	Industry 4.0	VII

PROFESSIONAL ELECTIVE - V

S.No	Course Code	Course Title	Semester
1	20RB7E08	Robotics and Automation in Food Industry	VII
2	20RB7E09	Field and Service Robotics	VII
3	20RB7E10	Virtual Reality and Augmented Reality	VII
4	20RB7E11	Micro Electro Mechanical Systems	VII
5	20ME7E14	Optimization Techniques	VII

OPEN ELECTIVE - III

S. No	Course Code	Course Title	Offering Dept.
1	20CE7001	Solid Waste Management	CIVIL
2	20CE7002	Building Planning and Drawing	CIVIL
3	20EE7001	Energy Auditing, Conservation and Management	EEE
4	20EC7001	Introduction to Global Positioning Systems	ECE
5	20BM7001	Industrial Sociology and Psychology	MBA
6	20ME7001	Bio-Mechanical Engineering	MECH
7	20CS7001	Full-Stack Development	CSE

OPEN ELECTIVE - IV

S. No	Course Code	Course Title	Offering Dept.
1	20CE7003	Introduction to Watershed Management	CIVIL
2	20EE7002	Introduction to Programmable Logic Controller	EEE
3	20BM7002	Business Skill Development	MBA
4	20EC7002	Remote Sensing	ECE
5	20ME7002	Green Engineering System	MECH
6	20CS7002	Software Testing Techniques	CSE
7	20IT7001	Introduction to Software Project Management	IT

SUBJECTS FOR B. TECH. (MINOR) IN ROBOTICS ENGINEERING

S.No	Course Code	Course Title	L	T	P	C	IM	EM	TM
1	20RB4N01	Mechanics of Solids	3	1	0	4	30	70	100
2	20RB5N01	Fundamentals of Industrial Robotics	3	1	0	4	30	70	100
3	20RB6N01	Fundamentals of CNC Machines	3	1	0	4	30	70	100
4	20RB7N01	Automation In Manufacturing	3	1	0	4	30	70	100
5	20RB7X01 20RB7X02	2 MOOCS courses @ 2credits each (Any ROBOTICS related Program Core subject from NPTEL/ SWAYAM course of 8 weeks (2 credits) other than the courses listed above needs to be taken)				4			

I SEMESTER	L	T	P	C
	3	-	-	3
20MA1T01 - LINEAR ALGEBRA				

Course Objectives:

- This course will illuminate the students in the concepts of calculus and linear algebra.
- This course equips the students with standard concepts and tools an intermediate level to advanced level and to develop the confidence; ability to handle various real world problems and their applications.

Bridge Course: Limits, continuity, Types of matrices

Unit I: Matrix Operations and Solving Systems of Linear Equations

Rank of a matrix by Echelon form, Normal form - solving system of homogeneous and non-homogeneous linear equations- Gauss Elimination, Jacobi and Gauss Seidel methods

Learning Outcomes:

At the end of this unit, the student will be able to

- solve system of linear equations. (K2)
- determine the rank of a matrix. (K2)

Unit II: Eigen values and Eigen vectors

Eigen values and Eigen vectors - and their properties (without proof). Cayley-Hamilton theorem (without proof), Finding inverse and powers of a matrix by Cayley-Hamilton theorem - Reduction of a matrix to diagonal form.

Learning Outcomes:

At the end of this unit, the student will be able to

- find eigen values and eigen vectors of a matrix. (K2)
- find inverse and powers of a matrix by Cayley-Hamilton theorem.(K2)

Unit III: Quadratic forms

Quadratic forms and nature of the quadratic forms, reduction of quadratic form to canonical form by orthogonal transformation.

Learning Outcomes:

At the end of this unit, the student will be able to

- reduce a matrix to diagonal form and identify special properties of a matrix, such as positive definite, etc., and use this information to facilitate the calculation of matrix characteristics; (K3)

Unit IV: Multivariable calculus

Expansions of functions: Taylor's and Maclaurin's series - Partial derivatives, total derivatives, chain rule, change of variables, Jacobians, maxima and minima of functions of two variables, method of Lagrange multipliers.

Learning Outcomes:

At the end of this unit, the student will be able to

- expand the given function as Taylor's and Maclaurin's series. (K3)
- find partial derivatives numerically and symbolically and use them to analyze and interpret the way in which a function varies. (K3)
- acquire the knowledge in maxima and minima of functions of several variables (K1)

- utilize Jacobian of a coordinate transformation to deal with the problems in change of variables (K3)

Unit V: Multiple Integrals

Double Integrals: Change of order of integration, double integrals in polar coordinates, areas enclosed by plane curves.

Triple Integrals: Evaluation of triple integrals, change of variables.

Learning Outcomes:

At the end of this unit, the student will be able to

- evaluate double integrals of functions of several variables in two dimensions using Cartesian and polar coordinates.(K3)
- apply double integration techniques in evaluating areas bounded by a region.(K4)

Textbooks:

- B. S. Grewal, Higher Engineering Mathematics, 43/e, Khanna Publishers, 2015.

References:

- Erwin Kreyszig, Advanced Engineering Mathematics, 9/e, John Wiley & Sons, 2013.
- B.V. RAMANA, Higher Engineering Mathematics, Tata McGraw Hill, 2007.

Course Outcomes:

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

- develop the use of matrix algebra techniques that is needed by engineers for practical applications (K3)
- familiarize with functions of several variables which is useful in optimization (K3)
- learn important tools of calculus in higher dimensions. Students will become familiar with double integral(K3)
- familiarize with triple integral and also learn the utilization of special functions. (K4)

WEB REFERENCES:

- <https://archive.nptel.ac.in/courses/111/107/111107108/>
- <https://nptel.ac.in/courses/111106051>
- <https://nptel.ac.in/courses/111105035>
- <https://nptel.ac.in/courses/111105121>
- <https://nitkkr.ac.in/docs/5-Multiple%20Integrals%20and%20their%20Applications.pdf>

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

I SEMESTER	L	T	P	C
	3	-	-	3
20BS1T01 - ENGINEERING PHYSICS				

COURSE OUTCOMES

After completion of course student able to:

1. Describe Basic crystal systems and determination of crystal structures
2. Explain Magnetic and Dielectric Materials properties
3. Describe Concept of Magnetic Induction and Super Conducting properties
4. Explain Pure & Doped Semiconductor materials for better utility
5. Describe Optical fibers and Optical properties of materials and their applications

SYLLABUS**UNIT –I: CRYSTAL STRUCTURE AND X-RAY DIFFRACTION****CRYSTAL STRUCTURE:**

Introduction – Space lattice – Basis – Unit Cell – Lattice parameters – Bravais lattices – Crystal systems – Structures and packing fractions of SC, BCC and FCC.

X-RAY DIFFRACTION:

Directions in crystals- planes in crystals- Miller indices and procedure to find Miller indices- Various planes in crystals- Separation between successive (h k l) planes-Bragg's law-Bragg's Spectrometer.

Learning Outcomes: At the end of this unit, the students will be able to

- **Explain** the seven crystal systems
- **Interpret** the crystal structure based on Bragg's law

UNIT – II: MAGNETIC AND DIELECTRIC PROPERTIES

MAGNETIC PROPERTIES: Introduction-Magnetic permeability – Magnetization – Relation between three magnetic vectors - Origin of magnetic moment – Classification of Magnetic materials- Dia, Para, Ferro, Anti-Ferro and Ferri-magnetism – Hysteresis- soft and Hard Magnetic materials.

DIELECTRIC PROPERTIES: Introduction-Dielectric constant- Relation between three electric vectors- Electronic and ionic polarizations (Quantitative) - orientation polarization (Qualitative) - Internal fields in solids- Clausius - Mossotti equation.

Learning Outcomes: At the end of this unit, the students will be able to

- **Classify** the magnetic materials into dia, para, ferro, anti ferro and ferri
- **Explain** the importance of hysteresis
- **Explain** the concept of polarization in dielectric materials.
- **Summarize** various types of polarization of dielectrics .
- **Interpret** Lorentz field and Claussius- Mosotti relation in dielectrics.

UNIT-III: ELECTROMAGNETIC WAVES AND SUPERCONDUCTIVITY

ELECTROMAGNETIC WAVES: Introduction-Electric flux –magnetic flux- Gauss law in electrostatics- Gauss law in magnetostatics- Ampere’s law - B for a Solenoid - Biot-Savart’s law-Magnetic Induction due to current carrying circular loop- Faraday’s law - Maxwell’s equations (Integral and differential forms).

SUPERCONDUCTIVITY: General and Thermal properties –Meissner effect – Type-I and Type-II superconductors – Flux quantization – BCS Theory of Superconductivity - Josephson effects – Applications of Superconductors.

Learning Outcomes: At the end of this unit, the students will be able to

- **Illustrate** the concept of electro magnetism based on fundamental laws of electro magnetism
- **Explain** Maxwell’s equations
- **Summarize** various properties and applications of superconductors

UNIT-IV: PHYSICS OF SEMICONDUCTORS:

Classification of solids based on band theory - Intrinsic semiconductors- density of charge carriers- Equation for conductivity – Extrinsic semiconductors- P-type and N-type- density of charge carriers- Drift and diffusion – Einstein’s equation – Hall Effect- Hall coefficient – Applications of Hall effect– direct & indirect band gap semiconductors.

Learning Outcomes: At the end of this unit, the students will be able to

- **Summarize** various types of solids based on band theory.
- **Outline** the properties of n-type and p-type semiconductors.
- **Identify** the type of semiconductor using Hall effect

UNIT-V: LASERS AND OPTICAL FIBERS

LASERS: Introduction– Characteristics of lasers – Spontaneous and Stimulated emission of radiation – Einstein’s coefficients – Population inversion - Three level and four level laser pumping schemes - Ruby laser – Helium-Neon laser- Applications of Laser.

FIBER OPTICS: Introduction to Optical fibers- Critical angle of propagation- Total internal reflection- Acceptance angle and acceptance cone- Numerical aperture- Classification of optical fibers based on refractive index profile-Classification of optical fibers based on modes- Attenuation in optical fibers - Applications of optical fibers.

Learning Outcomes: At the end of this unit, the students will be able to

- **Design** various types of lasers
- **Explain** the principle and propagation of light through Optical fibers
- **Discuss** the application of lasers and Optical fibers

TEXT BOOK:

A text book of “Engineering Physics” by M. N. Avadhanulu, P.G. Kshirasagar & TVS Arun Murthy, S Chand publications, 11th Addition 2019.

REFERENCE BOOKS:

1. Introduction to solid state physics 8th edition by *Charles Kittel*
2. Solid state Physics by *S.O. Pillai*
3. Engineering Physics by *Shatendra Sharma and Jyotsna Sharma, Pearson Education, 2018.*
4. Engineering Physics by *Palanisamy (Scitech Publishers)*
5. Engineering Physics by *D. Thirupathi Naidu and M. Veeranjanyulu*

WEB REFERENCES:

1. <https://onlinecourses.nptel.ac.in> › noc22_ph31 ›
2. <https://onlinecourses.nptel.ac.in> ›
3. <https://onlinecourses.nptel.ac.in> › noc22_ph45 ›
4. <https://onlinecourses.nptel.ac.in> › noc22_ph35 ›

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	2	-	-	2	-	-	-	2	-	-
CO2	3	-	-	-	2	-	-	1	-	-	-	2	-	-
CO3	3	-	-	-	2	-	-	1	-	-	-	2	-	-
CO4	3	-	-	-	2	-	-	1	-	-	-	-	-	-
CO5	3	-	-	-	2	-	-	1	-	-	-	2	-	-
Avg	3.00				2.0	-	-	1.2	-	-	-	2	-	-

I SEMESTER	L	T	P	C
	2	-	2	3

20ME1T01 :: ENGINEERING GRAPHICS

COURSE OUTCOMES: Students are able to

CO1: Construct polygons, conics, cycloids, involutes. (K3)

CO2: Draw the orthographic projections of points, lines and planes in different positions. (K2)

CO3: Draw the orthographic projections of solids in different views. (K2)

CO4: Draw the orthographic projections of sectioned solids and development of surface of solids. (K2)

CO5: Prepare Isometric views of simple solids and conversion of Isometric to Orthographic views and vice-versa. (K2)

UNIT I

POLYGONS AND PLANE CURVES

Basic Geometrical constructions, Curves used in engineering practices: Construction of regular polygons, Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of square and circle – Drawing of tangents and normal to the above curves.

UNIT II

PROJECTION OF POINTS, LINES AND PLANES

Orthographic Projection – Principles - Principal planes - First angle projection - Projection of points, Projection of straight lines inclined to both the principal planes (only First angle projections).

Projections of Planes: Regular planes perpendicular and parallel to one reference plane and inclined to the other reference plane; inclined to both the Reference planes.

UNIT III

PROJECTION OF SOLIDS

Projections of Solids: Prisms, Pyramids, Cone and Cylinder, Simple positions of solids and axis of the solid parallel to one plane and inclined to other plane.

UNIT IV

PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES

Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids, cylinders and cones.

UNIT V

ISOMETRIC PROJECTIONS

Principles of Isometric projection – Isometric scale – Isometric projections of simple solids - Prisms, pyramids, cylinders, cones - combination of two solid objects in simple vertical positions and Conversion of Isometric views to Orthographic views; Conversion of Orthographic views to Isometric views.

TEXT BOOKS:

1. Engineering Drawing by N.D. Butt, Chariot Publications 2016.
2. Engineering Drawing + AutoCAD by K. Venugopal, V. Prabhu Raja, New Age 2010.

REFERENCE BOOKS:

1. Engineering Drawing by K.L.Narayana & P. Kannaiah, Scitech Publishers 2016.
2. Engineering Graphics for Degree by K.C. John, PHI Publishers 2009.
3. Engineering Graphics by PI Varghese, McGrawHill Publishers 2013.

WEB REFERENCES:

1. <https://archive.nptel.ac.in/courses/112/105/112105294/>
2. <https://archive.nptel.ac.in/courses/124/107/124107159/>
3. <https://archive.nptel.ac.in/courses/112/102/112102304/>
4. https://ia800107.us.archive.org/18/items/TextbookOfEngineeringDrawing_201802/Textbook%20of%20Engineering%20Drawing.pdf

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3				1							1	3	
CO2	3				1							1	3	
CO3	3				1							1	3	
CO4	3				1							1	3	
CO5	3				1							1	3	
Avg	3				1							1	3	

I SEMESTER	L	T	P	C
	3	-	-	3
20EE1T01 :: BASIC ELECTRICAL AND ELECTRONICS ENGINEERING				

COURSE OUTCOMES: *After successful completion of this course, students should be able to:*

- CO1 : Analyze different electrical networks using KVL, KCL and Theorems.
- CO2 : Understand the basic concepts of single-phase system for simple AC circuit.
- CO3 : Demonstrate the construction, working and operating characteristics of AC & DC machines.
- CO4 : Study the construction details, operation and characteristics of various semiconductor devices, digital and logic operations.

SYLLABUS

UNIT-I : ELECTRICAL CIRCUITS

Basic definitions – types of network elements Electrical Circuit Elements (R, L and C), Voltage and Current Sources, Ohms Laws, Kirchoff’s Laws and Star/Delta Conversion, Series-Parallel- Series and Parallel (Only Resistor), Superposition, Thevenin’s and Norton’s Theorems, Problems in Simple Circuits with DC Excitation.

UNIT-II : AC FUNDAMENTALS

Representation of Sinusoidal Waveforms, Peak and RMS Values. Real Power, Reactive Power, Apparent Power, Power Factor. Concept of phase angle and phase difference Single phase Circuits - Voltage and Current Relations in Star/Delta Connections-Simple Problems.

UNIT-III : ELECTRICAL MACHINES

Electrical Machines: DC Machines: Classification of DC Machines-DC Generator and Motor Construction-Principle of operation –EMF Equation-Performance Characteristics-Simple problems AC Machines: Classification of AC Machines-Transformers-Synchronous Machines, Induction motor Performance Characteristics-Starting Methods-Simple problems.

UNIT- IV : Semi -Conductor Devices and Its Characteristics

Characteristics of PN Junction Diode — Zener Diode- Intrinsic and Extrinsic Semiconductors – Semiconductor Diodes– Bipolar Junction Transistors-CB, CE, CC Configurations and Characteristics – FET – MOSFET – Silicon-controlled Rectifier – DIAC – TRIAC-Half wave and Full wave Rectifiers- Voltage Regulation.

UNIT-V : INTRODUCTION TO DIGITAL ELECTRONICS

Binary Number System – Logic Gates – Boolean Algebra -De Morgan’s Theorem-Simplification of Boolean Expressions using De Morgan’s Theorem – Half and Full Adders – A/D and D/A Conversion.

TEXT BOOKS:

1. Basic Electrical Engineering, D.P. Kothari and I.J. Nagrath, 3rd edition 2010, Tata McGraw Hill.
2. Basic Electrical Engineering, P. V. Prasad, S. Sivanagaraju, K. R. Varmah, and Chikku Abraham, Cengage, 2019.
3. Basic Electrical & Electronics Engineering – J. B. Gupta, S. K. Kataria & Sons Publications, 2019 edition.

REFERENCE BOOKS:

1. Basic Electrical Engineering - D.C. Kulshreshtha, 2009, Tata McGraw Hill.
2. Fundamentals of Electrical Engineering, L.S. Bobrow, Oxford University Press, 2011
3. Electrical and Electronics Technology, E. Hughes, 10th Edition, Pearson, 2010.
4. Electrical Engineering Fundamentals, Vincent Deltoro, Second Edition, Prentice Hall India, 1989.
5. Principles of Electrical Engineering and Electronics”, V K Mehta & Rohit Mehta,S Chand Publishers,2019 edition.

WEB REFERENCES:

1. <https://nptel.ac.in/courses/108108076>
2. <https://nptel.ac.in/courses/108102097>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	3	2	2		-	-	-	-	-		-	-
CO2	1	3	1	3	1		-	-	-	-	-		-	-
CO3	1	2	2	3	3		-	-	-	-	-		-	-
CO4	2	2	3	1	3		-	-	-	-	-		-	-
Avg	1.75	2	2.25	2.25	2.25		-	-	-	-	-		-	-

I SEMESTER	L	T	P	C
	-	-	3	1.5

20BS1L01 :: ENGINEERING PHYSICS LAB

COURSE OUTCOMES

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

CO1: Demonstrate the basic knowledge to know the frequency of a vibrator, hall coefficient, (K3)

CO2: Attain knowledge to verify some of the properties of physical optics. (K4)

CO3: Develop skills to plot various characteristic curves and to calculate the physical properties of given materials. (K4)

CO4: Calculate some the properties of semiconducting materials. (K2)

STUDENT HAS TO DO ANY TEN OF THE FOLLOWING

1. Determination of wavelength of Laser using diffraction grating.
2. Determination of Numerical Aperture and Acceptance angle of an Optical Fiber.
3. Determination of the charge carrier density by using Hall Effect.
4. Determination of the Band Gap of a Semiconductor using a p-n junction diode.
5. Study of Characteristic curves (I/V) of a Zener diode to determine its Breakdown voltage.
6. Determination of Temperature coefficient of resistance of a Thermistor by using its Characteristic curve.
7. Study the variation of intensity of magnetic field along the axis of a circular current carrying coil by using Stewart and Gee's experiment.
8. Study of Characteristic curves (I/V) of a P-N diode.
9. Determine Frequency of given electrically driven tuning fork in Transverse and Longitudinal modes by using Melde's apparatus
10. Determine frequency of A.C. supply by using Sonometer.
11. Determination of the Time Constant for a C-R Circuit
12. Determination of the Planck's constant by using Photo-Cell
13. Determination of dielectric constant of a given material

I SEMESTER	L	T	P	C
	-	-	3	1.5

20EE1L01 :: BASIC ELECTRICAL AND ELECTRONICS ENGINEERING LAB

COURSE OUTCOMES: *After successful completion of this course, students should be able to:*

- CO1 : Acquire knowledge on electrical networks by using KVL,KCL.
- CO2 : Analyze the performance characteristics and to determine efficiency of DC machines
- CO3 : Under stand the characteristics of AC machines
- CO4 : Apply knowledge on PN junction diode , transistor and Rectifiers

LIST OF EXPERIMENTS

SECTION A: ELECTRICAL ENGINEERING:

1. Verification of KCL & KVL.
2. Open circuit Characteristics of DC Shunt generator.
3. Swinburne's test on DC Shunt Motor.
4. Brake test on DC Shunt motor.
5. Speed control of D.C. Shunt motor by a) Armature Voltage control b) Field flux control method
6. Open circuit and Short circuit test on a Single Phase Transformers.
7. Draw the Torque-Slip Characteristic of a Three Phase Induction Motor.
8. Regulation of Synchronous Machine using EMF Method.

SECTION B: ELECTRONICS ENGINEERING:

The following experiments are required to be conducted as compulsory experiments:

1. PN junction diode characteristics a) Forward bias b) Reverse bias (Cut in voltage and Resistance calculations)
2. Transistor CE characteristics (input and output)
3. Half wave rectifier with and without filters.
4. Full wave rectifier with and without filters.

Any 10 Experiments has to be conducted from Section A & B

REFERENCE BOOKS:

1. Department lab manual.

I SEMESTER	L	T	P	C
	-	-	3	1.5
20ME1L02 :: BASIC CAD LAB				

COURSE OBJECTIVE

To impart the students with necessary computer aided modeling skills using standard CAD packages.

COURSE OUTCOMES: Students will be able to

- CO1.** Demonstrate the usage of CAD software and to draw the geometric entities, to create 2D and 3D wire frame models. [K3]
- CO2.** Understand the paper-space environment thoroughly [K2]
- CO3.** Create geometrical model of simple solids and machine parts and display the same as an Isometric, Orthographic or Perspective projection. [K3]

UNIT -I

INTRODUCTION TO COMPUTER AIDED DRAFTING- Generation of points, lines, curves, polygons, dimensioning. Types of modeling-Object selection commands, edit, zoom, cross, hatching, pattern filling, utility commands in object selection commands, 2D and 3D wire frame modeling

UNIT-II

VIEW POINTS AND VIEW PORTS - View point coordinates and views displayed, Examples to exercise different options like save, restore, delete, joint, single option

UNIT-III

COMPUTER AIDED SOLID MODELING- Isometric projections, orthographic projections of isometric projections, modeling of simple solids, machines and machine parts

- Draw the following component by Using Polar Co-Ordinate System.
- Drawing of a Title Block with necessary Text and Projection Symbol.
- Generating 2D machine component.
- Generating a 2D drawing of the machine component.
- Drawing front view, top view and side view of objects from the given pictorial views.
- Obtaining 2-D Multiview Drawings from 3-D Model.
- Creation of front view and section view of a crank.
- Generate orthographic views from a 3D Model by using V PORTS.
- 3D MODELING COMMANDS.
- Generate a 3D model of the given machine component.

I SEMESTER	L	T	P	C
	-	-	3	1.5
20HS1L01 :: ENGLISH PROFICIENCY LAB				

COURSE OBJECTIVES

- To improve the language proficiency of technical under graduates in English with emphasis on LSRW Skills.
- To provide learning environment to practice Listening, Speaking, Reading and Writing Skills within and beyond the classroom environment.
- To assist students to carry on the tasks and activities through guided instructions and materials.
- To effectively integrate English language learning with employability skills and training.
- To design the main course material and exercises with authentic materials drawn from everyday use to cater to everyday needs.
- To provide hands-on experience through case-studies, mini-projects, group and individual presentations.

COURSE OUTCOMES

a) Reading Skills.

- Addressing explicit and implicit meaning of a text.
- Understanding the context.
- Learning new words and phrases.
- Using words and phrases in different contexts.

b) Writing Skills:

- Using the basic structure of a sentence.
- Applying relevant writing formats to create paragraphs, essays, letters, E-Mails, reports and presentations.
- Retaining a logical flow while writing.
- Planning and executing an assignment creatively.

c) Interactive skills:

- Analyzing a topic of discussion and relating to it.
- Participating in discussions and influencing them.
- Communicating ideas effectively.
- Presenting ideas coherently within a stipulated time.

d) Life Skills and Core Skills:

- Examining self-attributes and identifying areas that require improvement self-diagnosis, self-motivation.
- Adopting to a given situation and developing a functional approach to find solutions-adaptability, problem-solving.
- Understanding the importance of helping others-community service, enthusiasm.

RELATIONSHIP OF COURSE TO PROGRAMME OUTCOMES

- A Ability to apply knowledge of mathematics, science, and engineering.
- B Ability to design and conduct experiments, as well as to analyze and interpret data.
- C Ability to design an Engineering system, component, or process.
- D Ability to function on multi-disciplinary teams
- E Ability to identify, formulate and solve engineering problems.
- F Understanding of professional and ethical responsibility.
- G Ability to communicate effectively √
- H Broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context. √
- I Recognition of the need for and an ability to engage in life-long learning.
- J Knowledge of contemporary issues.
- K Ability to use the techniques, skills, and modern engineering tools necessary for engineering practices.
- L Ability to find location of substations and benefits derived through their optimal location.

COURSE DESCRIPTION

Communicating in a language is also a skill. So a student has to look for an opportunity to practice English language in order to acquire proficiency in English. „Enrich your interactive Skills: Part - A“ is designed to provide opportunities for engineering students to revise and consolidate the basic skills in listening, speaking, reading and writing in addition to giving ample practice in various communicative functions and Life skills.

PRE REQUISITES

The student is expected to have basic knowledge in English language and must be able to write in English. He is also expected to possess fundamental knowledge of general English grammar and vocabulary.

SYLLABUS

UNIT	TOPIC
1	Vowels, Consonants, Pronunciation, Phonetic transcripts
2	Word stress and syllables
3	Rhythm and Intonation
4	Contrastive Stress –Homographs
5	Word Stress : Weak and Strong forms , Stress in compound words

Text Book:

“InfoTech English” by Maruthi Publications

Reference Books:

1. Better English Pronunciation by O’ Connor
2. Phonetics and Phonology – Peter Roach
3. A Grammar of Spoken English – Harold Palmer
4. English Phonetics – Bansal and Harrison

Testing Pattern:

A) Internal lab Exam:	30 Marks
Regular performance in the language /communication /lab completion in the lab manual	15M
Written test	15M
B) External lab Exam Pattern:	70 Marks
Written test	30M
Oral test	30M
Viva (during exam marks will be awarded by external examiner)	10M

II SEMESTER	L	T	P	C
	3	-	-	3
20MA2T02 :: DIFFERENTIAL EQUATIONS AND NUMERICAL METHODS				

Course Objectives:

- To enlighten the learners in the concept of differential equations.
- To furnish the learners with basic concepts and techniques at plus two level to lead them into advanced level by handling various real world applications.

Unit I: Linear differential equations of higher order:

Solutions of Non-homogeneous equations of higher order with constant coefficients – with non-homogeneous terms of the type e^{ax} , $\sin ax$, $\cos ax$, polynomials in x^n , $e^{ax} V(x)$ and $x^n V(x)$ – Method of Variation of parameters.

Learning Outcomes:

At the end of this unit, the student will be able to

- identify the essential characteristics of linear differential equations with constant coefficients (K3)
- solve the linear differential equations with constant coefficients by appropriate method (K3)

Unit –II: Partial Differential Equations of First Order:

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Solutions of first order linear (Lagrange) equations and nonlinear (standard types) equations.

Learning Outcomes:

At the end of this unit, the student will be able to

- apply a range of techniques to find solutions of standard PDEs (K3)
- outline the basic properties of standard PDEs (K2)

Unit III: Interpolation

Finite differences, Differences of a polynomial, relation between operators, to find one or more missing terms, Newton's interpolation formulae, and interpolation with unequal intervals- Lagrange's formula.

Learning Outcomes:

After the completion of this unit student will be able to

- explain various discrete operators and find the relation among operators (K2)
- apply Newton's forward and backward formulas for equal and unequal intervals (K3)

Unit IV: Numerical Solution of Equations and Numerical integration

Numerical Solution of Equations: Solution of algebraic and transcendental equations - Bisection Method, Method of False Position, Newton-Raphson Method, useful deduction from Newton-Raphson Method.

Numerical Integration – Trapezoidal rule, Simpson's $\frac{1}{3}$ rule and Simpson's $\frac{3}{8}$ rule.

Learning Outcomes:

After the completion of this unit student will be able to

- find approximate roots of an equation by using different numerical methods (K3)
- find integral of a function by using different numerical methods (K3)

Unit V: Numerical Methods to Solve Ordinary Differential Equations

Numerical Methods to Solve Ordinary Differential Equations - Taylor’s series, Euler’s and modified Euler’s methods, Runge-kutta method of fourth order for solving first order equations.

Learning Outcomes:

After the completion of this unit student will be able to

- solve ordinary differential equations by using different numerical schemes (K3)

Textbooks:

1. B. S. Grewal, Higher Engineering Mathematics, 43/e, Khanna publishers,2015.

References:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9/e, John Wiley & Sons, 2013.
2. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, 2008.

Course Outcomes:

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

1. solve the differential equations related to various engineering fields (K3)
2. identify solution methods of partial differential equations that model physical processes (K3)
3. evaluate the approximate roots of polynomial and transcendental equations by different algorithms(K3)
4. solve integrate and ordinary differential equations by various numerical techniques.(K3)

WEB REFERENCES:

1. <https://archive.nptel.ac.in/courses/111/105/111105134/>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2.5	2	2					2			2	3	2
CO2	3	2.5	2	2					2			2	3	2
CO3	3	2.5	2	2					2			2	3	2
CO4	3	2.5	2	2					2			2	3	2
CO5	3	2.5	2	2					2			2	3	2
Avg	3	2.5	2	2					2			2	3	2

II SEMESTER	L	T	P	C
	3	-	-	3
20BS2T02 :: ENGINEERING CHEMISTRY				

COURSE OUTCOMES

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

CO1: Explain the impurities present in raw water, problems associated and how to avoid them (K2)

CO2: Explain the advantages of Polymers in daily life (K2)

CO3: Explain the theory of construction of battery and fuel cells and theories of corrosion and prevention methods. (K2)

CO4: Differentiate conventional and non-conventional energy sources and their advantages and disadvantages. (K2)

CO5: Identify the usage of advanced materials in day to day life (K2)

UNIT I: WATER TECHNOLOGY

[9 Hours]

Part-A

Hard water-Types of hardness-Units of Hard Water-Disadvantages of hard water-Determination of hardness by EDTA complexometric method.

Portable water- its specifications-steps involved in purification of water (Sedimentation, Filtration, Disinfection)-chlorination, break point of chlorination.

Boiler Feed Water-Boiler troubles: Scale and sludge-priming and foaming-boiler corrosion-caustic embrittlement.

Part-B

Industrial Water Treatment: Softening methods: zeolite process-ion exchange process.

Brackish water treatment (desalination methods): Reverse osmosis - electro dialysis.

Learning Outcomes: At the end of this unit, the students will be able to Explain

The impurities present in raw water, problems associated with them and how to avoid them

UNIT-II: POLYMERS AND COMPOSITE MATERIALS

[9 Hours]

Part-A

Polymers-degree of polymerization-functionality-preparation, properties and applications of individual polymers-Bakelite-PVC-Poly styrene.

Plastics: Types (thermosetting and thermoplastic)-compounding of plastics-moulding Process. (Injection moulding, Compression moulding, Extrusion moulding, Transfer moulding)

Part-B

Rubbers and elastomers: Introduction-natural rubber-vulcanization of rubber-synthetic rubbers-Buna-N, Buna-S.

Composite materials: Fiber reinforced plastics-biodegradable polymers-biomedical polymers, Recycling of e-waste.

Learning Outcomes: At the end of this unit, the students will be able to

- **Outline** the properties of polymers and various additives added and different methods of forming plastic materials.
- **Explain** the preparation, properties and applications of some plastic materials.
- **Discuss** natural and synthetic rubbers and their applications.

UNIT III: ELECTRO CHEMICAL CELLS AND CORROSION

[12 Hours]

Electrochemical Cells: Introduction–single electrode potential - electrochemical cell-electrochemical series and applications. Reference electrodes-standard hydrogen electrode and calomel electrode-construction of glass electrode. Batteries: Construction, working and cell reaction of primary (dry cell) and Secondary (Pb acid and Li-ion) battery. Fuel cells (H₂-O₂, Methanol-Air cells).

Corrosion: Cause and consequences of corrosion-theories of corrosion (Chemical and Electrochemical corrosion)-types of corrosion (Galvanic, Differential aeration (waterline and pitting corrosion), stress Corrosion). Factors influencing rate of corrosion-nature of metal-nature of corrosive atmosphere. Corrosion Prevention methods: Cathodic protection-Sacrificial anodic method-Impressed voltage method. Metallic coatings: Galvanization-Tinning-Electro plating-Electro less plating.

Learning Outcomes: At the end of this unit, the students will be able to

- **Explain** the theory of construction of battery and fuel cells.
- **Categorize** the reasons for corrosion and study some methods of corrosion control.

UNIT IV: CONVENTIONAL AND NONCONVENTIONAL ENERGY RESOURCES

[9 Hours]

Conventional energy sources: Classification and characteristics of fuels-solid, Liquid and gaseous fuels-advantages and disadvantages-calorific value-higher and lower calorific values-construction and working of bomb calorimeter-analysis of coal-proximate and ultimate analysis-numerical problems related to bomb calorimeter, Dulong's formula and coal analysis-petroleum refining-cracking – petrol and diesel knocking – octane number and cetane number – gaseous fuels – Natural gas – CNG - LPG

Non-conventional energy sources: Solar energy: Advantages-disadvantages of solar cells-construction and working of photo voltaic cell -Introduction to hydro power-geo thermal power-tidal and wave power.

Learning Outcomes: At the end of this unit, the students will be able to

- **Differentiate** conventional and non-conventional energy sources and their advantages and disadvantages.
- **design** sources of energy by different natural sources

UNIT V: CHEMISTRY OF MATERIALS

[9 Hours]

Part-A

Nano materials: Introduction-sol-gel method-characterization by SEM and TEM methods- carbon nanotubes and fullerenes: Types, preparation and applications

Semiconductors: Preparation (Distillation, Zone refining)

Part-B

Cement: Constituents of cement -Setting and Hardening of cement - Decay of Cement.

Refractories: Definition of refractory-classification and properties of refractoriness-applications of refractories.

Learning Outcomes: At the end of this unit, the students will be able to

- **Outline** the awareness of materials like nanomaterials and fullerenes and their uses.
- **Explain** the techniques that detect and measure the surface properties of materials.
- **Illustrate** the commonly used industrial materials.

Text Books:

T1. A Text Book of Engineering Chemistry - N. Y. S. Murthy, V. Anuradha & K. Ramana Rao, Maruthi Publications. (2018)

T2. A Text Book of Engineering Chemistry - K. Sessa Maheswaramma, Mridula Chugh, Pearson Publications (2018).

Reference Books:

R1. Engineering Chemistry – Jain & Jain, Dhanpat Rai Publishing Company (Latest Edition)

R2. Text Book of Engineering Chemistry - Shashi Chawla, Dhanpat Rai & Co. (P) Limited ((Latest Edition))

R3. Chemistry –Prasanta Rath, Subhendu Chakroborthy, Cengage publications (2018)

WEB REFERENCES:

1. https://onlinecourses.nptel.ac.in/noc22_mm45/preview
2. <https://phohen.com/post-detail/fundamentals-of-combustion-iit-kanpur---nptel/703719715>
3. https://onlinecourses.nptel.ac.in/noc20_mm10/preview
4. https://onlinecourses.nptel.ac.in/noc20_cy30/preview
5. https://onlinecourses.nptel.ac.in/noc21_cy10/preview
6. https://onlinecourses.nptel.ac.in/noc20_cy18/preview
7. https://onlinecourses.nptel.ac.in/noc21_cy18/preview

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	2	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	2	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	2	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	2	-	-	-	-	-	-	-
CO5	3	-	-	-	-	-	2	-	-	-	-	-	-	-
Avg	3.0	-	-	-	-	-	2.0	-	-	-	-	-	-	-

II SEMESTER	L	T	P	C
	3	-	-	3
20CS2T01 :: PROBLEM SOLVING USING C PROGRAMMING				

Course Outcomes**COURSE OUTCOMES**

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

CO1: Analyse a computational problem and develop an algorithm/flowchart to find its solution (**K2**)

CO2: Develop C programs with branching and looping statements, which uses Arithmetic, Logical, Relational or bitwise operators (**K3**)

CO3: Divide a given computational problem into a number of modules and develop C program with arrays(**K3**)

CO4: Write C programs which use pointers for array processing and parameter passing (**K3**)

CO5: Develop C programs with structure or union and files for storing the data to be processed. (**K3**)

UNIT-I**Contact Hours : 10**

INTRODUCTION TO PROGRAMMING : What is computer, Block diagram of Computer, Development of Computer languages, Translators, Computer Codes, Computer Arithmetic, Programming Techniques, Algorithm, Flowchart

BASICS OF C : History of C, Character Set, Identifiers, Keywords, Tokens, Variables, constants, operators, Data types, expressions, expression evaluation, operator precedence and associativity, typecasting C program structure.

Contact Hours : 8**UNIT-II**

CONSOLE I/O OPERATIONS : Formatted I/O - printf & scanf, Unformatted I/O functions.

CONTROL FLOW STATEMENTS: Branching Statements - if, if – else, switch. **Looping statements**- while, do – while, for, nested for. **Unconditional Statements** - break, continue, goto, exit.

UNIT-III**Contact Hours : 12**

ARRAYS : Array declaration , initialization and Accessing, Types of Arrays : 1-D and 2-D Arrays, Arrays as Function Arguments

FUNCTIONS: Introduction to Functions, Types of Function, Function prototypes, parameter passing techniques, Scope of variables, Storage classes, Recursion

UNIT-IV**Contact Hours : 8****STRINGS:** Reading String from terminal, Writing string to Screen, String Handling Functions.**POINTERS:** Pointer Declaration, Initialization and Accessing , Types of Pointers, Pointer Arithmetic, Dynamic memory allocation**Contact Hours : 10****UNIT-V****STRUCTURE :** Introduction to structures, Definition of structure , declaration of structure variable, accessing of structure members, array of structures, **Union, enum, bit fields, typedef****FILES :** Introduction to Files, Types of File, File Modes, Writing and Reading Files, File management I/O functions**TEXT BOOKS**

- Programming in ANSI C by E. Balguruswamy, Tata Mc-Graw Hill
- Programming With C, Schaum Series

REFERENCE BOOKS

- The „C“ programming language by Kernighan and Ritchie, Prentice Hall
- Computer Programming in „C“ by V. Rajaraman , Prentice Hall
- Programming and Problem Solving by M. Sprankle, Pearson Education
- How to solve it by Computer by R.G. Dromey, Pearson Education

WEB REFERENCES:

<https://archive.nptel.ac.in/courses/106/105/106105171/>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	-	-	-	-	2	-	-	2	2	
CO2	3	3	2	2	-	-	-	-	2	-	-	2	2	
CO3	3	2	2	2	-	-	-	-	2	-	-	2	2	
CO4	3	2	2	2	-	-	-	-	2	-	-	2	2	
CO5	3	2	2	2	-	-	-	-	2	-	-	2	2	
Average	3.0	2.5	2.25	2.0	-	-	-	-	2	-	-	2.0	2.0	

II SEMESTER	L	T	P	C
	3	-	-	3
20HS2T01 :: ENGLISH				

A. PROGRAMME CONTENT

- 1 Intensive and extensive reading
- 2 Written communication
- 3 Listening and oral communication
- 4 Vocabulary consolidation and expansion
- 5 Practicing grammar

B. ELABORATION OF THE PROGRAMME CONTENT

1. Intensive and Extensive Reading

- a. Identifying the main theme/the central idea of a passage
- b. Understanding the meaning of words, phrases and sentences in context
- c. Understanding the logical relationship between sentences (through recognition of grammatical structures such as linkers and connectors)
- d. Distinguishing statements of fact from beliefs, opinions, hypotheses, and expressions of probability and certainty
- e. Inferring facts, opinions, instances, reasons, causes, results, requests, conclusions, and general statements
- f. Skimming passages to identify general ideas and information
- g. Scanning passages to locate specific detail
- h. The use of one's knowledge, opinions, and imagination to provide information / situations related to that given in the text; and comparison and contrast.

2. Written Communication

- a. Writing outlines and summaries
- b. Writing paragraphs with attention to topic sentences and supporting sentences
- c. Writing paragraphs with attention to coherence and cohesion
- d. Practicing clutter-free writing

3. Listening and Oral Communication

- a. Effective listening involving
 - Identification of key words and phrases and specific information, application of one's previous knowledge of to understand the ideas dealt with in the text being listened to.
 - Attention to communication strategies such as approaching another person and opening a conversation with him/her, making friends with a stranger, thanking, apologizing, paying a

compliment, seeking clarification, making enquiries, and creating an appropriate context for a formal discussion.

- b. Taking part in speaking activities for interactional purposes such as,
 - Introducing oneself to others, introducing others, making enquiries, seeking information
 - Responding to enquiries, supplying information
 - Expressing agreement/disagreement in information situations
- c. Taking part in speaking activities for transactional purposes with attention to the communication strategies listed in 1 (a) above.

4. Vocabulary consolidation and expansion

- a. Inferring word meaning from available clues
- b. Distinguishing words with similar meanings
- c. Using connecting words
- d. Learning one-word substitutes

Developing a verbal repertoire with the following dimensions:

- Contexts of use
 - Collocations
 - Differences in speaking and writing
 - Strategic use
- e. Using strategic vocabulary to organize and manage both oral and written communication successfully in academic, professional, and social contexts
 - f. Raising one's knowledge of redundancy, circumlocution, and imprecise and confusing expressions in order to avoid them in one's own speech and writing.

5. Practicing grammar

- a. Consolidation as well as remediation in the following areas:
Parts of speech, Tenses and usage of grammar in context
- b. Learning to avoid some of the common pitfalls in the area of grammar in Indian usage of English (e.g. using the present continuous tense to describe actions which happen regularly; using state verbs in the continuous form; tense mixing)

C. TEXT BOOK: Building Effective Communication Skills

By Maruthi Publications (2019)

SYLLABUS:

S No	Content
UNIT -I	Vocabulary Building 1.1 Video Lesson 1.2.1 Word formation 1.2.2. Root words 1.2.3. Prefixes and Suffixes 1.2.4. Synonyms and Antonyms 1.3 Parts of Speech 1.4 Note- making, Note-taking
UNIT -II	Basic Writing Skills 2.1 Video Lesson 2.2.1 Basic sentence structure 2.2.2. Clauses and Phrases 2.2.3 Punctuations 2.2.4 Creating coherence 2.2.5 Organizing principles of paragraph documents 2.2.6 Techniques for writing precisely 2.3 Tenses 2.4 Letter Writing
UNIT-III	Identifying Common Errors in Writing 3.1 Video Lesson 3.2.1 Sub + verb agreement 3.2.2 Noun pronoun agreement 3.2.3 Articles 3.2.4 Preposition 3.2.5 Redundancies 3.2.6 Clichés 3.3.1 Active - Passive Voice 3.3.2 Reported Speech 3.4 Resume Writing
UNIT-IV	Nature and Style of sensible Writing 4.1 Video Lesson 4.2.1 Describing 4.2.2 Classifying 4.2.3 Writing Introduction and conclusion 4.3.1 Conditional Sentences 4.3.2 Degrees of Comparison 4.4 Email writing

UNIT-V	<p>Writing Practice</p> <p>5.1 Video Lesson</p> <p>5.2.1 Comprehension</p> <p>5.2.2 Precise writing</p> <p>5.2.3 Essay Writing</p> <p>5.3 Simple Compound and Complex Sentences</p> <p>5.4 Report Writing</p>
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WEB REFERENCES:

1. <https://archive.nptel.ac.in/courses/109/106/109106067/>
2. www.englishclub.com
3. www.learnenglish.com

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1					1			2	2	3		1		
CO2					1			2	2	3		1		
CO3					1			2	2	3		1		
CO4					1			2	2	3		1		
CO5					1			2	2	3		1		
Avg					1			2	2	3		1		

II SEMESTER	L	T	P	C
	2	-	2	3
20ME2T01 :: ENGINEERING MECHANICS				

COURSE OUTCOMES: Student will be able to

- CO1. Illustrate the various types of forces and moments.[K2]
- CO2. Analyze the rigid body in equilibrium and determine the effects by the laws of friction.[K4]
- CO3. Evaluate the centroid, moment of inertia of surfaces and centre of gravity, mass moment of inertia of solids. [K5]
- CO4. Calculate the kinetics and kinematics force exerted in rigid body. [K3]
- CO5. Perceive the concept of work energy principle and virtual work its application.[K3]

SYLLABUS

UNIT-I

Introduction to Engineering Mechanics: System of Forces, Coplanar Concurrent Forces, Components in plane - Resultant- Moment of Forces and its Application; Couples - General case of parallel forces in a plane. Equilibrium of Rigid Bodies in two dimensions - Free body diagram.

UNIT-II

Resultant- Moment of Forces: Types of Moment of Forces, Varignon Principle, Applications of Moment of Forces

Friction: Introduction, Types of friction, Laws of Friction, Limiting friction, Angle of repose, Angle of friction, Cone of friction. Equilibrium analysis of simple systems with sliding friction, Wedge friction, Screw friction.

UNIT-III

Centroid & Centre Of Gravity: Centroid- Simple and Composite figures. Centre of gravity - Simple and Composite bodies, Theorems of Pappus.

Moment Of Inertia: Moment of Inertia, Product of Inertia and Principal moment of inertia for planes. Mass moment of inertia for solids.

UNIT-IV

Kinetics: Analysis as a Particle and analysis as a Rigid Body in Translation – Central Force Motion – Equations of Plane Motion – Fixed Axis Rotation – Rolling Bodies.

Kinematics: Rectilinear and Curvilinear Motion – Velocity and Acceleration – Motion of Rigid Body – Types and their Analysis in Planar Motion.

UNIT-V

Work Energy Method: Work-Energy principle and its Application in plane motion of connected bodies. Impulse-Momentum method.

Virtual Work: Virtual displacements, Principle of virtual work for particle and Ideal system of rigid bodies. Application of virtual work principle.

TEXT BOOKS:

1. R.K. Bansal, A Text Book of Engineering Mechanics, 6th edition, Laxmi Publications, 2013.
2. S. S. Bhavikatti, Engineering Mechanics, 6th edition, New Age International Publishers, 2018.
3. R.S. Khurmi & N. Khurmi, Engineering Mechanics, 22nd edition, S. Chand publications, 2019.
4. A.K. TAYAL, Engineering Mechanics, 14th edition, UMESH Publications, 2010.

REFERENCE BOOKS:

1. S.Timoshenko & D.H. Young, Engineering Mechanics, 5th edition, McGraw Hill education, 2017.
2. D.S. Bedi and MP Poonia, Engineering Mechanics, 2nd edition, Khanna Book Publishing Co. (P) Ltd, 2019.
3. DP Sharma, Engineering Mechanics, 1st edition, Pearson Education, 2011
4. Reddy Vijay Kumar K. and J. Suresh Kumar, Engineering Mechanics – Statics & Dynamics, 3rd edition, BSP Books Pvt.Ltd, 2010.

WEB REFERENCES:

1. <https://nptel.ac.in/courses/112/106/112106286/#>
2. <https://www.ncertbooks.guru/engineering-mechanics/>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1			1							3	
CO2	3	3	2			1							3	1
CO3	3	3	2										2	
CO4	3	3	1			1							3	1
CO5	3	3	1										3	
Avg	3	2.8	1.4			0.6							2.8	0.4

II SEMESTER	L	T	P	C
	-	-	3	1.5
20ME2L02 :: ENGINEERING WORKSHOP				

COURSE OBJECTIVE: To impart hands-on practice on basic Engineering trades and skills.

COURSE OUTCOMES: Students will be able to

- CO1: Model and Develop various basic prototypes in Carpentry trade [K3]
- CO2: Model and Develop various basic prototypes in Fitting trade [K3]
- CO3: Perform Various Forging Operations [K3]
- CO4: Perform various House Wiring Techniques. [K3]
- CO5: Develop various basic prototypes in the trade of Sheet metal. [K3]

NOTE: At least **Two** Exercises to be done from each trade.

TRADE:

I. CARPENTRY:

- 1. CROSS LAP JOINT
- 2. DOVETAIL JOINT
- 3. MORTISE and TENNON JOINT

II. FITTING:

- 1. SQUARE FIT
- 2. V-FIT
- 3. HALF ROUND FIT

III. FORGING:

- 1. ROUND ROD TO SQUARE
- 2. S-HOOK
- 3. ROUND ROD TO SQUARE HEADED BOLT

IV. HOUSE WIRING:

- 1. PARALLEL/SERIES CONNECTION OF THREE BULBS
- 2. STAIRCASE WIRING
- 3. FLOURESCENT LAMP FITTING

V. SHEET METAL:

- 1. SQUARE TRAY
- 2. HOLLOW CYLINDER
- 3. OPEN SCOOP

MANUAL:

- 1. Engineering Workshop Practice Lab Manual Prepared by Mechanical Faculty.

II SEMESTER	L	T	P	C
	-	-	3	1.5

20BS2L02 :: ENGINEERING CHEMISTRY LAB

OUTCOMES: The experiments introduce volumetric analysis: Acid-Base, complexometric, Redox, Conductometric and potentiometric titrations. Then they are exposed to a few instrumental methods of chemical analysis.

Thus at the end of the lab course, the student is exposed and able to

1. Identify the concentration of given solution by different methods of chemical analysis **(K3)**
2. Analyze the water purity by checking hardness, DO and Acidity. **(K4)**
3. Estimate the Cu^{+2} , Fe^{+3} , Ca^{+2} , Mg^{+2} ions and Ascorbic acid present in given solution. **(K4)**
4. Identify the pour and cloud point of lubricants. **(K3)**
5. Understand the principles of conductometric and potentiometric titrations. **(K2)**

SYLLABUS:

1. Estimation of HCl using standard Na_2CO_3 through acid-base titration.
2. Estimate the total hardness of water using standardized EDTA solution through complexometric titration.
3. Estimation of KMnO_4 using standard $\text{H}_2\text{C}_2\text{O}_4$ through redox titration method.
4. Estimation of Dissolved Oxygen in given water sample by Winkler's Method
5. Determination of Ferric (Fe^{+3}) ions using standard $\text{K}_2\text{Cr}_2\text{O}_7$ solution
6. Determination of Copper (II) using standard hypo solution.
7. Estimation of strong acid by using strong base through conductometric titration method.
8. Estimation of strong acid by using strong base through potentiometric titration method.
9. Preparation of polymer (Demo).
10. Determination of Vitamin „C“.
11. Determination of Pour and Cloud Point of lubricating oils

REFERENCE BOOKS

1. A Textbook of Quantitative Analysis, Arthur J. Vogel.

II SEMESTER	L	T	P	C
	-	-	3	1.5

20CS2L01 :: C PROGRAMMING LAB

Course Objectives:

- To impart knowledge on various Editors, Raptor.
- To make the students understand the concepts of C programming.
- To nurture the students on Control Structures and develop different operations on arrays.
- To make use of String fundamentals and modular programming constructs.
- To implement programs using dynamic memory allocation.
- To explain the concepts of Structure, Unions and files for solving various problems.

List of Experiments:**1. Introduction to Algorithms and Flowcharts**

- 1.1) Implement Algorithm Development for Exchange the values of Two numbers.
- 1.2) Given a set of n student's examination marks (in the range 0-100) make a count of the number of students that passed the examination. A Pass is awarded for all of 50 and above.
- 1.3) Given a set of n numbers design an algorithm that adds these numbers and returns the resultant sum. Assume N is greater than or equal to zero.

2. Introduction to C Programming

- 2.1) Exposure to Turbo C, Code Blocks IDE, Dev C++, Falcon C++.
- 2.2) Writing simple programs using printf(), scanf() .

3. Raptor

- 3.1) Introduction to Raptor.
- 3.2) Draw a flow chart to find the Sum of 2 numbers.
- 3.3) Draw a flow chart to find Simple interest.

4. Basic Math

- 4.1) Write a C Program to convert Celsius to Fahrenheit and vice versa.
- 4.2) Write a C Program to find largest of three numbers using ternary operator.
- 4.3) Write a C Program to Calculate area of a Triangle using Heron's formula.

5. Control Flow- I

- 5.1) Write a C Program to Find Whether the Given Year is a Leap Year or not.
- 5.2) Write a C program to find the roots of a Quadratic Equation.
- 5.3) Write a C Program to make a simple Calculator to Add, Subtract, Multiply or Divide Using Switch...case.

6. Control Flow- II

- 6.1) Write a C Program to Find Whether the Given Number is Prime number or not.
- 6.2) Write a C Program to Find Whether the Given Number is Armstrong Number or not.
- 6.3) Write a C program to print Floyd Triangle.

7. Control Flow- III

- 7.1) Write a C program to find the sum of individual digits of a positive integer.
- 7.2) Write a C program to check whether given number is palindrome or not.

7.3) Write a C program to read two numbers, x and n, and then compute the sum of the geometric progression $1+x+x^2+x^3+\dots+x^n$.

Practice Programs:

- Write a C program to print all natural numbers from 1 to n. - using while loop
- Write a C program to print all natural numbers in reverse (from n to 1). - using while loop
- Write a C program to print all alphabets from a to z. - using while loop
- Write a C program to print all even numbers between 1 to 100. - using while loop
- Write a C program to print sum of all even numbers between 1 to n.
- Write a C program to print sum of all odd numbers between 1 to n.
- Write a C program to print table of any number.
- Write a C program to find first and last digit of any number.
- Write a C program to count number of digits in any number.
- Write a C program to calculate sum of digits of any number.
- Write a C program to calculate product of digits of any number.
- Write a C program to swap first and last digits of any number.
- Write a C program to enter any number and print its reverse.
- Write a C program to enter any number and check whether the number is palindrome or not.
- Write a C program to find frequency of each digit in a given integer.
- Write a C program to enter any number and print it in words.
- Write a C program to print all ASCII character with their values.
- Write a C program to enter any number and print all factors of the number.
- Write a C program to enter any number and calculate its factorial.
- Write a C program to find HCF (GCD) of two numbers.
- Write a C program to find LCM of two numbers.
- Write a C program to check whether a number is Prime number or not.
- Write a C program to check whether a number is Armstrong number or not.
- Write a C program to check whether a number is Perfect number or not.
- Write a C program to check whether a number is Strong number or not.
- Write a C program to print Fibonacci series up to n terms.

8. Arrays

- 8.1) Write a C program to search an element in the given array (Linear Search).
- 8.2) Write a C program to perform matrix addition.
- 8.3) Write a C program to perform matrix multiplication.

Practice Programs:

- Write a C program to read and print elements of array.
- Write a C program to find sum of all array elements. - using recursion.
- Write a C program to find maximum and minimum element in an array. - using recursion.
- Write a C program to find second largest element in an array.
- Write a C program to copy all elements from an array to another array.
- Write a C program to insert an element in an array.
- Write a C program to delete an element from an array at specified position.
- Write a C program to print all unique elements in the array.
- Write a C program to print all negative elements in an array.
- Write a C program to count total number of even and odd elements in an array.

- Write a C program to count total number of negative elements in an array.
- Write a C program to count total number of duplicate elements in an array.
- Write a C program to delete all duplicate elements from an array.
- Write a C program to count frequency of each element in an array.
- Write a C program to merge two array to third array.
- Write a C program to find reverse of an array.
- Write a C program to convert lowercase string to uppercase.
- Write a C program to convert uppercase string to lowercase.
- Write a C program to toggle case of each character of a string.
- Write a C program to find total number of alphabets, digits or special character in a string.

9. Pointers

- 9.1) Write a C Program to Perform Addition, Subtraction, Multiplication and Division of two numbers using Command line arguments.
- 9.2) Write a C program to find sum of n elements entered by user. To perform this program, allocate memory dynamically using malloc () function.
- 9.3) Write a C program to find sum of n elements entered by user. To perform this program, allocate memory dynamically using calloc () function.

10. Functions, Array & Pointers

- 10.1) Write a C Program to demonstrate parameter passing in Functions.
- 10.2) Write a C Program to find Fibonacci, Factorial of a number with Recursion and without recursion.
- 10.3) Write a C Program to find the sum of given numbers with arrays and pointers.

Practice Programs:

- Program to change the value of constant integer using pointers.
- Program to print a string using pointer.
- Program to count vowels and consonants in a string using pointer.
- Program to read array elements and print with addresses.

11. Strings

- 11.1) Implementation of string manipulation operations with library function:
 - a) copy
 - b) concatenate
 - c) length
 - d) compare
- 11.2) Implementation of string manipulation operations without library function:
 - a) copy
 - b) concatenate
 - c) length
 - d) compare
- 11.3) Verify whether the given string is a palindrome or not.

12. Structures

- 12.1) Write a C Program to Store Information of a book Using Structure.
- 12.2) Write a C Program to Add Two Complex Numbers by Passing Structure to a Function.

13. Files

- 13.1) Write a C program to open a file and to print the contents of the file on screen.
- 13.2) Write a C program to copy content of one file to another file.
- 13.3) Write a C program to merge two files and store content in another file.

14. Application

Creating structures to capture the student's details save them in file in proper record format, search and prints the student details requested by the user.

Note: Draw the flowcharts using Raptor from Experiment 3 to Experiment 6.

Course Outcomes:

- Implement basic programs in C and design flowcharts in Raptor.
- Use Conditional and Iterative statements to solve real time scenarios in C.
- Implement the concept of Arrays and Modularity and Strings.
- Apply the Dynamic Memory Allocation functions using pointers.
- Develop programs using structures, and Files.

Reference Books:

1. Let Us C Yashwanth Kanetkar, 16th edition, BPB Publications.
2. Programming in C A-Practical Approach Ajay Mittal. Pearson Education.
3. The C programming Language, Dennis Richie and Brian Kernighan, Pearson Education.
4. Problem solving using C , K Venugopal, 3rd Edition, TMG Publication.

Web Links:

1. <https://www.hackerrank.com/>
2. <https://www.codechef.com/>
3. <https://www.topcoder.com/>
4. <https://code-cracker.github.io/>
5. <https://raptor.martincarlisle.com/>
6. <https://nptel.ac.in/courses/106105085/2>

II SEMESTER	L	T	P	C
	-	-	3	1.5
20HS2L02 :: ENGLISH COMMUNICATIONS LAB				

COURSE OBJECTIVES

- To improve the language proficiency of technical under graduates in English with emphasis on LSRW Skills.
- To provide learning environment to practice Listening, Speaking, Reading and Writing Skills within and beyond the classroom environment.
- To assist students to carry on the tasks and activities through guided instructions and materials.
- To effectively integrate English language learning with employability skills and training.
- To design the main course material and exercises with authentic materials drawn from everyday use to cater to everyday needs.
- To provide hands-on experience through case-studies, mini-projects, group and individual presentations.

COURSE OUTCOMES

e) Reading Skills.

- Addressing explicit and implicit meaning of a text.
- Understanding the context.
- Learning new words and phrases.
- Using words and phrases in different contexts.

f) Writing Skills:

- Using the basic structure of a sentence.
- Applying relevant writing formats to create paragraphs, essays, letters, E-Mails, reports and presentations.
- Retaining a logical flow while writing.
- Planning and executing an assignment creatively.

g) Interactive skills:

- Analyzing a topic of discussion and relating to it.
- Participating in discussions and influencing them.
- Communicating ideas effectively.
- Presenting ideas coherently within a stipulated time.

h) Life Skills and Core Skills:

- Examining self-attributes and identifying areas that require improvement self-diagnosis, self-motivation.
- Adopting to a given situation and developing a functional approach to find solutions-adaptability, problem-solving.
- Understanding the importance of helping others-community service, enthusiasm.

RELATIONSHIP OF COURSE TO PROGRAMME OUTCOMES

- A Ability to apply knowledge of mathematics, science, and engineering.
- B Ability to design and conduct experiments, as well as to analyze and interpret data.
- C Ability to design an Engineering system, component, or process.
- D Ability to function on multi-disciplinary teams
- E Ability to identify, formulate and solve engineering problems.
- F Understanding of professional and ethical responsibility.
- G Ability to communicate effectively √
- H Broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context. √
- I Recognition of the need for and an ability to engage in life-long learning.
- J Knowledge of contemporary issues.
- K Ability to use the techniques, skills, and modern engineering tools necessary for engineering practices.
- L Ability to find location of substations and benefits derived through their optimal location.

COURSE DESCRIPTION

Communicating in a language is also a skill. So a student has to look for an opportunity to practice English language in order to acquire proficiency in English. „Enrich your interactive Skills: Part - A“ is designed to provide opportunities for engineering students to revise and consolidate the basic skills in listening, speaking, reading and writing in addition to giving ample practice in various communicative functions and Life skills.

PRE REQUISITES

The student is expected to have basic knowledge in English language and must be able to write in English. He is also expected to possess fundamental knowledge of general English grammar and vocabulary.

SYLLABUS

UNIT	TOPIC
1	Vowels, Consonants, Pronunciation, Phonetic transcripts
2	Word stress and syllables
3	Rhythm and Intonation
4	Contrastive Stress –Homographs
5	Word Stress : Weak and Strong forms , Stress in compound words

Text Book:

“InfoTech English” by Maruthi Publications

Reference Books:

1. Better English Pronunciation by O’ Connor
2. Phonetics and Phonology – Peter Roach
3. A Grammar of Spoken English – Harold Palmer
4. English Phonetics – Bansal and Harrison

Testing Pattern:

B) Internal lab Exam:	30 Marks
Regular performance in the language /communication /lab completion in the lab manual	15M
Written test	15M
B) External lab Exam Pattern:	70 Marks
Written test	30M
Oral test	30M
Viva (during exam marks will be awarded by external examiner)	10M

III SEMESTER	L	T	P	C
	3	-	-	3
20MA3T03 :: VECTOR CALCULUS AND LAPLACE TRANSFORMS				

COURSE OBJECTIVES:

- This course will illuminate the students in the concepts of calculus and Complex Variables .
- To enlighten the learners in the concept of differential equations and vector calculus.

UNIT I: Vector Differentiation

Scalar and vector point functions, vector operator del, del applied to scalar point functions-Gradient, del applied to vector point functions-Divergence and Curl, physical interpretations of div F and curlF.

Learning Outcomes:

At the end of this unit, the student will be able to

- Apply del to scalar and vector point functions (K3)
- Illustrate the physical interpretation of Gradient, Divergence and Curl (K3)

UNIT II: Vector integration

Integration of Vectors-Line integral-circulation-work done, surface integral-flux, Green's theorem in the plane (without proof), Stoke's theorem (without proof), volume integral, Divergence theorem (without proof).

Learning Outcomes:

At the end of this unit, the student will be able to

- Find the work done in moving a particle along the path over a force field (K3)
- Evaluate the rate of fluid flow along and across curves (K3)
- Apply Green's, Stoke's and Divergence theorems in evaluation of double and triple integrals (K3)

UNIT III: Laplace Transforms

Introduction – definition – conditions for the existence, Laplace transforms of elementary functions, properties of Laplace transforms, Laplace Transforms of derivatives and integrals, multiplication by t^n , division by t , evaluation of integrals by Laplace transforms.

Learning Outcomes :

After the completion of this unit student will be able to

- Examine the properties of Laplace transforms (K3)
- Apply the Laplace transforms for different types of functions(K3)

UNIT IV: Inverse Laplace Transforms

Introduction – definition, method of partial fractions, other methods of finding inverse transforms, Convolution theorem, Application to differential equations .

Learning Outcomes :

After the completion of this unit student will be able to

- Apply the Inverse Laplace transforms for different types of functions(K3)

UNIT V: Calculus of complex functions

Introduction –Limit and continuity of $f(z)$, Derivative of $f(z)$ -Cauchy – Riemann equations, Analytic functions, Harmonic functions-Orthogonal system, Applications to flow problems.

Learning Outcomes:

After the completion of this unit student will be able to

- Define continuity, differentiability and analyticity for complex functions(K1)
- Apply Cauchy Riemann equations to complex functions in order to determine whether a given continuous function is analytic (K3)

TEXTBOOKS:

1. B. S. Grewal, Higher Engineering Mathematics, 43/e, Khanna Publishers, 2015.

REFERENCES:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9/e, John Wiley & Sons, 2013.
2. B.V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill, 2007.

COURSE OUTCOMES:

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

1. Interpret the physical meaning of scalar and vector point functions different operators such as Del, gradient, curl and divergence (k3)
2. Estimate the work done against a field, circulation and flux using vector calculus and Familiarize vector integral theorems. (k3)
3. Solve many problems in engineering with the knowledge of laplace (k3)
4. Apply the inverse laplace transforms for different types of functions (k3)
5. Know the fundamentals of the theory of analytic functions (k3)

WEB REFERENCES:

- (1) <https://archive.nptel.ac.in/courses/111/107/111107108/>
- (2) <https://archive.nptel.ac.in/courses/111/106/111106139/>
- (3) <https://nptel.ac.in/courses/111106141>

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

III SEMESTER	L	T	P	C
	3	-	-	3
20ME3T01 :: MECHANICS OF SOLIDS				

COURSE OBJECTIVE:

1. The student will acquire the fundamental concepts of deformable bodies.
2. The student will be able to draw the shear force and bending moment diagrams for various beams.
3. The student will acquire the knowledge to sketch both stress distribution for bending and shear loads for different sections.
4. The student will compute beam deflections under transverse loads using various methods.
5. The student will compute stress in thin cylinder thick cylinder and spheres due to external and internal pressure.

COURSE OUTCOMES: Students are able to

CO1. Calculate stresses and strains in structural members subjected to various types of loadings. [K3]

CO2: Sketch the Shear force and bending moment diagrams of beams subject to combination of loads. [K3]

CO3: Determine and Sketch the stress distribution in section of the beam subjected to Bending and Shear loads. [K3]

CO4: Determine the Shear stresses and Modulus of rigidity, Slope and Deflection in shafts.[K3]

CO5: Evaluate stresses in thin and thick cylinders. [K4]

UNIT -I

SIMPLE STRESSES AND STRAINS: Introduction, Stress, Strain, Types of Stresses, Elasticity and Elastic Limit, Hook’s Law, Elastic Moduli, Modulus of Elasticity, Factor of Safety, Constitutive Relationship between Stress and Strain. Elastic Constants: Introduction, Longitudinal Strain, Lateral Strain, Poisson’s Ratio, Volumetric Strain, Volumetric Strain of a Cylindrical Rod, Sphere and Rectangular block Bulk Modulus, Expression for Young’s Modulus in Terms of Bulk Modulus.

Principal Stresses and Strains: Introduction, Principal Planes and Principal Stresses, Methods of determining stresses on Oblique Section - Analytical Method, Graphical Method, Mohr’s Circle.

UNIT -II

SHEAR FORCE AND BENDING MOMENT: Introduction, Types of Beams, Types of Loads, Sign Conventions for Shear Force and Bending Moment, Shear Force and Bending Moment diagram for a Cantilever, simply supported, Over hanging beams with different loads and combination of loads, Point loads, UDL, UVL and couple. Relation between Load, Shear Force and Bending Moment.

UNIT -III

FLEXURAL STRESSES: Introduction, Pure Bending or Simple Bending, Theory of Simple Bending, Expression for Bending Stress, Neutral Axis and Moment of resistance, Bending Stresses in Symmetrical Sections, Section Modulus, Section Modulus for Various Shapes of Beam Sections, Bending Stress in Unsymmetrical Sections

Shear Stresses: Introduction, Shear Stress at a Section, Shear Stress Distribution for Different Sections like Rectangular, Circular, Triangular, I, T and Angle sections.

UNIT -IV

DEFLECTION OF BEAMS: Introduction, Deflection and Slope of a Beam Subjected to Uniform Bending Moment, Relation between Slope, Deflection and Radius of Curvature, Deflection of a Simply Supported, cantilever Beams Carrying point load and UDL using Macaulay's Method and Moment Area Method. Double integration Method

Torsion:

Introduction, Shear Stress Produced in a Circular, Maximum Torque Transmitted by a Circular Solid Shaft and Hollow Circular Shafts, Power Transmitted by Shafts, Expression for Torque in Terms of Polar Moment of Inertia, Polar Modulus, Strength of a Shaft of Varying Sections, Combined Bending and Torsion.

UNIT -V

THIN CYLINDERS AND SPHERES: Introduction, Stresses in a Thin Cylindrical Vessel Subjected to Internal Pressure, Circumferential Stress, Longitudinal Stress, Efficiency of a Joint, Effect of Internal Pressure on the Dimensions of a Thin Cylindrical Shell, Thin Spherical Shells,

Thick Cylinders: Introduction, Stresses in a Thick Cylindrical Shell, Stresses in Compound Thick Cylinders. Columns and struts: Rankine theory

TEXT BOOKS:

1. R.K.Bansal, A Text Book of Strength of Materials: Mechanics of Solids, 6 th Edition, Laxmi Publications, 2018.
2. R K Rajput, Strength of Materials, 6th Edition, S. Chand Publishing, 2015.
3. James and Gere, Mechanics of materials , 6th edition, Cengage Learning publications, 2010
4. Popov E, Solid Mechanics, 2 nd Edition, Prentice Hall India Learning Private Limited, 2002.

REFERENCES:

1. S.S. Rattan, Strength of Materials ,Mc-Graw Hill Private Limited, 3 rd Edition , New Delhi, 2017
2. Ferdinand P. Beer, E. Russell Johnston Jr. , John T. DeWolf, David F. Mazurek , Mechanics of Materials, 7th Edition, 2014.
3. Stephen P. Timoshenko, James M. Gere, Mechanics of Materials, 2 nd Edition, C B S Publishers, 2011.
4. R. K Bansal, Strength of Materials, Laxmi Publications, New Delhi, Revised 4 th Edition, 2010.

WEB REFERENCES:

1. <https://nptel.ac.in/courses/112102284>
2. <https://nptel.ac.in/courses/112107147>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1								1	3	
CO2	2	2	2	1		2						1	3	
CO3	3	2	1	2		2						1	3	
CO4	3	1	2	1								1	3	
CO5	3	1	1	1		1						1	3	
Avg	3	1.8	1.6	1.2		1						1	3	

III SEMESTER	L	T	P	C
	3	-	-	3
20RB3T01 :: FUNDAMENTALS OF INDUSTRIAL ROBOTICS				

COURSE OBJECTIVE:

1. Understand classification of robots and basic components
2. Get acquainted with performing spatial transformations and solve kinematics of the robot.
3. Get acquainted with performing spatial transformations and solve Dynamics of the robot.
4. Analysis skills associated with trajectory planning and programming a robot.
5. Understand the present & future applications of a robot and working of sensors, drive systems.

COURSE OUTCOMES: Students will be able to

- CO1.** Demonstrate the classification and basic components of robots. [K2]
- CO2.** Apply various motion analysis principles to solve problems involving Manipulator Kinematics. [K3]
- CO3.** Apply Jacobian and Lagrangian principles to solve manipulator Dynamics Problems. [K3]
- CO4.** Program a robot to perform tasks in industrial applications [K3]
- CO5.** Explain working of sensors and various applications of Robots in industry. [K2]

UNIT – I

INTRODUCTION: History of robots, Classification of robots, Present status and future trends. Basic components of robotic system. Basic terminology- accuracy, repeatability, resolution, Degree of freedom. Mechanisms and transmission, End effectors, Grippers-different methods of gripping, Mechanical grippers-slider crank mechanism, screw type, rotary actuators, cam type gripper, magnetic grippers, vacuum grippers, air operated grippers, Specifications of robot.

UNIT – II

MOTION ANALYSIS: Homogeneous transformations as applicable to rotation and translation, problems– Euler Angles.

MANIPULATOR KINEMATICS: D-H Notations, joint coordinates and world coordinates, Forward and inverse kinematics, problems of simple robotic manipulators.

UNIT – III

MANIPULATOR DYNAMICS: Differential transformation of manipulators, Jacobians, Lagrange, Euler and Newton, Euler formulations, Problems.

ROBOT CONTROLS: Point to point control, Continuous path control, Intelligent robot, Control system for robot joint, Control actions, Feedback devices, Encoder, Resolver, LVDT, Motion Interpolations, Adaptive control.

UNIT – IV

TRAJECTORY PLANNING: Trajectory planning: Joint space scheme- cubic polynomial fit, obstacle avoidance in operation space-cubic polynomial fit with via point, blending scheme.

INTRODUCTION TO ROBOTIC PROGRAMMING: On-line and off-line programming, programming examples.

UNIT – V

SENSORS: Internal sensors- Position sensors, & Velocity sensors, External sensors-Proximity sensors, Tactile Sensors, & Force or Torque sensors.

ROBOT APPLICATIONS IN MANUFACTURING: Material Transfer, Machine loading and un-loading operations, processing operations - spot and continuous arc welding & spray painting, Assembly operations, Inspection, Safety in robotics, Training, maintenance.

DRIVE SYSTEM: hydraulic, pneumatic and electric systems

TEXT BOOKS:

1. Industrial Robotics -Mikell P. Groover, Mitchell Weiss, Roger N. Nagel, Nicholas G. Odrey/TATA McGraw-Hill Education 1986
2. Robotics and Control - R.K. Mittal, I. J. Nagrath / Tata Mc Graw Hill Publishing Company Ltd 2003
3. Introduction to Robotics / John J. Craig/ Pearson 2019

REFERENCES:

1. Robotics, control Sensing, vision and intelligence - K.S. Fu, R.C.Gonzalez, C.S.G Lee / Tata Mc Graw Hill Education. 1987
2. Introduction to Robotics – Analysis, Systems, Applications – Saeed B. Niku / Pearson Education 2011
3. Robot Analysis – Mechanics of Serial and Parallel Manipulators - Lung-Wen Tsai, John-Wiley Publications, New York.1999

WEB REFERENCES:

1. <https://archive.nptel.ac.in/courses/112/105/112105249/>
2. <https://archive.nptel.ac.in/courses/112/108/112108298/>
3. <https://archive.nptel.ac.in/courses/112/107/112107289/>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3											1	2	
CO2	3	3	2									1	2	
CO3	3	2	2									1	2	
CO4	3	2	2									1	2	
CO5	3											1	2	
Avg	3	1.4	1.2									1	2	

III SEMESTER	L	T	P	C
	3	-	-	3
20RB3T02 :: ENGINEERING MATERIALS				

COURSE OBJECTIVE:

1. Understand properties of metals, crystal structure and grain size.
2. Understand the phase diagrams of materials and Strengthening Mechanisms.
3. Familiarize properties and applications of ceramics, composite materials.
4. Explain the properties and classification of cast irons and steels.
5. Analyze properties of non-ferrous metals and alloys.

COURSE OUTCOMES: Students will be able to

CO1. Explain the properties of metals with respect to crystal structure and grain size [K2]

CO2 .Interpret the phase diagrams of materials and describe the concept of Strengthening Mechanisms [K2]

CO3. Describe the concept of heat treatment and Case hardening of steels [K1]

CO4. Distinguish different types of steels, ool and cast irons [K2]

CO5. Explain Properties and Applications of Nonferrous alloys and composite materials. [K2]

UNIT-I

ENGINEERING MATERIALS: Introduction, Classification of Materials, Mechanical Properties of Materials, Case Study: Delhi Iron Pillar and Wootz Steel.

CRYSTALLOGRAPHY: Unit cell, Classification, Bravais Lattices, Packing factor and coordination number in cubic systems, Miller Indices for Cubic systems, Imperfections in solids- point, line and volume, slip and twinning, Determination of grain size.

UNIT –II

MECHANISM OF CRYSTALLIZATION: Nuclei Formation, crystal growth

CONSTITUTION OF ALLOYS: Types of solid solution- substitutional and interstitial solid solutions, Hume Rothery rules for solid solution.

PHASE DIAGRAMS: Phase, Phase equilibrium, Gibbs Phase rule – one component system, two component system, Construction of binary phase diagram- isomorphous, eutectic, eutectoid, peritectic and peritectoid systems, Fe-Fe₃C equilibrium diagram, Lever rule-Isomorphous. **STRENGTHENING MECHANISMS:** Grain Refinement, Strain hardening, Solid solution strengthening, Dispersion strengthening.

UNIT – III

HEAT TREATMENT PROCESSES: Stages of heat treatment, TTT and CCT diagram of eutectoid steel, Annealing- full annealing, spheroidizing, stress relief annealing, process annealing, Normalizing, Hardening, Tempering- austempering, martempering.

CASE HARDENING: Flame hardening, Induction hardening, Carburizing, Cyaniding, Nitriding.

UNIT – IV

STEELS: Stainless steels- ferritic, martensitic, austenitic, Tool steels- water hardened, shock resistance, cold-work, hot-worked tool steels, properties , applications .

CAST IRONS: Structure, Properties and Applications- white cast iron, malleable cast iron, grey cast iron, spheroidal graphite cast iron.

UNIT – V

NON-FERROUS METALS AND ALLOYS: Properties and Applications of Copper and its alloys- cartridge brass, cupronickel, gun metal, naval brass, bell metal, speculum metal, phosphor bronze.

ALUMINIUM AND ITS ALLOYS: Duralumin, Hindalium, Magnalium, Aluminium–Scandium,

TITANIUM AND ITS ALLOYS: α and Near α , β Alloys, α - β Alloys.

COMPOSITE MATERIALS: Classification of composites, particle reinforced materials, fiber reinforced composite materials and metal matrix composites.

TEXT BOOKS:

1. V. Rahghavan , Materials Science and Engineering: A First Course, 6th edition., PHI Publications, 2015.
2. Sidney H. Avener , Introduction to Physical Metallurgy, 2nd edition, Tata McGraw Hill Edition. 1997.

REFERENCE BOOKS:

1. V.D. Kodgire, S.V.Kodgire ,Material science and metallurgy,42nd edition, Everest Publishing House. 2018
2. R.Balasubramaniam , Material Science and Engineering 2nd edition, Wiley India,2014.
3. O.P.Khanna ,Material Science & Metallurgy, 2nd edition , Dhanpatrai publications,2014.
4. R.K.Rajput, Engineering materials and metallurgy, Revised edition , S.Chand& company, New Delhi, 2012

WEB REFERENCES:

1. <https://nptel.ac.in/courses/113102080>
2. <https://archive.nptel.ac.in/courses/112/108/112108150/>
3. <https://archive.nptel.ac.in/courses/113/107/113107078/>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1									1	1	
CO2	3	1	1	1								1	2	
CO3	3	1	3	1		1						2	1	2
CO4	3		3	2		1					2	2	3	
CO5	3		3	2		1					2	2	3	
Avg	3	0.8	2.2	1.2		0.6					0.8	1.6	2	0.4

III SEMESTER	L	T	P	C
	3	-	-	3
20RB3T03 :: MACHINE TOOLS				

COURSE OBJECTIVES:

1. The course provides students with fundamental knowledge and principles in material removal processes.
2. In this course, the students apply the fundamentals and principles of metal cutting to practical applications through multiple labs using lathes, milling machines, grinding machines, and drill presses, Computer Numerical Control etc.

COURSE OUTCOMES: Student are able to

- CO1: Explain the fundamentals of machining processes and machine tools. (K2)
- CO2: Describe different types of Lathe operations. (K2)
- CO3: Explain different types of planner and slotter operations. (K3)
- CO4: Describe working principles of milling machine. (K4)
- CO5: Explain different types of finishing process (K2)

UNIT – I: FUNDAMENTALS OF MACHINING: 12

Metal cutting theory -element of cutting process , geometry of single point tool angles, chip formation and types of chips, built up edge and its effects, chip breakers, mechanics of orthogonal cutting - Merchant's force diagram, cutting forces, cutting speeds, feed, depth of cut, tool life, coolants, tool materials.

UNIT – II: LATHE: 12

Engine lathe - principle of working, specification of lathe , types of lathe , work holders tool holders , taper turning, thread turning - attachments, Constructional features of speed gear box and feed gear box, Turret and capstan lathes, Collet , Chucks, other work holders, Tool holding devices - box and tool layout, Principal features of automatic lathes - classification , single spindle and multi-spindle automatic lathes , tool layout and cam design for automats.

UNIT – III: SHAPING, SLOTTING AND PLANNING MACHINES: 12

Shaping, slotting and planning machines-Principles of working , principal parts , specifications, operations performed, machining time calculations.

DRILLING MACHINES: Principles of working, Specifications, Types, Operations Performed, Tool holding devices, Twist drill

UNIT – IV: BORING AND MILLING MACHINES:

Boring Machines - fine Boring machines , jig boring machine, deep hole drilling Machine. Milling Machine- Principles of working, specifications , classification , principle features of horizontal, vertical and universal Milling Machine, machining operations, types of cutters, geometry of milling cutters , methods of indexing, accessories to milling machines.

UNIT –V: FINISHING PROCESSES:

12

Theory of grinding ,Classification of grinding machines- cylindrical and surface grinding machines, tool and cutter grinding machines, Different types of abrasives, bonds, specification and selection of a grinding wheel, Lapping, Honing & Broaching operations- comparison to grinding. Jigs & fixtures- Principles of design of jigs and fixtures and uses, classification of jigs & fixtures.

TEXT BOOKS:

1. 1 R.K. Jain and S.C. Gupta, Production Technology,16th Edition, Khanna Publishers, 2017
2. S kalpak Jian S R. schemed, Manufacturing- Engineering and Technology, 7th Edition, Pearson publications, 2014.
3. B. S. Raghuvamsi, Workshop Technology - Vol. - II, 2nd edition, Dhanapat Rai publications 2016.

REFERENCES:

1. R. K. Jain, Production Technology, 16th Edition, Khanna publishers, 2017.
2. P.N Rao, Manufacturing Technology Vol-II, 5th Edition, Tata McGraw Hill Publications, 2018
3. M.C. Shaw, Metal cutting Principles, 2nd edition, CBS publications, 2002.

WEB REFERENCES:

1. <https://archive.nptel.ac.in/courses/112/105/112105127/>
2. <https://archive.nptel.ac.in/courses/112/105/112105233/>
3. <https://nptel.ac.in/courses/112105127>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1										1	3	
CO2	3											1	3	
CO3	3	1										1	3	
CO4	3											1	3	
CO5	3											1	3	
Avg	3	0.4										1	3	

III SEMESTER	L	T	P	C
	-	-	3	1.5
20RB3L01 :: BASIC ROBOTICS LAB				

COURSE OBJECTIVE

- To introduce different types of robotics and demonstrate them to identify different parts and components.
- To write programming for simple operations.

COURSE OUTCOMES: Students are able to

CO1. Perform the programming operation for pick and place operation. [K3]

CO2. Perform the programming for machining operations like cutting and welding [K3]

CO3. Demonstrate the forward and inverse kinematics of Robots [K3]

LIST OF EXPERIMENTS:

1. Determination of maximum and minimum position of links.
2. Verification of transformation (Position and orientation) with respect to gripper and world coordinate system
3. Estimation of accuracy, repeatability and resolution.
4. Robot programming and simulation for pick and place operation.
5. Robot programming and simulation for any industrial process (Packaging, Assembly)
6. Robot programming and simulation for machining (cutting, welding)
7. Robot programming and simulation for multi process.
8. Robot programming and simulation for Color identification.
9. To analyze Forward kinematics of robots.
10. To analyze Inverse kinematics of robots.

III SEMESTER	L	T	P	C
	-	-	3	1.5
20RB3L02 :: ENGINEERING MATERIALS LAB				

COURSE OBJECTIVE:

To impart practical exposure on the microstructures of various materials and their hardness evaluation. Also to impart practical knowledge on the evaluation of material properties through various destructive testing procedures.

COURSE OUTCOMES: Students are able to

CO1. Perform the tensile ,bending and torsion tests [K3]

CO2. Perform the hardness tests and determine the hardness of metals [K3]

CO3. Calculate torsional rigidity and elasticity modulus of the shaft. [K3]

CO4. Identify and compare microstructure of the material with standard structure. [K2]

CO5. Perform Jomney end quench test and find the hardenability of steel. [K2]

SECTION – A

MATERIAL TESTING LAB:

1. Direct tension test
2. Bending test
3. Torsion test
4. Hardness test
 - A) Brinell’s hardness test
 - B) Rockwell hardness test
5. Test on springs.
6. Impact test

SECTION – B

METALLURGY LAB:

1. Preparation and study of the Micro Structure of pure metals like Iron, Cu and Al.
2. Preparation and study of the Microstructure of Mild steels, low carbon steels, high – C steels.
3. Study of the Micro Structures of Cast Irons.
4. Study of the Micro Structures of Non-Ferrous alloys.
5. Study of the Micro structures of Heat treated steels.
6. Hardenability of steels by Jomney End Quench Test.
7. To find out the hardness of various treated and untreated steels.

Note: ANY 5 EXPERIMENTS FROM EACH SECTION A AND B

III SEMESTER	L	T	P	C
	-	-	3	1.5
20RB3L03 :: MACHINE TOOLS LAB				

COURSE OBJECTIVES:

1. To Study working system and important parts and functions of the Machines like Lathe, Drilling, Milling, shaping and Slotting Machine.
2. To Study material, geometry of tools used in metal cutting like single point, multi-point cutting tools.
3. To practice machining operations like plain turning, step turning, taper turning and thread cutting on Lathe Machines.
4. Also practice on Machines to perform operations like drilling, grinding, key way cutting, gear cutting. Learn working on Tool and cutter grinding machine and cylindrical grinding machine

COURSE OUTCOMES: Students are able to

- CO1. Perform various machining operations in Lathe machine. [K3]
- CO2. Perform various machining operations in Shaping machine. [K3]
- CO3. Perform various machining operations in Milling machine. [K3]
- CO4. Perform various machining operations in Drilling machine. [K3]
- CO5. Perform various machining operations in Slotting machine. [K3]
- CO6. Perform various machining operations in Grinding machine. [K3]

COURSE CONTENT:

1. Study of general purpose machines – lathe machine, drilling machine, milling machine, shaper machine, slotting machine, grinding machine, and Surface grinder
2. Step turning on lathe machine.
3. Taper turning on lathe machine
4. Thread cutting on lathe machine.
5. Knurling on lathe machine.
6. Drilling and Tapping.
7. Shaping operations.
8. Slotting operations.
9. Milling operations.
10. Surface grinding operations.

III SEMESTER	L	T	P	C
	-	-	4	2
20RB3S01 :: MATLAB PROGRAMMING				

COURSE OBJECTIVES:

- To provide the exposure to the students about MATLAB programming.
- To provide hands on experience on MATLAB program for various applications.

COURSE OUTCOMES;

Students are able to

CO1.Perform fundamental engineering computing in MATLAB environments and using simple commands.

[K4]

CO2. Perform 2D and 3D plotting and make communication with Excel in MATLAB software. [K4]

CO3. Apply conditional statements to obtain solutions. [K4]

CO4. Make loops in MATLAB programs to obtain solutions. [K4]

CO5. Write program using MATLAB to solve simple Engineering problems.[K4]

Topic to be covered

1. MATLAB environment and commands
2. Linear Algebra and matrices
3. Fundamental engineering computing
4. Save, load, display and fprintf commands
5. Communication with Excel
6. 2D and 3D plotting
7. Solutions to systems of linear equations
8. Conditional statements
9. Loops
10. MATLAB scripts and functions
11. Polynomials, including differentiation and integration
12. Using MATLAB for simple engineering problems

III SEMESTER	L	T	P	C
	2	-	-	-

20CE3M01 :: ENVIRONMENTAL SCIENCE

UNIT-I: Multidisciplinary nature of Environmental Studies:

Definition, Scope and Importance –Sustainability: Stockholm and Rio Summit–Global Environmental Challenges: Global warming and climate change, acid rains, ozone layer depletion, population growth and explosion, effects; Role of information technology in environment and human health.

Ecosystems: Concept of an ecosystem. - Structure and function of an ecosystem; Producers, consumers and decomposers. - Energy flow in the ecosystem - Ecological succession. - Food chains, food webs and ecological pyramids; Introduction, types, characteristic features, structure and function of Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems.

UNIT-II: Natural Resources:

Natural resources and associated problems. Forest resources: Use and over – exploitation, deforestation – Timber extraction – Mining, dams and other effects on forest and tribal people.

Water resources: Use and over utilization of surface and ground water – Floods, drought, conflicts over water, dams – benefits and problems.

Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources.

Food resources: World food problems, changes caused by non-agriculture activities-effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity.

Energy resources: Growing energy needs, renewable and non-renewable energy sources use of alternate energy sources.

Land resources: Land as a resource, land degradation, Wasteland reclamation, man induced landslides, soil erosion and desertification; Role of an individual in conservation of natural resources; Equitable use of resources for sustainable lifestyles.

UNIT-III: Biodiversity and its conservation:

Definition: genetic, species and ecosystem diversity-classification - Value of biodiversity: consumptive use, productive use, social-Biodiversity at national and local levels. India as a mega-diversity nation - Hot-spots of biodiversity - Threats to biodiversity: habitat loss, man-wildlife conflicts. - Endangered and endemic species of India – Conservation of biodiversity: conservation of biodiversity.

UNIT – IV Environmental Pollution:

Definition, Cause, effects and control measures of Air pollution, Water pollution, Soil pollution, Noise pollution, Nuclear hazards. Role of an individual in prevention of pollution. - Pollution case studies, Sustainable Life Studies. Impact of Fire Crackers on Men and his wellbeing.

Solid Waste Management: Sources, Classification, effects and control measures of urban and industrial solid wastes. Consumerism and waste products, Biomedical, Hazardous and e – waste management.

UNIT – V Social Issues and the Environment:

Urban problems related to energy -Water conservation, rain water harvesting-Resettlement and rehabilitation of people; its problems and concerns. Environmental ethics: Issues and possible solutions. Environmental Protection Act -Air (Prevention and Control of Pollution) Act. –Water (Prevention and control of Pollution) Act -Wildlife Protection Act -Forest Conservation Act-Issues involved in enforcement of environmental legislation. -Public awareness.

Environmental Management: Impact Assessment and its significance various stages of EIA, preparation of EMP and EIS, Environmental audit. Ecotourism, Green Campus – Green business and Green politics.

The student should Visit an Industry / Ecosystem and submit a report individually on any issues related to Environmental Studies course and make a power point presentation.

Text Books:

1. K. V. S. G. Murali Krishna , Environmental Studies,VGS Publishers, Vijayawada, 2010
2. R. Rajagopalan, Environmental Studies, 2nd Edition, Oxford University Press, 2011
3. P. N. Palanisamy, P. Manikandan, A. Geetha, and K. Manjula Rani, Environmental Studies, 2nd Edition , Pearson Education, Chennai,2015

Reference:

1. Deeshita Dave & P. Udaya Bhaskar Text Book of Environmental Studies, Cengage Learning, 2011
2. Shaashi Chawla, A Textbook of Environmental Studies, TMH, New Delhi,2017
3. Benny Joseph, Environmental Studies, Tata McGraw Hill Co, New Delhi, 2006
4. Anubha Kaushik, C P Kaushik , Perspectives in Environment Studies, New Age International Publishers, 2014

IV SEMESTER	L	T	P	C
	3	-	-	3
20CS4T04 :: PYTHON PROGRAMMING				

COURSE OUTCOMES:

At the end of the course students are able to

1. Recognize core programming basics and program design with functions using Python programming language.
2. Interpret the high-performance programs designed to strengthen the practical expertise.
3. Develop applications for real time problems by applying python data structure concepts.
4. Understand and apply the concepts of packages, handling, multithreading and socket programming.
5. Analyze the importance of object-oriented programming over structured programming.
6. Design user interface using case study for application development.

UNIT – I:

Introduction: History of Python, Need of Python Programming, Applications Basics of Python Programming Using the REPL(Shell), Running Python Scripts, Variables, Assignment, Keywords, Input-Output, Indentation.

UNIT – II:

Types, Operators and Expressions: Types - Integers, Strings, Booleans; Operators- Arithmetic Operators, Comparison (Relational) Operators, Assignment Operators, Logical Operators, Bitwise Operators, Membership Operators, Identity Operators, Expressions and order of evaluations Control Flow- if, if-elif-else, for, while, break, continue, pass

UNIT – III:

Data Structures Lists - Operations, Slicing, Methods; Tuples, Sets, Dictionaries, Sequences. Comprehensions.

UNIT – IV:

Functions - Defining Functions, Calling Functions, Passing Arguments, Keyword Arguments, Default Arguments, Variable-length arguments, Anonymous Functions, Fruitful Functions(Function Returning Values), Scope of the Variables in a Function - Global and Local Variables.

Modules: Creating modules, import statement, from. Import statement, name spacing,

Python packages, Introduction to PIP, Installing Packages via PIP, Using Python Packages

UNIT – V:

Object Oriented Programming OOP in Python: Classes, 'self variable', Methods, Constructor Method, Inheritance, Overriding Methods, Data hiding.

Error and Exceptions: Difference between an error and Exception, Handling Exception, try except block, Raising Exceptions, User Defined Exceptions

TEXT BOOKS

1. Mark Lutz, Learning Python, O'rielly, 5th edition, 2013

2. Vamsi Kurama, Python Programming: A Modern Approach, Pearson, 2nd edition, 2018.

REFERENCE BOOKS:

1. Kenneth A, Introduction to Python, Lambert, Cengage, 2e, 2019.
2. W.Chun, Core Python Programming, Pearson, 2e, 2006.
3. Allen Downey, Think Python, Green Tea Press

WEB REFERENCES:

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2. https://onlinecourses.nptel.ac.in/noc21_cs78/preview
3. https://onlinecourses.nptel.ac.in/noc20_cs83/preview

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	2			2					3	
CO2	3	3	3	3	2			2					3	
CO3	3	3	3	3	3			2					3	
CO4	3	3	3	3	3			3					3	
CO5	3	3	3	3	3			3					3	
Avg	3	3	3	3	2.6			2.4					3	

IV SEMESTER	L	T	P	C
	3	-	-	3
20ME4T01 :: THEORY OF MACHINES				

COURSE OBJECTIVES

The objectives of the course are as follows:

1. To impart knowledge on various terminologies, criteria and analysis methods related to mechanisms, various mechanisms with lower pairs and their applications.
2. To impart skills to analyze the position, velocity and acceleration of mechanisms.
3. To familiarize higher pairs like cams and gears.
4. To analyze the effect of gyroscopic couple and also to construct turning moment diagrams.
5. To impart mathematical methods for estimating rotary and reciprocating unbalance in mechanisms and machines. And also to familiarize with the Governors.

COURSE OUTCOMES: Students will be able to

- CO1. Analyze and explain** the terminology and criteria of mechanisms as well as working of mechanisms with lower pairs [K3]
- CO2. Analyze** the velocity of various links in mechanisms using velocity diagrams or instantaneous center method as well as **determine** the acceleration of links using acceleration diagrams. [K3]
- CO3. Design and analyze** Cams for specified motion and follower and also can **explain** the terminology of Gears as well as **analyze** Gears and Gear Trains kinematically. [K4]
- CO4. Analyze** the effect of gyroscopic couple on planes and ships as well as **Construction** of turning moment diagrams and **apply** them in designing flywheels. [K4]
- CO5. Estimate** unbalances force in rotating members and reciprocating mechanisms and **Solve** problems of Governors. [K3]

UNIT-I: SIMPLE MECHANISMS

Basics of Mechanisms and Machines: Types of links, Degrees of freedom, Kinematic pairs – lower pairs and higher pairs, Kinematic chains, mechanisms, Machines, Mobility (Grubler–Kutzbach criterion), inversions - Grashof’s conditions for 4-bar chain, inversions of slider crank chain and double slider crank chain with their applications

Mechanisms with Lower Pair: Pantograph, Exact Straight-Line Mechanisms – Peaucellier, Hart and Scott Russell mechanisms, Approximate Straight-Line Mechanisms – Grasshopper, Watt, Tchebicheff and Robert Mechanisms, Modified Scott Russell mechanism, Hooke’s Joint.

UNIT-II: VELOCITY & ACCELERATION DIAGRAMS

Velocity and Acceleration Analysis of Mechanisms: Velocity and acceleration, Motion of link in machine – Determination of Velocity Acceleration diagram for a given mechanism, Coriolis acceleration- determination of Coriolis component of acceleration.

Plane motion of body: Instantaneous center of rotation, centrodes and axodes – relative motion between two bodies, Three centers in line theorem, Graphical determination of instantaneous center, Diagrams for Simple mechanisms and determination of angular velocity of points and links.

UNIT-III: CAMS, GEARS & GEAR TRAINS:

CAMS : Introduction, classification of cams and followers, cam profiles for knife edge, roller and flat faced followers for uniform velocity, uniform acceleration and simple harmonic motion.

Gears & Gear Trains: Gear – Types and profile, nomenclature of spur & helical gears, Laws of gearing – interference, requirement of minimum number of teeth in gears, Gear trains – simple, compound and reverted gear trains, Determination of speed and torque in epicyclic gear trains.

UNIT-IV: GYROSCOPE and TURNING MOMENT DIAGRAMS:

Gyroscope: Principle of Gyroscopic effect, effect of precession motion on the stability of airplanes and ships.

Turning Moment Diagrams: Introduction, Turning moment diagram for single and multi-cylinder engines- Fluctuation of energy, coefficient of fluctuation of speed, Energy stored in Flywheel- flywheel in punching press.

UNIT-V: BALANCING OF MASSES AND GOVERNORS

Balancing of Rotating Masses: Static and dynamic balancing-balancing of single rotating mass by balancing masses in same plane and in different planes.

Balancing of Reciprocating Masses: Inertia effect of crank and connecting rod, unbalance in slider crank mechanism

Governors: Introduction, centrifugal governor, watt, porter and Proell governors, spring loaded governors, hartnell and hartung with auxiliary springs

TEXT BOOKS:

1. S.S Rattan, Theory of Machines, 5th Edition, Tata McGrawHill, 2017
2. Thomas Bevan, Theory of Machines, 3rd edition, CBS Publishers & Distributors, 2009.

REFERENCE BOOKS:

1. R. K. Bansal, Theory of Machines, 5th Edition, Laxmi Publications (P)Ltd., 2016
2. John J. Uicker, Gordon R. Pennock, Joseph E. Shigley, Theory of Machines And Mechanisms, 4th Edition, Oxford University Press, 2014
3. Cleghorn W.L., Nikolai Dechev, Mechanics of Machines, Oxford University Press, 2015.
4. Ghosh A. and Mallick A.K., Theory of Mechanisms and Machines, 3rd Edition, Affiliated East-West Pvt. Ltd, New Delhi, 2008.
5. Robert L. Norton, Kinematics and Dynamics of Machinery, SIE, Tata McGrawHill, 2017.
6. R S Khurmi, Theory of Machines, 14th Edition, S. Chand, 2017.

WEB REFERENCES:

1. <https://archive.nptel.ac.in/courses/112/104/112104121/>
2. <https://nptel.ac.in/courses/112101096>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1			2						1	3	
CO2	3	3	2	2		1						1	3	
CO3	3	3	3	2		1						1	3	
CO4	3	3	3	2								3	3	
CO5	3	3	3	2								3	3	
Avg	3	2.8	2.4	1.6		0.8						1.8	3	

IV SEMESTER	L	T	P	C
	3	-	-	3
20MA4T07 :: PROBABILITY AND STATISTICS				

Course Objectives:

1. To familiarize the students with the foundations of probability and statistical methods
2. To impart probability concepts and statistical methods in various applications of Engineering
3. To introduce the correlation and regression and method of least squares

Unit-1 Probability:

Probability, probability axioms, addition law and multiplicative law of probability, conditional probability, Baye's theorem, random variables (discrete and continuous), probability density functions, properties, mathematical expectation.

Learning Outcomes:

At the end of this unit, the student will be able to

- define the terms trial, events, sample space ,probability and laws of probability (K₁)
- make use of probabilities of events in finite sample space from experiments (K₃)
- apply Baye's theorem to real time problems(K₃)
- explain the notion of random variable, distribution functions and expected value(K₂)

Unit-2 Probability distributions:

Probability distributions:Binomial, Poisson and normal distribution –their properties.

Learning Outcomes:

At the end of this unit, the student will be able to

- apply Binomial and Poisson distributions for real data to compute probabilities, theoretical frequencies (K₃)
- interpret the properties of normal distribution and its applications (K₂)

Unit-3 Sampling distribution and Testing of hypothesis, large sample tests:

Basic terminology in sampling, sample techniques (with and without replacement), sampling distribution of means for large and small samples (with known and unknown variance).

Formulation of null hypothesis, alternative hypothesis, the critical and acceptance regions, level of significance, two types of errors.

Large Sample Tests: Test for single proportion, difference of proportions, test for single mean and difference of means. Confidence interval for parameters in one sample and two sample problems

Learning Outcomes:

At the end of this unit, the student will be able to

- explain the concept of sampling distribution for large and small samples (K₂)
- apply the concept of hypothesis testing for large samples (K₄)

Unit-4 Small sample tests:

Student t-distribution (test for single mean, two means and paired t-test), testing of equality of variances (F-test),Chi-square test for goodness of fit and independence of attributes.

Learning Outcomes:

At the end of this unit, the student will be able to

- apply the concept of testing of hypothesis for small samples to draw the inferences (K₃)
- estimate the goodness of fit (K₃)

Unit-5 Curve Fitting and Correlation:

Curve Fitting: Method of least squares -Fitting a straight line, Second degree parabola -exponential curve-power curves

Correlation: Simple correlation, correlation coefficient (for ungrouped data), rank correlation. Linear regression, regression lines, regression coefficients.

Learning Outcomes:

At the end of this unit, the student will be able to

- adopt correlation methods and principle of least squares and regression lines (K₃)

Course Outcomes:

At the end of this unit, the student will be able to

1. make use of the concepts of probability and their applications (k₃)
2. apply discrete and continuous probability distributions(K₃)
3. use the components of a classical hypotheses test(K₃)
4. examine Significance tests based on small and large sampling tests(K₃)
5. use correlation methods and principle of least squares, regression lines (K₃)

Books:

1. Probability and Statistics by Dr. K. Murugesan & P. Gurusamy, Anuradha Publications, 2011
2. Higher Engineering Mathematics, 43rd Edition, Khanna Publications by Dr. B.S. Grewal, 2012

Reference:

1. Ramana B.V., Higher Engineering Mathematics, Tata Mc Graw Hill New Delhi 11th Reprint 2010
2. Miller & Freund Probability and statistics for engineers by Richard A. Johnson, PHI publications, 2011

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1. <https://archive.nptel.ac.in/courses/111/102/111102134/>
2. <https://archive.nptel.ac.in/courses/111106137/>

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

IV SEMESTER	L	T	P	C
	3	-	-	3
20RB4T01 :: FUNDAMENTALS OF CNC MACHINES				

COURSE OBJECTIVES:

- The main objective of this course is that the students will learn the importance of CNC machines.
- To understand the different types of CNC Machines and their features.
- By undergoing this subject the students will learn to use the CNC machines efficiently for manufacturing desired products and knowledge of programming and use of CNC tooling.

COURSE OUTCOMES: Students are able to

CO1: Explain the construction features of CNC machine tools.

CO2: Illustrate the various types of Accessories and feedback devices used in CNC machines.

CO3: Explain the working of Position transducer as well as Control systems and Interfaces.

CO4: Analyze the Automatically Programming Tool Language and develop a program on different examples

CO5: Analyze the CNC Programming tools and develop a program on different examples.

UNIT – I

Introduction to CNC Machine tools: Evolution of Computerized control in manufacturing, Components, Working principle of CNC, DNC and Machining centers.

Constructional features of CNC machine tools: Introduction, Spindle drives, Transmission belting, axes feed drives, Slide ways, Ball screws.

UNIT – II

Accessories: Work tables, Spindles, Spindle heads, Beds and Columns, Tooling – Automatic Tool changer (ATC).

Feedback devices: Introduction, Digital incremental displacement measuring systems, Incremental rotary encoders, Digital absolute measuring system.

UNIT –III

Electro-magnetic analogue position transducers: Principle, advantages, characteristics, Synchros, Synchro-Resolvers, Inductos, Laser interferometer.

Control Systems and interface: Open and closed loop systems, Microprocessor based CNC systems, block diagram of typical CNC system, description of hard ware and soft interpolation systems, Standard and optional features of CNC control systems.

UNIT – IV

APT programming: APT language structure, APT geometry, Definition of point, time, vector, circle, plane, patterns and matrices. APT motion commands: setup commands, point-to point motion commands, continuous path motion commands, post processor commands, control commands, Macro subroutines, Part programming preparation for typical examples.

UNIT – V

CNC Programming: Part programming fundamentals, Preparatory functions, Miscellaneous functions, Programming number, Canned cycles, Tool length compensation, Cutter Radius compensation, Sub Programs, Part programming preparation for typical examples.

TEXT BOOKS:

1. RadhaKrishnanan, “Computer Numerical Control Machines” New Central Book Agency, 1st edition, 2013.
2. Yoram Koren, “Computer Control of manufacturing systems” McGraw Hill Education, 1st edition, 2017
3. P N RAO, “CAD/CAM Principles and Applications” McGraw Hill Education, 3rd edition, 2017

REFERENCES:

1. Peter Smid, “CNC Programming Hand book” 2nd edition, 2003.
2. B S V Ramarao, “Optimization of Computer Numerical Control Machine output parameters” LAP Lambert Academic Publishing, 1st edition, 2020.

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1. <https://archive.nptel.ac.in/courses/112/105/112105211/>
2. <https://archive.nptel.ac.in/courses/112/105/112105306/>

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

IV SEMESTER	L	T	P	C
	3	-	-	3
20BM4T01 :: MANAGERIAL ECONOMICS AND FINANCIAL ANALYSIS				

UNIT-I Managerial Economics and Demand Analysis: Definition – Nature and Scope of Managerial Economics - Relation with other disciplines - Concept of Demand-Types-Determinants - Law of Demand - Elasticity of Demand - Types and Measurement-Demand forecasting.

UNIT-II Production and Cost Analysis: Production function - Law of Variable proportions - Isoquants and Iso costs -Law of returns- Economies of Scale - Cost Concepts - Cost Volume Profit Analysis – Applications of BEP (Simple Problems).

UNIT-III Market Structures and Pricing Policies: Perfect Competition, Monopoly, Monopolistic Competition and Oligopoly – Features – Price & Output Determination - Pricing Methods

UNIT-IV Forms of Organizations and Business Cycles: Business Organization- Sole Trader – Partnership - Joint Stock Company - State/Public Enterprises and their forms - Business Cycles: Meaning and Features - Phases of Business Cycle.

UNIT-V Capital Budgeting and Accounting: Concept and sources-Techniques of evaluating capital budgeting(Simple problems)

Introduction to Accounting: Branches-Systems of Accounting-Single Entry-Double Entry System-Journal-Ledger-Trail Balance-Final Accounts-Ratio Analysis(Simple problems)

TEXTBOOKS:

1. Aryasri: Managerial Economics and Financial Analysis, 2/e, TMH, 2005.
2. T.V.Ramana & B. Kuberudu: Managerial Economics and Financial Analysis, Himalaya Publishing House, Mumbai
3. Varshney & Maheswari: Managerial Economics, Sultan Chand, 2003.

REFERENCE BOOKS:

1. Ambrish Gupta, Financial Accounting for Management, Pearson Education, New Delhi.
2. H. Craig Peterson & W. Cris Lewis, Managerial Economics, PHI, 4th Ed.
3. Suma Damodaran, Managerial Economics, Oxford University Press.
4. Lipsey & Chrystel, Economics, Oxford University Press.
5. S. A. Siddiqui & A. S. Siddiqui, Managerial Economics & Financial Analysis, New age International Space Publications.
6. Domnick Salvatore: Managerial Economics in a Global Economy, 4th Edition, Thomson.
7. Narayanaswamy: Financial Accounting A Managerial Perspective, PHI.
8. Raghunatha Reddy & Narasimhachary: Managerial Economics & Financial Analysis, Scitech.
9. S.N. Maheswari & S.K. Maheswari, Financial Accounting, Vikas.

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1. <https://nptel.ac.in/courses/110101005>
2. <https://nptel.ac.in/courses/122106031>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		3				1					2	1		1
CO2		3				2					1	2		2
CO3		2				2					2	2		1
CO4		2				2					2	2		1
CO5		2				2					2	2		1
Avg		2.4				1.08					1.08	1.08		1.2

IV SEMESTER	L	T	P	C
	-	-	3	1.5
20CS4L04 :: PYTHON PROGRAMMING LAB				

COURSE OUTCOMES:**At the end of the course students are able to**

- | | |
|---|-----------|
| CO1: Apply core programming basics and program design with functions using Python | K4 |
| CO2: programming language. | K3 |
| CO3: Interpret the high-performance programs designed to strengthen the practical expertise. | K3 |
| CO4: Develop applications for real time problems by applying python data structure | K4 |
| CO5: concepts. | K4 |
| CO6: Test and apply the concepts of packages, handling, multithreading and socket programming. | K3 |
| Divide the importance of object oriented programming over structured programming. | |
| Design user interface using case study for application development. | |

Exercise 1 - Basics

- Running instructions in Interactive interpreter and a Python Script
- Write a program to purposefully raise Indentation Error and correct it

Exercise 2 - Operations

- Write a program to compute distance between two points taking input from the user(Pythagorean Theorem)
- Write a program add.py that takes 2 numbers as command line arguments and prints its sum.

Exercise - 3 Control Flow

- Write a Program for checking whether the given number is an even number or not.
- Using a “for loop”, write a program that prints out the decimal equivalents of 1/2, 1/3, 1/4, . . .1/10
- Write a program using a “for loop” that loops over a sequence. What is sequence?
- Write a program using a “while loop” that asks the user for a number, and prints a countdown from that number to zero.

Exercise 4 - Control Flow - Continued

- Find the sum of all the primes below two million. Each new term in the Fibonacci sequence is generated by adding the previous two terms. By starting with 1 and 2, the first 10 terms will be: 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, ...
- By considering the terms in the Fibonacci sequence whose values do not exceed four million, find the sum of the even-valued terms.

Exercise - 5 - DS

- Write a program to count the numbers of characters in the string and store them in a dictionary data structure
- Write a program to use split and join methods in the string and trace a birthday with a dictionary data structure.

Exercise - 6 DS - Continued

- a) Write a program combine lists that combines these lists into a dictionary.
- b) Write a program to count frequency of characters in a given file. Can you use character frequency to tell whether the given file is a Python program file, C program file or a text file?

Exercise - 7 Files

- a) Write a program to print each line of a file in reverse order.
- b) Write a program to compute the number of characters, words and lines in a file.

Exercise - 8 Functions

- a) Write a function ball collides that takes two balls as parameters and computes if they are colliding. Your function should return a Boolean representing whether or not the balls are colliding.
Hint: Represent a ball on a plane as a triple of (x, y, r), r being the radius
If (distance between two balls centers) \leq (sum of their radii) then (they are colliding)
- b) Find mean, median, mode for the given set of numbers in a list.

Exercise - 9 Functions - Continued

- a) Write a function nearly equal to test whether two strings are nearly equal. Two strings A and B are nearly equal when a can be generated by a single mutation on B.
- b) Write a function dups to find all duplicates in the list.
- c) Write a function unique to find all the unique elements of a list.

Exercise - 10 - Functions - Problem Solving

- a) Write a function cumulative product to compute cumulative product of a list of numbers.
- b) Write a function reverse to reverse a list. Without using the reverse function.
- c) Write function to compute GCD, LCM of two numbers. Each function shouldn't exceed one line.

Exercise 11 - Multi-D Lists

- a) Write a program that defines a matrix and prints
- b) Write a program to perform addition of two square matrices
- c) Write a program to perform multiplication of two square matrices

Exercise - 12 - Modules

- a) Install packages requests, flask and explore them using (pip)
- b) Write a script that imports requests and fetch content from the page. Eg. (Wiki)
- c) Write a simple script that serves a simple HTTP Response and a simple HTML Page

Exercise - 13 OOP

- a) Class variables and instance variable and illustration of the self-variable
 - i) Robot
 - ii) ATM Machine

IV SEMESTER	L	T	P	C
	-	-	3	1.5
20ME4L01 :: THEORY OF MACHINES LAB				

COURSE OBJECTIVE:

- Expose the students practically to the concepts they studied in Theory of Machines subject.

COURSE OUTCOMES: Students will be able to

- CO1: **Analyze** basic mechanisms like four bar mechanism, single slider crank chain and double slider crank chain mechanisms [K3]
- CO2: **Analyze** kinematically working of cams with various types of followers [K3]
- CO3: Experimentally **determine** the performance characteristics of different types of governors [K4]
- CO4: **Estimate** unbalance existing in mechanisms [K4]

LIST OF EXPERIMENTS

1. A study on a combination of Four bar Mechanisms
2. A study on single slider crank and double slider crank chain mechanisms.
3. Analyze the motion of Cam and follower.
4. To study various types of gears.
5. To perform experiment on watt Governor to prepare performance characteristic Curves, and to find stability & sensitivity
6. To perform experiment on porter Governor to prepare performance characteristic Curves, and to find stability & sensitivity.
7. To perform experiment on proell Governor to prepare performance characteristic Curves, and to find stability & sensitivity.
8. To perform experiment on Hartnell loaded Governors to prepare performance characteristic Curves, and to find stability & sensitivity.
9. To verify the torque relation for gyroscope.
10. To determine moment of inertia of flywheel.
11. To perform the experiment for static balancing on static balancing machine.
12. To perform the experiment for dynamic balancing on dynamic balancing machine.
13. To demonstrate whirling of a shaft

Note: Any 10 out of above 13 are to be executed

IV SEMESTER	L	T	P	C
	-	-	3	1.5
20RB4L01 :: CNC PROGRAMMING LAB				

COURSE OBJECTIVE

To impart knowledge in CNC programming for turning and milling operations.

COURSE OUTCOMES: Students will be able to

CO1: Develop simple CNC program for various operations in CNC Lathe and CNC Milling machines.
[K2]

CO2: Develop CNC program from the component drawings. [K3]

LIST OF EXPERIMENTS:

Generate a program for following operations by using G codes and M codes on CNC lathe and milling machines.

1. **CNC Lathe:** Machining of Mechanical components like

- Facing Operation
- Turning Operation
- Multiple Turning Operation
- Threading Operation

2. **CNC Milling:** Machining of simple components like

- Linear and Circular Interpolation.
- Mirroring
- Rotation
- Circular Pocketing
- Rectangular Pocketing

IV SEMESTER	L	T	P	C
	-	-	4	2
20RB4S01 :: ROBO ANALYZER				

COURSE OBJECTIVE:

- Expose the students about RoboAnalyzer software and make them use of it to learn robotics concepts.

COURSE OUTCOMES: Students will be able to

CO1: **Identify** geometry of robot and understand the coordinate frames and transformations. [K2]

CO2: **Analyze** the workspace of 6 axis robot and create joint trajectories. [K2]

CO3: **Develop** application oriented tasks using RoboAnalyzer. [K6]

COURSE CONTENTS:

1. Introduction to RoboAnalyzer – Usage of RoboAnalyzer
2. Industrial Robots – Virtual Models of Industrial Robots
3. Application: Control a virtual robot using a joystick, DH Parameters, Robot Geometry - Understanding coordinate frames and transformations,
4. Robot Kinematic Analysis - Forward kinematics of robots - Inverse kinematics of robots - Case Study: Kinematics of MTAB Mini Robot ,
5. Workspace Analysis - Case Study: Workspace Analysis of a 6 axis robot,
6. Robot Dynamics – Inverse and Forward dynamics of robots,
7. Trajectory Planning – Creating robot joint trajectories ,
8. Cartesian Motion of Industrial Robots - Application: Writing a welding profile using a virtual robot

IV SEMESTER	L	T	P	C
	2	-	-	-

20BM4M01 :: INDIAN CONSTITUTION

UNIT I: Introduction to Indian Constitution-Constitution meaning of the term, Indian Constitution - Sources and constitutional history, Features - Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy.

UNIT II: Union Government and Administration Structure of the Indian Union: Federalism, Centre State relationship, President: Role, powers and position, PM and Council of ministers, Cabinet and Central Secretariat, Lok Sabha, Rajya Sabha, The Supreme Court and High Court: Powers and Functions

UNIT III: State Government and its Administration Governor - Role and Position - CM and Council of ministers, State Secretariat: Organisation, Structure and Functions

UNIT IV: Local Administration - District's Administration Head - Role and Importance, Municipalities - Mayor and role of Elected Representative - CEO of Municipal Corporation PachayatiRaj: Functions of Pachayat Raj Institution: Zila Panchayat, Elected officials and their roles, CEO Zila Panchayat: Block level Organizational Hierarchy - (Different departments), Village level - Role of Elected and Appointed officials - Importance of grass root democracy.

UNIT V: Election Commission: Election Commission- Role of Chief Election Commissioner and Election Commissionerate -State Election Commission: Functions of Commissions for the welfare of SC/ST/OBC and women.

TEXTBOOKS:

1. Durga Das Basu, Introduction to the Constitution of India, Prentice Hall of India Pvt. Ltd.
2. SubashKashyap, Indian Constitution, National Book Trust
3. J.A. Siwach, Dynamics of Indian Government & Politics

REFERENCE BOOKS:

1. D.C. Gupta, Indian Government and Politics
2. H.M.Sreevai, Constitutional Law of India, 4th edition in 3 volumes (Universal Law Publication)
3. J.C. Johari, Indian Government and Politics Hans
4. J. Raj Indian Government and Politics
5. M.V. Pylee, Indian Constitution Durga Das Basu, Human Rights in Constitutional Law, Prentice – Hall of India Pvt. Ltd.. New Delhi
6. Noorani, A.G., (South Asia Human Rights Documentation Centre), Challenges to Civil Right), Challenges to Civil Rights Guarantees in India, Oxford University Press 2012.

e-Resources:

- 1) nptel.ac.in/courses/109104074/8
- 2) nptel.ac.in/courses/109104045/
- 3) nptel.ac.in/courses/101104065/
- 4) www.hss.iitb.ac.in/en/lecture-details
- 5) www.iitb.ac.in/en/event/2nd-lecture-institute-lecture-series-indian-constitution

V SEMESTER	L	T	P	C
	3	-	-	3

20RB5T01 :: INTRODUCTION TO MICROPROCESSORS AND MICROCONTROLLERS

COURSE OBJECTIVES:

- To learn the basics of digital electronics and understand the operation of logic gates.
- To understand the working of adders and subtractors and analyze different types of decoders, encoders, code converters, multiplexers and comparators.
- To enumerate the architecture and fundamentals of microprocessors.
- To know about the interfacing hardware used in microprocessor, interfacing of a microcontroller

COURSE OUTCOMES: Students are able to

- CO1.** Classify different number systems and Understand Digital Logic gates.[K2]
- CO2.** Explain different elements used in combinational and sequential logic circuits. [K2]
- CO3.** Explain the microprocessor architecture and execute programs based on 8086 microprocessors. [K2]
- CO4:** Describe 8086 system bus structure and advanced processors. [K2]
- CO5:** Describe the memory Interfacing and I/O interfacing circuits. [K2]

UNIT-I DIGITAL ELECTRONICS

Number systems - binary number system, signed binary numbers, binary arithmetic, floating point representation of numbers, 1’s, 2’s, 9’s and 10’s complement arithmetic, BCD, octal and hexadecimal number system, weighted & non weighted binary codes, error detecting and correcting codes. **Logic Gates-** Digital signals, NAND and NOR operations, Exclusive-OR and Exclusive NOR operations, Basic laws and fundamental theorems of Boolean algebra, Canonical (SOP and POS) forms, simplification of logic functions using K-Map, don’t care conditions.

UNIT-II COMBINATIONAL AND SEQUENTIAL LOGIC CIRCUITS

Combinational Logic circuits - adders and their use as subtractors, parallel binary adder, carry look ahead adder, binary multiplier and divider, multiplexers, demultiplexers, decoders, encoders, code converters, comparators.

Sequential logic circuits - classification, latches and flip-flops, SR-latch, D-latch, D flip-flop, JK flip-flop, T flip-flop, registers and counters, shift registers, asynchronous sequential circuits. **Memories** - classification of memories-RAM, ROM, PROM, EEPROM.

UNIT III THE 8086 MICROPROCESSORS

Introduction to 8086, Microprocessor architecture, addressing modes, Instruction set and assembler directives, Assembly language programming, Modular Programming, Byte and string manipulation.

UNIT IV 8086 MICROPROCESSOR PROGRAMMING

8086 signals, Basic configurations, System bus timing, System design using 8086 – I/O programming, Introduction to Multiprogramming, System Bus Structure, Multiprocessor configurations, Coprocessor, Introduction to advanced processors.

UNIT V MICROCONTROLLER

Architecture of 8051, Special Function Registers (SFRs), I/O Pins Ports and Circuits, Instruction set, Addressing modes. **Interfacing Microcontroller** - programming 8051 Timers - serial port programming, interrupts programming, LCD & Keyboard Interfacing, ADC, DAC & Sensor Interfacing, External Memory Interface, Stepper Motor and Waveform generation, Comparison of Microprocessor, Microcontroller.

TEXT BOOKS:

1. M. Morris Mano, Michael D. Ciletti, "Digital Design", 6th Edition, Pearson, 2018.
2. Dhanasekharan Natarajan, "Fundamentals of Digital Electronics" 2nd edition, Springer International Publishing, 2021.
3. Mathur Sunil, Microprocessor 8086: Architecture, Programming and Interfacing, PHI Learning Pvt. Ltd, 2011.
4. Yu-Cheng Liu, Glenn A.Gibson, "Microcomputer Systems: The 8086 / 8088 Family - Architecture, Programming and Design", Second Edition, Prentice Hall of India, 2007.
5. Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D.McKinlay, The 8051 Microcontrollers and Embedded systems Using Assembly and C, 2nd Edition, Pearson, 2011.

REFERENCE BOOKS:

1. John F. Wakerly, "Digital Design Principles and Practices", 5th Edition, Pearson Education, 2018.
2. Charles H. Roth, Jr., Larry L Kinney, Eugene B. John, "Fundamentals of Logic Design" 7th Edition, Cengage Learning, 2020.
3. A.K.Ray, K.M.Bhurchandi, "Advanced Microprocessors and Peripherals" 3rd edition, Tata McGraw Hill, 2017.
4. Douglas V Hall, SSSP Rao, Microprocessors and Interfacing – Programming and Hardware, 3rd Edition, Tata McGraw Hill Education Private Limited, 2012.

WEB REFERENCES:

1. https://onlinecourses.nptel.ac.in/noc21_ee18/preview
2. <https://nptel.ac.in/courses/108105132>
3. <https://nptel.ac.in/courses/106105185>
4. https://www.tutorialspoint.com/microprocessor/microcontrollers_8051_architecture.htm

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3				1	1	1					1	1	
CO2	3	2			1	1	1					1	2	
CO3	3				1	1	1					1	1	
CO4	3				1	1	1					1	1	
CO5	3	2	1		1	1	1					1	1	
Avg	3	0.8	0.2		1	1	1					1	1.2	

V SEMESTER	L	T	P	C
	3	-	-	3

20RB5T02 :: INTERNET OF THINGS

COURSE OBJECTIVE:

- To discuss the fundamentals relating to IoT, Things in IoT, Communication Models and APIs
- To learn the difference between M2M and IoT and familiarize the concepts of SDN and Network Virtualization.
- To enumerate various hardware used for IoT Applications
- To learn the use of IoT through various case studies
- To learn the concepts, applications of IIoT and Industry 4.0.

COURSE OUTCOMES: Students are able to

- CO1:** Summarize the basic principles, physical and logical design, functional blocks, communication systems and API of IoT systems. [K2]
- CO2:** Differentiate between IoT and M2M technologies, explain the concepts of Software Defined Networks (SDN) and Network Virtualization. [K2]
- CO3:** Describe hardware components used for computing, communicating, sensing, actuation, I/O interfaces in IoT. [K2]
- CO4:** Summarize the applications of IoT through various case studies. [K2]
- CO5:** Explain the concepts of IIoT and Industry 4.0, their requirements and benefits [K3]

UNIT – I

INTRODUCTION TO IOT

Defining IoT, characteristics of IoT, physical design of IoT, logical design of IoT, functional blocks of IoT, communication models & APIs.

UNIT – II

IOT & M2M

Basics of networking, M2M and IoT technology fundamentals, devices and gateways, Software defined networks (SDN), Network Virtualization.

UNIT -III

ELEMENTS OF IOT

Hardware components- computing (Arduino, Raspberry Pi), Communication, Sensing, Actuation, I/O interfaces.

UNIT – IV

IOT CASE STUDIES

IoT case studies and mini projects based on industrial automation, transportation, agriculture, healthcare, home automation.

UNIT – V

INDUSTRIAL INTERNET OF THINGS (IIOT)

Key IIOT technologies, catalysts and precursors of the IIoT, innovation and the IIoT, intelligent devices, key opportunities and benefits, Industry 4.0 - definition, four main characteristics, design principles, building blocks, Smart manufacturing.

TEXT BOOKS:

1. Shriram K Vasudevan, Abhishek S Nagarajan, RMD Sundaram, Internet of Things Paperback, 2nd edition, Wiley, 2019.
2. stAlasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, 1st edition, A press, 2017.
3. Arsheep Bahga, Vijay Madiseti, Internet of Things: A Hands-On Approach Paperback, 1st Edition, Orient Black swan Private Limited, 2015.

REFERENCE BOOKS:

1. Dimitrios Serpanos, Marilyn Wolf, “Internet-of-Things (IoT) Systems: Architectures, Algorithms, Methodologies”, 1st Edition, Springer, 2018.
2. Marco Schwartz, Internet of Things with Arduino Cookbook, Packt Publishing Limited, 2016.
3. Rajkumar Buyya, Amir Vahid Dastjerdi, Internet of Things: Principles and Paradigms, 1st edition, Morgan Kaufmann, 2016.
4. Dieter Uckelmann, Mark Harrison, Florian Michahelles, Architecting the Internet of Things, Springer, 2011.

WEB REFERENCES:

1. <https://nptel.ac.in/courses/106105166>
2. <https://nptel.ac.in/courses/108108098>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2		3	3								2	2	
CO2	2		2	3										
CO3	3													
CO4		2					2		2	2		2	2	
CO5	2	3	3	2									2	
Avg	1.8	1	1.6	1.6			0.4		0.4	0.4		0.8	1.2	

V SEMESTER	L	T	P	C
	3	-	-	3

20RB5T03 :: CONTROL SYSTEMS

COURSE OBJECTIVES

- To enable the students to understand the requirement and importance of controls system and its functions.
- To learn the methods for analyzing the behavior of nonlinear control systems and the designing of control systems.

COURSE OUTCOMES: Students are able to

CO1: Explain linear systems, deduce mathematical model, obtain block diagrams/signal flow graphs and to obtain Transfer function [K2]

CO2: Analyze the time response and time response specifications with steady state error for various types of input. [K4]

CO3: Identify complete performance of the system will be satisfactory and the operation is stable [K2]

CO4: Explain the Frequency response analysis using Bode plot, Polar Plot and Nyquist plot Method [K2]

CO5: Explain concept of state variable, state space, nonlinear system, nonlinear characteristics. [K2]

UNIT – I

MATHEMATICAL MODELING OF CONTROL SYSTEMS: Introduction, Open Loop and Closed Loop control systems and their differences, Classification of control systems, Feedback characteristics, Transfer function of linear systems, Differential equations of electrical networks, Translational and Rotational mechanical systems, Transfer function of DC serve motor, Block diagram algebra, Signal flow graph, Reduction using Mason's gain formula.

UNIT – II

TIME RESPONSE ANALYSIS: Introduction-Standard Test Signals, Time Response of First Order Systems, Time Response of Second Order Systems, Time Domain Specifications, Steady State Errors and Error Constants, Effects of PI, PD and PID Controllers.

UNIT – III

STABILITY AND ROOT LOCUS TECHNIQUE: The concept of stability, Routh's Hurwitz stability criterion, Relative Stability analysis, limitations of Routh's stability, Root locus concept, construction of root loci, effect of addition of poles and zeros root locus

UNIT – IV

FREQUENCY RESPONSE ANALYSIS: Introduction to frequency domain specifications , Bode diagrams, transfer function from the Bode diagram, phase margin and gain margin, stability analysis from Bode plots, Polar plots, Nyquist stability criterion.

UNIT- V

STATE SPACE ANALYSIS: 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 it’s properties, concepts of controllability and observability.

TEXT BOOKS:

1. Katsuhiko Ogata, Modern Control Engineering Prentice, 7th Edition, Hall of India, New Delhi, 2016.
2. Benjamin C. Kuo, Automatic control systems, 9th Edition, John Wiley & Sons, Inc, 2010.

REFERENCE BOOKS:

1. M Gopal, IJ Nagrath, Control System Engineering, 6th Edition, Generic, 2017.
2. Dhanesh Manik, Control Systems, 1st edition, Cengage Learning India, 2012.
3. S.Palani, Control Systems Engineering, 2nd edition, Tata Mc Graw Hill Publications, 2010.

WEB REFERENCE:

1. <https://nptel.ac.in/courses/107106081>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2		1	1						3	
CO2	3	3	2	2		1	1						3	
CO3	3	3	2	2		1	1						2	1
CO4	3	3	2	2		1	1						3	
CO5	3	3	2	2		1	1						2	
Avg	3	3	2	2		1	1						2.6	0.2

V SEMESTER (PROFESSIONAL ELECTIVE I)	L	T	P	C
	3	-	-	3
20RB5E01 :: HUMANOID ROBOTICS				

COURSE OBJECTIVES:

- To learn the kinematics and dynamics of Humanoid Robots
- To learn the generation of biped walking patterns and control
- To the different methods for generation of Whole Body Motion Patterns
- To the methods for simulating humanoid robot dynamics

COURSE OUTCOMES: Students are able to

- CO1:** Explain the kinematics of humanoid Robots [K2]
- CO2:** Describe the dynamics of humanoid Robots [K2]
- CO3:** Interpret different walking patterns and its generation.[K2]
- CO4:** Explain the different methods for generation of whole body motion patterns [K2]
- CO5:** Describe the dynamic simulation, dynamics of rotating rigid body [K2]

UNIT – I INTRODUCTION TO KINEMATICS

Coordinate Transformations, Characteristics of Rotational Motion, Velocity in Three-dimensional Space, Robot Data Structure and Programming, Kinematics of a Humanoid Robot.

UNIT – II ZERO MOMENT POINT& DYNAMICS

Zero Moment Point (ZMP) and Dynamics, ZMP and Ground Reaction Forces, Measurement of ZMP, Dynamics of Humanoid Robots, Calculation of ZMP from Robot’s Motion.

UNIT – III BIPED WALKING

Biped Walking, Two Dimensional Walking Pattern Generation, 3D Walking Pattern Generation, ZMP Based Walking Pattern Generation, Stabilizer, Pioneers of Dynamic Biped Walking Technology, Additional Methods for Biped Control.

UNIT – IV GENERATION OF WHOLE BODY MOTION PATTERNS

Patterns to Dynamically Stable Motion, Remote Operation of Humanoid Robots with Whole Body Motion Generation, Reducing the Impact of a Humanoid Robot Falling Backwards Whole Body Motion, Converting Whole Body Motion.

UNIT – V DYNAMIC SIMULATION

Dynamic Simulation, Dynamics of Rotating Rigid Body, Spatial Velocity, Dynamics of Rigid Body, Dynamics of link system, Forward and Inverse dynamics, Featherstone’s method.

TEXT BOOKS:

1. Shuuji Kajita, Hirohisa Hiruka wa, Kensuke Harada and Kazuhito Yokoi, Introduction to Humanoid Robotics, 1st Edition, Springer, 2014.
2. Dragomir N. Nenchev, Atsushi Konno, Teppei Tsujita, Humanoid Robots, Modelling and Control, 4th Edition, Butterworth-Heinemann, 2019

3. Matthias Hackel, Humanoid Robots: Human like Machines, 3rd Edition I-Tech Education and Publishing, 2019.

REFERENCE BOOKS:

1. Jürgen Handke, Humanoide Roboter Showcase, Partner und Werkzeug, 2nd Edition, 2020.
2. Mordechai Ben-Ari, Francesco Mondada, Elements of Robotics, 1st Edition, Springer, 2017.

WEB REFERENCES:

1. <https://www.youtube.com/watch?v=aafrygMri38>
2. <https://archive.nptel.ac.in/courses/112/104/112104308/>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	2			1						2	3	
CO2	3	1	2			1						2	3	
CO3	3	1	2			1						2	3	
CO4	3	1	2			1						2	3	
CO5	3	1	2			1						2	3	
Avg	3	1	2			1						2	3	

V SEMESTER (PROFESSIONAL ELECTIVE I)	L	T	P	C
	3	-	-	3
20RB5E02 :: MACHINE VISION				

COURSE OBJECTIVES:

- To know about the principles and applications of vision system in modern manufacturing environment
- To learn about the algorithms in vision and recognition of object
- To be familiar about the components used for vision and its applications

COURSE OUTCOMES:

Students are able to

CO1 Explain the functions of components of vision systems. [K2]

CO2. Describe the image capturing and processing techniques [K2]

CO3. Interpret vision system in other machines [K2]

CO4. Knowledge for recognizing the objects. [K2]

CO5. Knowledge in application of vision and image processing in robot operations. [K2]

UNIT I VISION SYSTEM

Basic Components, Elements of visual perception, Lenses, Pinhole cameras, Gaussian Optics, Cameras, Camera-computer interfaces.

UNIT II VISION ALGORITHMS

Fundamental Data Structures- Images, Regions, Sub-pixel Precise Contours, Image Enhancement -Gray value transformations, image smoothing, Fourier Transform, Geometric Transformation, Image segmentation, Segmentation of contours, lines, circles and ellipses, Camera calibration, Stereo Reconstruction.

UNIT III OBJECT RECOGNITION

Object recognition, Approaches to Object Recognition, Recognition by combination of views – objects with sharp edges, using two views only, using a single view, use of dept values.

UNIT IV APPLICATIONS

Transforming sensor reading, Mapping Sonar Data, Aligning laser scan measurements - Vision and Tracking-following the road, Iconic image processing, Multiscale image processing, Video Tracking, Learning landmarks-landmark spatiograms, K-means Clustering, EM Clustering.

UNIT V ROBOT VISION

Basic introduction to Robotic operating System (ROS), Real and Simulated Robots, Introduction to OpenCV, Open NI and PCL, installing and testing ROS camera Drivers, ROS to OpenCV - The cv bridge Package.

TEXT BOOKS:

1. Carsten Steger, Markus Ulrich, Christian Wiedemann, “Machine Vision Algorithms and Applications”, WILEY-VCH, Weinheim,2008.
2. Damian M Lyons,“Cluster Computing for Robotics and Computer Vision”, World Scientific, Singapore, 2011.

REFERENCE BOOKS:

1. Rafael C. Gonzalez and Richard E.woods, “Digital Image Processing”, Addition - Wesley Publishing Company, New Delhi, 2007.
2. Shimon Ullman, “High-Level Vision: Object recognition and Visual Cognition”, A Bradford Book, USA, 2000.
3. R.Patrick Goebel, “ ROS by Example: A Do-It-Yourself Guide to Robot Operating System – Volume I”, A Pi Robot Production, 2012.

WEB REFERENCES:

1. https://www.assemblymag.com/ext/resources/White_Papers/Sep16/Introduction-to-Machine-Vision.pdf
2. <https://www.nowpublishers.com/article/DownloadSummary/ROB-001>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3			3				2	1		2	2	
CO2	3	3			3				2	1		2	2	
CO3	3	3			3				2	1		2	2	
CO4	3	3			3				2	1		2	2	
CO5	3	3			3				2	1		2	2	
Avg	3	3			3				2	1		2	2	

V SEMESTER (PROFESSIONAL ELECTIVE I)	L	T	P	C
	3	-	-	3
20RB5E03 :: HYDRAULICS AND PNEUMATICS				

COURSE OBJECTIVES:

- To provide students with knowledge on the application of fluid power in process, construction and manufacturing industries.
- To provide students with an understanding of the fluids and components utilized in modern industrial fluid power system.
- To develop a measurable degree of competence in the design, construction and operation of fluid power circuits

COURSE OUTCOMES: The students are able to

CO1: Explain the Fluid power and operation of different types of pumps.[K2]

CO2: Summarize the features and functions of hydraulic, actuators and Flow control valves. [K2]

CO3; Explain the different types of hydraulic circuits and systems. [K2]

CO4 Explain the working of different pneumatic circuits and systems. [K2]

CO5 Summarize the various troubleshooting methods and applications of hydraulic and pneumatic systems. [K2]

UNIT I FLUID POWER PRINCIPLES AND HYDRAULIC PUMPS

Introduction to Fluid power, Advantages and Applications, Fluid power systems – types of fluids, properties of fluids and selection, Basics of Hydraulics – Pascal’s Law, principles of flow, Friction loss, work, power and torque problems,

Sources of Hydraulic power : Pumping Theory, Pump classification, construction, working, design, advantages, disadvantages, performance, Selection criteria of Linear and Rotary, Fixed and Variable displacement pumps – Problems.

UNIT II HYDRAULIC ACTUATORS AND CONTROL COMPONENTS

Hydraulic Actuators: Cylinders – types and construction, application, Hydraulic cushioning, Hydraulic motors, Control Components - direction control, Flow control and pressure control valves – types, construction and operation, Servo and proportional valves – applications, Accessories - Reservoirs, Pressure Switches, Applications, Fluid Power ANSI symbols, Problems.

UNIT III HYDRAULIC CIRCUITS AND SYSTEMS: Accumulators, Intensifiers, Industrial hydraulic circuits – regenerative, Pump Unloading, Double- Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical hydraulic servo systems.

UNIT IV PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS: Properties of air, Perfect Gas Laws, Compressor – filters, regulator, lubricator, muffler, air control valves, quick exhaust valves, pneumatic actuators, Design of Pneumatic circuit – cascade method, Electro pneumatic system – elements, ladder diagram, problems, Introduction to fluidics and pneumatic logic circuits.

UNIT V TROUBLESHOOTING AND APPLICATIONS: Installation, Selection, Maintenance, Troubleshooting and remedies in hydraulic and pneumatic systems, Design of hydraulic circuits for drilling, planning, shaping, surface grinding, press and forklift applications, Design of pneumatic circuits for pick and place applications and tool handling in CNC Machine tools, Low cost Automation, Hydraulic and Pneumatic power packs.

TEXT BOOKS:

1. Anthony Esposito, “Fluid Power with Applications”, 5th edition, Pearson Education, 2015.
2. Majumdar S.R., “Oil Hydraulics Systems- Principles and Maintenance”, 7th edition, Tata McGraw- Hill, 2016.

REFERENCES BOOKS:

1. Anthony Lal, “Oil hydraulics in the service of industry”, 9th edition, Allied publishers, 2012.
2. Dudleyt, A. Pease and John T. Pippenger, “Basic Fluid Power”, 7th edition, Prentice Hall, 2007.
3. Majumdar S.R., “Pneumatic systems – Principles and maintenance”, 8th edition, Tata McGraw Hill, 2015
4. Michael J, Prinches and Ashby J. G, “Power Hydraulics”, 12th edition, Prentice Hall, 2009.
5. Shanmugasundaram.K, “Hydraulic and Pneumatic controls”, 7th edition, Chand & Co, 2016.

WEB REFERENCE:

1. <https://archive.nptel.ac.in/courses/112/106/112106300/>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		1	2		1	1					1		1
CO2	3		1	2		1	1					1		1
CO3	3		1	2		1	1					1		1
CO4	3		1	2		1	1					1		1
CO5	3		1	2		1	1					1		1
Avg	3		1	2		1	1					1		1

V SEMESTER (PROFESSIONAL ELECTIVE I)	L	T	P	C
	3	-	-	3
20RB5E04 :: SENSORS FOR ENGINEERING APPLICATIONS				

COURSE OBJECTIVES:

1. To learn the various sensors that are to be measured in real life instrumentation.
2. To select the right process or phenomena on which the sensor should depend on.
3. To be aware of the various sensors available for measurement and control applications.

COURSE OUTCOMES:

Students are able to

CO1. Explain the operation of various sensors and transducers in their respective fields. [K2]

CO2. Explain Sensors for mechanical systems or mechanical sensors [K2]

CO3. Identify and select the right process or phenomena of thermal sensors [K3]

CO4. Explain the magnetic sensors used in various applications. [K2]

CO5. Summarize the different types of Electrical sensors. [K2]

UNIT - Introduction to sensors and transducers:

Need for sensors in the modern world. Different fields of sensors based on the stimuli - various schematics for active and passive sensors. Static and dynamic characteristics of sensors.

Unit-II Mechanical Sensors:

Introduction, Inductive sensors, Sensitivity and Linearity of the sensor, Materials, Capacitive sensor, Parallel plate capacitor sensor, Piezoelectric Elements, Piezoelectric Materials, Deformation Modes & Multimorphs.

Unit-III Thermal Sensors:

Introduction, Gas thermometric sensor, Thermal expansion type thermometric sensor, Acoustic temperature sensor, Thermistors, Thermo EMF sensor, Materials for Thermo EMF sensor, Thermo couple construction.

Unit-IV Magnetic Sensor:

Introduction, Sensors and principles behind, The Yoke coil sensor, The Coaxial type sensor, Force and Displacement sensor, Hall Effect, The Hall Effect sensor.

Unit-V Smart Sensors:

Introduction, Primary Sensor, Compensation, Data Communication, The Automation.

Introduction, Film Sensors, Thick Film Sensors, Thin Film Sensors, MEMS, Micro Machining, Nano Sensors.

Introduction, On Board Automobile Sensors (Automotive Sensors), Pressure Sensors, Temperature Sensors, Torque and Position Sensors, Home Appliance Sensors.

TEXT BOOKS:

1. D.Patranabis, "Sensors and Transducers", PHI Private limited, Second edition, 2008.
2. Julian W. Gardner, Vijay K. Varadan, Osama O. Awadelkarim "Microsensors, MEMS and Smart Devices", New York: Wiley, 2013.

REFERENCE:

1. Jacob Fraden, "Handbook of Modern Sensors, Physics, Designs, and Applications", Springer.
2. Manabendra Bhuyan, "Intelligent Instrumentation Principles and Applications", CRC Press.
3. Randy Frank, "Understanding Smart Sensors", Second edition, Artech House
4. Clarence W. de Silva, "Sensor systems: Fundamentals and applications" CRC Press, 2016 Edition, ISBN 9781498716246.

WEB RESOURCES:

1. <https://nptel.ac.in/courses/108108147>
2. <https://www.nap.edu/read/4782/chapter/8>
3. <https://www.coursera.org/lecture/industrial-internet-of-things/sensor-technology-and-industrial-applications-cNbVG>
4. <https://www.te.com/usa-en/industries/sensor-solutions.html>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1										2	
CO2	2	3			2	2							2	
CO3	1	2	2		2	2							2	
CO4	1	2			1	1							2	
CO5	2	2			1	1							2	
Avg	1.8	2.2	0.6		1.2	1.2							2	

V SEMESTER (PROFESSIONAL ELECTIVE I)	L	T	P	C
	3	-	-	3
20ME5E04 :: PRODUCTION PLANNING AND CONTROL				

COURSE OBJECTIVES:

- To understand functions of production planning and control.
- To crack various forecasting problems.
- To solve inventory problems using ABC, VED and EOQ models.
- To find the new facility location and layout using Algorithms.
- To solve the production scheduling problems and understand the recent trends.

COURSE OUTCOMES: Students are able to

- CO1. Explain the objectives and functions of production planning and control. [K2]
- CO2. Solve the various forecasting problems in production planning. [K3]
- CO3. Calculate the required quantities of materials by using ABC, VED and EOQ models. [K3]
- CO4. Determine the new facility location and layout problems. [K3]
- CO5. Apply scheduling techniques to solve the scheduling problems and explain the recent trends. [K3]

UNIT I

INTRODUCTION

Production Planning and Control - objectives, functions, elements of production control, Types of production, Organization of production planning and control department, Internal organization of department

UNIT II

FORECASTING

Forecasting - importance of forecasting, types of forecasting, applications, General principles of forecasting, Forecasting techniques, Qualitative and Quantitative methods

UNIT III

INVENTORY AND MATERIAL MANAGEMENT

Inventory Management - functions of inventories, relevant inventory costs, ABC analysis, VED analysis, EOQ model, Inventory control systems, P and Q Systems
 Material Management: Material requirement planning, Manufacturing resource planning, Capacity Requirement Planning

UNIT IV

FACILITY LOCATION AND FACILITY LAYOUT

Facility Location - factors influencing plant location, location alternatives, single facility location, multifacility facility location, Warehouse Location.
 Facility Layout - objectives, layout classification, layout design procedure, CRAFT, ALDEP and CORELAP methods

UNIT V

SCHEDULING AND RECENT TRENDS

Sequencing, Master production schedule, Scheduling - performance measures, Gantt chart, standard scheduling methods: one-machine n job problem, two-machine n job problem, three-machine n job problem.

Recent Trends: Enterprise resource planning, Lean manufacturing, Just-in-time manufacturing, Supply chain management

TEXT BOOKS:

1. Martand T Telsang, Industrial Management and Production Management, 5th Edition, S Chand Publishers, 2016.
2. R. Panneerselvam, Production and Operation Management, 3rd Edition, PHI Learning Pvt. Ltd., 2017.
3. Shailendra Kale, Production and Operation Management, 1st Edition, McGraw Hill, Education Pvt. Ltd., 2013.

REFERENCE BOOKS:

1. S.K. Mukhopadhyay, Production Planning and Control, 3rd Edition, PHI Learning Pvt. Ltd, 2015.
2. Samuel Ellian, Elements of Production Planning and Control, 3rd Edition, McGraw Hill, Education Pvt. Ltd., 2018.
3. S.N. Chary, Production and Operations Management, 6th Edition, McGraw Hill, Education Pvt. Ltd., 2019.

WEB REFERENCES:

1. <https://archive.nptel.ac.in/courses/110/107/110107141/>
2. <https://archive.nptel.ac.in/courses/112/107/112107143/>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3							1	1	1		1	3	
CO2	2	3			1	1					2	2	2	
CO3	2	3			1	1					2	1	2	
CO4	2	3			1	1					2	2	2	
CO5	3	3							1	1	2	1	1	
Avg	2.4	2.4			0.6	0.6		0.2	0.4	0.4	1.6	1.4	2	

V SEMESTER (OPEN ELECTIVE -I)	L	T	P	C
	3	-	-	3
20EE5001 :: NON-CONVENTIONAL ENERGY SOURCES				

COURSE OUTCOMES:

After successful completion of this course, students should be able to:

CO1	:	Analyze solar radiation data and solar thermal systems (k4)
CO2	:	Identify the methods and analysis of wind energy generation systems (k3)
CO3	:	Explain the biomass and geothermal energy, its mechanism of production and its applications (k2)
CO4	:	Explain basic principle and working of hydro, tidal energy systems. (k2)
CO5	:	Explain basics of Chemical Energy Sources(k2)

SYLLABUS

UNIT-I	:	Solar Energy:
Introduction - Renewable Sources - prospects, Solar radiation at the Earth Surface - Equivalent circuit of a Photovoltaic (PV) Cell - I-V & P-V Characteristics - Solar Energy Collectors: Flat plate Collectors, concentrating collectors - Solar Energy storage systems and Applications: Solar Pond - Solar water heating - Solar Green house.		
UNIT-II	:	Wind Energy:
Introduction - basic Principles of Wind Energy Conversion, the nature of Wind - the power in the wind - Wind Energy Conversion - Site selection considerations - basic components of Wind Energy Conversion Systems (WECS) - Classification - Applications.		
UNIT-III	:	Biomass and Geothermal Energy:
Introduction - Biomass conversion technologies - Photosynthesis, factors affecting Bio digestion - classification of biogas plants - Types of biogas plants - selection of site for a biogas plant		
Geothermal Energy: Introduction, Geothermal Sources – Applications - operational and Environmental problems		
UNIT-IV	:	Energy From hydro, oceans, Waves & Tides:
Hydro: Basic working principle – classification of hydro – types of turbines		
Oceans: Introduction - Ocean Thermal Electric Conversion (OTEC) – methods - prospects of OTEC in India.		
Waves: Introduction - Energy and Power from the waves - Wave Energy conversion devices.		
Tides: Basic principle of Tide Energy -Components of Tidal Energy.		

UNIT-V	:	Chemical Energy Sources:
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Fuel Cells: Introduction - Fuel Cell Equivalent Circuit - operation of Fuel cell - types of Fuel Cells - Applications.

Hydrogen Energy: Introduction - Methods of Hydrogen production - Storage and Applications

Magneto Hydro Dynamic (MHD) Power generation: Principle of Operation - Types.

TEXT BOOKS:

1. G.D.Rai, Non-Conventional Energy Sources, Khanna Publications, 2011.
2. John Twidell & Tony Weir, Renewable Energy Sources, Taylor & Francis, 2013.

REFERENCE BOOKS:

1. S.P.Sukhatme & J.K.Nayak, Solar Energy-Principles of Thermal Collection and Storage, TMH, 2011.
2. John Andrews & Nick Jelly, Energy Science- principles, Technologies and Impacts, Oxford, 2nd edition, 2013.
3. Shoba Nath Singh, Non- Conventional Energy Resources, Pearson Publications, 2015.

V SEMESTER (OPEN ELECTIVE –I)	L	T	P	C
	3	-	-	3

20ME5001 :: WASTE TO ENERGY CONVERSION

COURSE OBJECTIVES

- To enable students to understand of the concept of waste to energy.
- To link technical and management principles for production of energy from waste.
- To learn about the best available technologies for waste to energy.
- To facilitate the students in developing skills in the decision making process.

COURSE OUTCOMES: Students are able to

- CO1. Describe of the concept of waste to energy, classifications and principles. [K2]
 CO2. Explain management principles for production of energy from waste. [K2]
 CO3. Explain the best available technologies for waste to energy. [K2]
 CO4. Describe the waste to energy options landfill gas, and energy from plastics.[K2]
 CO5. Apply the knowledge in planning and operations of waste to energy plants [K3]

UNIT-I-INTRODUCTION

Waste - types of waste, Principles of waste management, Waste utilization, Waste management hierarchy, 3R Principle of Reduce, Reuse and Recycle, Waste as a resource, alternate energy source.

UNIT-II WASTE SOURCES & CHARACTERIZATION

Source of waste, Waste production in different sectors such as domestic, industrial, agriculture, postconsumer waste etc, Waste management tools and techniques for reducing waste segregation and scientific disposal, Characterization of waste for energy utilization, Waste selection criteria.

UNIT-III TECHNOLOGIES FOR WASTE TO ENERGY

Energy biochemical conversion – energy production from organic waste through anaerobic digestion, fermentation, Thermo-chemical conversion – combustion, incineration, heat recovery, pyrolysis, gasification, plasma arc technology, other newer technologies, Case studies.

UNIT-IV WASTE TO ENERGY OPTIONS

Waste to energy options - landfill gas, methane emission, collection and recovery, Refuse Derived Fuel (RDF), Fluff, Briquettes, Pellets, Alternate Fuel Resource (AFR) – production and use in cement plants, Energy from plastic wastes, Non-recyclable plastic wastes for energy recovery, Energy recovery from wastes and optimization of its use, Energy analysis.

UNIT-V WASTE TO ENERGY PLANTS & ENVIRONMENTAL IMPLICATIONS

Wasteto Energy Plants: Waste management activities – collection, segregation, transportation and storage requirements, Location and Site of waste to energy plants.

EnvironmentalImplications: Environmental impact of waste to energy, Safety and environmental standards, Savings on non-renewable fuel resources, Carbon credits and its types.

TEXT BOOKS:

1. Marc Rogoff Francois Screve, Waste-to-Energy, 3rd Edition, William Andrew, 2019.
2. B.T. Nijaguna, Biogas Technology, 1st Edition, New Age International Pvt. Ltd, 2002.

REFERENCE BOOKS:

1. Vishal Prasad, BarkhaVaish, Advances in Waste-to-Energy Technologies, 1st Edition, CRC Press, 2019.
2. Dev Vrat Kamboj, Manoj Kumar Solanki, Waste to Energy: Prospects and Applications, 1st Edition, Springer, 2021.
3. P. Jayarama Reddy, Energy Recovery from Municipal Solid Waste by Thermal Conversion Technologies, 1st Edition, CRC Press/ Balkema, 2016.

WEB REFERENCE:

1. <https://archive.nptel.ac.in/courses/103/107/103107125/>

V SEMESTER (OPEN ELECTIVE –I)	L	T	P	C
	3	-	-	3

20CS5001 :: INTERNET OF THINGS AND APPLICATIONS

Course Outcome:**At the end of the course students are able to**

1. Explain Arduino IDE tool and Arduino Programming concept.
2. Illustrate concept hardware configuration with Firmata protocols.
3. Explain the knowledge Arduino pin configuration.
4. Differentiate various sensors configuration and workflows.
5. Define architecture of IoT.

UNIT-I (Introduction to Arduino)

Introduction to Arduino, history of Arduino, variants, Uno board block diagram, installation of Arduino, Arduino IDE, Arduino programming, functions and statements.

UNIT-II (Configuration)

Connecting Arduino board, introducing the Firmata Protocol, uploading a Firmata sketch to the Arduino board, testing the Firmata protocol.

UNIT-III (Components)

List of components, software flow design, hardware flow design, hardware prototyping software, designing the hardware prototype, Arduino sketch default functions and custom function, setting Arduino board, pin configuration, working with pins.

UNIT-IV (Prototype)

Potentiometer-continuous observation from an analog input connection, Buzzer-generating sound alarm pattern, DC motor-controlling motor speed using PWM, LED- controlling LED brightness using PWM, Servomotor-moving the motor to a certain angle.

UNIT-V (Networking and cloud)

Arduino and computer networking, networking fundamentals, Obtaining the IP address, Networking extensions for Arduino with libraries and class, architecture of IoT web applications, IoT cloud platforms, develop cloud-based IoT applications.

Textbooks:

1. Python programming for Arduino by Pratik desai, Packt Publishing.
2. Internet of Things with Arduino Cookbook by Marco Schwartz.
3. Introduction to Arduino by Alan G. Smith.

References

1. Beginning Arduino by Michael McRoberts, 2e.
2. Getting Started with Arduino Massimo Banzi Second Edition.

V SEMESTER (OPEN ELECTIVE –I)	L	T	P	C
	3	-	-	3

20CS5002 :: DATA ENGINEERING

Course Outcomes:

Student able to state and analyze:

1. Preprocessing techniques for various datasets,
2. Standard database systems concepts like tables, relations, query, NoSQL
3. Information retrieval techniques such as Relevance Ranking, Indexing etc
4. Data processing algorithms and data structures
5. Visualization techniques like Table, graph, histogram, pie-chart

UNIT- I:

Data Engineering: introduction, importance of data engineering, Data engineering vs data science

Data Collection: Various sources of data, types of data: text, video, audio, biology etc.

Data Preprocessing: data Cleaning: missing values, noise elimination, data integration, data transformation: Normalization, Data Reduction: data cube aggregation, dimensionality reduction.

UNIT-II

Data bases: Database Schema, ER diagram, introduction to SQL, functions and stored procedures, indexing: B+tree index files, data base system architecture: Client-Server Architecture, introduction to MongoDB,

NoSQL: The Value of Relational Databases, Getting at Persistent Data, Concurrency, Integration, Standard Model, Impedance Mismatch, Application and Integration Databases, Attack of the Clusters, The Emergence of NoSQL

UNIT-III

Information Retrieval: Relevance Ranking Using Terms, Relevance Using Hyperlinks, Synonyms, Homonyms, and Ontologies, Indexing of Documents, Measuring Retrieval Effectiveness, Crawling and Indexing the Web, Information Retrieval: Beyond Ranking of Pages, Directories and Categories

UNIT-IV

Data Analysis: correlation analysis: bivariate correlation, partial correlation, correlation coefficients.

Regression: simple linear regression, multiple linear regression, principal component analysis, analysis of variance

UNIT- V

Data Visualization: Table, graph, histogram, pie-chart, area-plot, box-plot, scatter-plot, bubble-plot, waffle charts, word clouds.

Text Books:

1. Data mining concepts and techniques Jiawei Han and Micheline Kamber (UNIT-I)
2. Silberschatz, Korth, Sudarshan, "Database System Concepts" McGraw Hill Education, Sixth edition, 2010, ISBN-13: 978-9332901384 (UNIT-II, UNIT-III)
3. "NoSQL distilled" A Brief Guide to the Emerging World of Polyglot Persistence Pramod J. Sadalage Martin Fowler, Addison Wesley (UNIT-II)
4. correlation and regression analysis by Dr. Mohamed Ahmed Zaid (UNIT-IV)

Reference Books:

1. Brian Shive, "Data Engineering: A Novel Approach to Data Design", Technics Publications, 2013. ISBN-13: 978-1935504603.
2. Joel Grus, "Python Data Science Handbook: Essential Tools for Working with Data", 1st Edition, O'Reilly, 2016. ISBN-13: 978-9352134915.

Web links:

<https://chartio.com/learn/charts/essential-chart-types>

V SEMESTER (OPEN ELECTIVE –I)	L	T	P	C
	3	-	-	3
20BM5001 :: INNOVATIONS AND ENTREPRENEURSHIP				

UNIT-I INNOVATION MANAGEMENT: Concept–Objectives-types of Innovation process of Innovation-sources of Innovation-Levels of Innovation -barriers of Innovation— Open and Closed Innovation-challenges faced while managing innovation.

UNIT-II CREATIVE INTELLIGENCE: Concept of Creativity-Importance Characteristics-Types of Creativity-Traits Congenial to Creativity-Triarchic theory of Intelligence – Creative thinking –Types-process of creative thinking-Sources and techniques for generating ideas.

UNIT-III ENTREPRENEURSHIP: Concept- characteristics-Importance classification-Theories of Entrepreneurship-entrepreneurship development-entrepreneurial process- challenges-Women Entrepreneurs.

UNIT-IV PROJECT FORMULATION AND APPRAISAL: Concept -Need Significance-steps - Economic Analysis; Financial analysis; Market analysis; Technical feasibility-project Appraisal-techniques of project appraisal.

UNIT-V INSTITUTIONS PROMOTING SMALL BUSINESS ENTERPRISES: Central level Institutions; SIDBI, NSIC, KVIC,SSIDC - State level Institutions- DICs – SFC SSIDC- other financial assistance, Government policy and taxation benefits- government policy for SSIs

TEXT BOOKS:

1. Vasanth Desai, —Entrepreneurship, Himalaya Publishing House, New Delhi, 2012
2. Arya Kumar: —Entrepreneurship, Pearson, Publishing House, New Delhi, 2012.
3. Keith Goffin and Rick Mitchell- Innovation Management, Springer, 2016

REFERENCES BOOKS:

1. Pradip N Khandwalla, Lifelong Creativity, An Unending Quest, Tata McGraw Hill, 2004.
2. Vinnie Jauhari, Sudanshu Bhushan, Innovation Management, Oxford Higher Education, 2014

V SEMESTER (OPEN ELECTIVE –I)	L	T	P	C
	3	-	-	3
20BM5003 :: DIGITAL MARKETING				

UNIT I- Introduction to Digital Marketing: Concept – scope- importance of digital marketing - Traditional marketing versus digital marketing – Types of digital marketing marketing mix and its implications for digital marketing--Challenges and opportunities for digital marketing

UNIT II- Content Marketing: Understanding Content Marketing, Content Creation Framework, Content marketing strategy and planning- Types of content marketing - Measuring and Analysing Your Content-Viral Marketing-Blog Marketing.

Unit III- Search Engine Optimization (SEO): What is SEO? SEO Importance and Its Growth in recent years, Ecosystem of a search Engine , kinds of traffic, Keyword Research & Analysis (Free and Paid tool & Extension), Recent Google Updates

UNIT IV-Email and Mobile Marketing: Introduction, process, design, content,email marketing metrics. Mobile Marketing: Concept, Process-tools-opportunities and challenges.

UNIT V-Social Media Marketing: Concepts- Process - Tools- Google and the Search Engine, Facebook, Twitter, YouTube and LinkedIn- Issues: Credibility, Fake News, Paid Influencers; social media and Hate/ Phobic campaigns.

TEXT BOOKS:

- 1.Puneet Singh Bhatia, “Fundamentals of Digital Marketing”, Pearson Education Publications, 2nd edition 2019
2. Seema Gupta, “Digital Marketing”, McGraw Hill Publications”, 2nd edition 2020
- 3.Ryan Deiss, Russ Henneberry, “Digital Marketing For Dummies”, Wiley Publications, 2020

REFERENCES BOOKS:

1. Joe Pulizzi, “Epic Content Marketing”, McGraw Hill Education, 2019
2. Puneet Singh Bhatia , “Social Media & Mobile Marketing”, Wiley Publications, 2019

V SEMESTER (OPEN ELECTIVE –I)	L	T	P	C
	3	-	-	3
20BM5004 :: BUSINESS ENVIRONMENT				

Unit-I Business Environment: Components and Significance – Economic Scope – Factors Influencing Business Environment – Dimensions of International Business Environment – Challenges.

Unit-II: Structure of Indian Economy: Economic systems- Economic planning with special reference to last three plans, public, private joint and cooperative sectors - Industrial Policy - Policy Resolutions of 1991- Economic Reforms-PPP

Unit-III Indian Business Environment: Competitiveness, Changes and Challenges, Sustainable Development, Social Responsibilities, Ethics in Business- Competition Act 2002 - Emerging Trend in Indian Business Environment

Unit-IV: International Trade: Balance of Payments – Concepts, Disequilibrium in BOP: Methods of Correction - Trade Barriers and Trade Strategy - Free Trade vs. Protection - World Financial Environment: Foreign Exchange Market Mechanism, Exchange Rate Determination, and Euro Currency.

Unit-V: Globalisation: International Economic Integration, Country Evaluation and Selection, Foreign Market Entry Methods, International Trading Blocks – WTO Origin, Objectives, Organisation, Structure and Functioning – WTO and India.

TEXT BOOKS:

1. Chidambaram, Indian Business Environment, Vikas, New Delhi
2. Suresh Bedi: Business Environment, Excel, New Delhi.
3. K.V.Sivayya and VBM Das: Indian Industrial Economy, Sultan Chand Publishers, Delhi. **REFERENCES**

BOOKS:

1. Pandey G.N., Environmental Management, Vikas Publishing House.
2. Sundaram& Black, International Business Environment – The Text and Cases, Prentice Hall of India.
3. Ghosh PK., Business Environment,Sultan Chand & Sons, New Delhi
4. Daniel John D and Redebough, Lee. H., International Business, AddisonWesley India
5. Saleem, Business Environment, Pearson, New Delhi.
6. Bhalla, V.K., & S. Sivaramu, International Business Environment and Business, Annual Publications

V SEMESTER (JOB ORIENTED ELECTIVE-I)	L	T	P	C
	3	-	-	3

20IT5J01 :: LINUX ADMINISTRATION

Course Outcomes:

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

1. Use various Linux commands that are used to manipulate system operations at admin level.
2. Write Shell Programming using Linux commands.
3. Design and write application to manipulate internal kernel level Linux File System.
4. Explain the user, group and storage management.
5. Configure SSH client and server.

UNIT – I

Introduction To Linux And Linux Utilities: A brief history of LINUX, architecture of LINUX, features of LINUX, introduction to vi editor. Linux commands- PATH, man, echo, printf, script, passwd, uname, who, date, stty, pwd, cd, mkdir, rmdir, ls, cp, mv, rm, cat, more, wc, lp, od, tar, gzip, unlink, du, find, unmask, ulimit, ps, finger, tail, head, sort, nl, uniq, cut, paste, join, tee, pg, comm, cmp, diff, tr, awk, cpio, apt.

UNIT – II

Introduction to Shells: Linux Session, Standard Streams, Redirection, Pipes, Tee Command, Command Execution, Command-Line Editing, Quotes, Command Substitution, Job Control, Aliases, Variables, Predefined Variables, Options, Shell/Environment Customization.

Filters: Filters and Pipes, Concatenating files, Display Beginning and End of files, Cut and Paste, Sorting, Translating Characters, Files with Duplicate Lines, Count Characters, Words or Lines, Comparing Files.

UNIT - III

Grep: Operation, grep Family(grep, egrep, fgrep), Searching for File Content.

Sed: Scripts, Operation, Addresses, commands, Applications, grep and sed.

Unix File Structure: Introduction to UNIX file system, inode (Index Node), file descriptors, system calls and device drivers.

UNIT – IV

User and Group Management: User accounts, local groups and group memberships, Configure networking and hostname resolution statically or dynamically, start, stop, and check the status of network services and network related commands.

Storage Management: List, create, delete, and modify physical storage partitions and tools

UNIT – V

Configuring SSH: Enabling the SSH Server, Using the SSH Client, Configuring Key- Based SSH Authentication, Using Graphical Applications with SSH.

Practical Learning: Installation of Any open source Linux Distribution, AWS Instance Creation and Learn How to Access through SSH.

TEXT BOOKS:

1. W. Richard. Stevens, Advanced Programming in the UNIX Environment, 3rd edition, Pearson Education, New Delhi, India.
2. Behrouz A. Forouzan, Richard F. Gilberg, Unix and shell Programming Thomson

REFERENCES:

1. Robert Love, O'Reilly, Linux System Programming, SPD.
2. W.R.Stevens, Advanced Programming in the UNIX environment, 2nd Edition, PearsonEducation.
3. W.R. Stevens, UNIX Network Programming, PHI.
4. Graham Glass, King Ables, UNIX for Programmers and Users, 3rd Edition, Pearson Education.

V SEMESTER (JOB ORIENTED ELECTIVE-I)	L	T	P	C
	3	-	-	3

20CS5J01 :: FULL STACK WITH JAVA

COURSE OUTCOMES:

At the end of the course, the student should be able to:

Design simple web pages using markup languages like HTML and CSS.

Create dynamic web pages using DHTML and java script that is easy to navigate and use.

Create web pages using AngularJS.

Build web applications using Servlet and JSP.

Understand various operations on Mongo Database.

UNIT-I:

HTML: An Introduction to HTML, Basic XHTML Syntax and Semantics, Basic HTML Elements: Images, Links, Lists, Tables, Forms, Frames, Division and Spanning, HTML 5.0.

CSS: Levels of Style sheets, Style specification formats, Selector forms, CSS Colors and Backgrounds, CSS Text and Font Properties, The Box Model, CSS Margins, Padding, and Borders Conflict Resolution.

UNIT-II:

Client-Side Scripting using Java Script and DOM

Java Script: The Basics of Java Script, Objects, Primitive operations and Expressions, Screen output and Keyboard input, Control statements, Object Creation and modification, Arrays, functions, Constructors, Pattern matching using Regular Expressions, DHTML: Positioning moving and Changing Elements.

DOM: Introduction to the Document Object Model DOM, HTML DOM Event Handling, Modifying Element Style, Document Tree, DOM Event Handling

UNIT-III:

Angular JS

Introduction to AngularJS: Expressions, Modules, Data Binding, Scopes, Directives & Events, Controllers, Filters, Services, HTTP, Tables, Select, Fetching Data from MySQL.

UNIT-IV:

Servlet and JSP

Servlet: Servlet Basics, Need of Server Side Programming,Servlet Life Cycle, Servlet Hello World Application, Web.xml Structure, Servlet Directives-include (), forward(), sendRedirect(), HttpServletRequest and HttpServletResponse in Servlet, Servlet and JDBC Integration.

JSP: JSP Basics, JSP Scripting Elements (Declaration, Expression, Scriptlet), Directive Elements (page,include,taglib) , Action Elements (jsp:forward, jsp: include,jsp:useBean), JSP Implicit Objects.

UNIT-V

Mongo DB: Introduction to Mongo DB, Mongo DB Environment, Create Database, Drop Database, Create Collection, Drop Collection, Read Operations, Write Operations.

TEXT BOOKS:

1. Programming the World Wide Web, Robert W Sebesta, 7ed, Pearson.
2. Web Technologies, Uttam K Roy, Oxford
3. Head First Servlet and JSP
4. Node.js, MongoDB, and AngularJS Web Development by Brad Dayley

REFERENCE BOOKS:

1. Web Technologies, HTML, JavaScript, PHP, Java, JSP, XML and AJAX, Black book, Dream Tech.
2. An Introduction to Web Design, Programming, Paul S Wang, Sanda S Katila, Cengage
3. Pro Angular JS by Adam Freeman
4. MEAN Web Development by Amos Q. Haviv

V SEMESTER	L	T	P	C
	-	-	3	1.5
20RB5L01 :: MICROPROCESSORS AND MICROCONTROLLERS LAB				

COURSE OBJECTIVES:

- To study about 8086 microprocessor and perform ALP using arithmetic, logical and shift operations.
- To learn modular and Dos/Bios programming using 8086 microprocessors.
- To learn interfacing of 8086 with I/O and other devices.
- To learn parallel and serial communication using 8051 microcontrollers.

COURSE OUTCOMES:

Students are able to

CO1: Write and perform assembly language programs for various problems .

CO2: Design minimum workable system using Microcontroller 8051.

CO3: Perform interfacing of different external devices like keyboard, DAC, ADC, Stepper motor.

PART-I: MICROPROCESSOR-8086 PROGRAMMING

1. Verify Arithmetic Operations for Multi byte Addition and Subtraction using ALP.
2. Execute ALP for Multiplication and Division for signed and unsigned Arithmetic operations.
3. Explain how Logical operations are performed in Microprocessors with the help of TASM Software.
4. Execute Sum of squares/cubes of a given n-numbers.
5. Factorial of given numbers.
6. Perform sorting and searching operations.
7. Apply DOS/BIOS to access various system resources for Reading data from keyboard.
8. Conversion between BCD and ASCII numbers.
9. Develop different programs for checking all String operations.
10. Develop assembly programs for different ASCII Arithmetic operation.

PART-II: INTERFACING WITH 8051 MICROCONTROLLERS

1. Write an Embedded C program to interface switches and LEDs/Seven Segment display.
2. Write an ALP to find addition of even numbers from a given array using 8051.
3. Find average of n-numbers using 8051.
4. Verify how Serial Communication Implemented in 8051 μ C.
5. Design a Traffic Light Controller.

NOTE: Any 10 of the above experiments are to be conducted.

V SEMESTER	L	T	P	C
	-	-	3	1.5
20RB5L02 :: INTERNET OF THINGS LAB				

COURSE OBJECTIVE

- Familiarize students with the use of Arduino for sensing and actuation purposes.

COURSE OUTCOMES: Students are able to

CO1: Measure temperature and humidity using various sensors	[K3]
CO2: Use IR sensor/push button to on/off LED	[K3]
CO3: Interface Bluetooth module with Arduino and Use the same	[K3]
CO4: Interface Actuating elements with Arduino and control the same	[K3]

LIST OF EXPERIMENTS

- Familiarization with Arduino and perform necessary software installation.
- Interface LED/Buzzer with Arduino and write a program to turn ON LED for 1 sec after every 2 seconds.
- Interface Push button/Digital sensor (IR/LDR) with Arduino and write a program to turn ON LED when push button is pressed or at sensor detection.
- Interface DHT11 sensor with Arduino and write a program to print temperature and humidity readings.
- Interface motor using relay with Arduino and write a program to turn ON motor when push button is pressed.
- Interface OLED with Arduino and write a program to print temperature and humidity readings on it.
- Interface Bluetooth with Arduino and write a program to send sensor data to smart phone using Bluetooth.
- Interface Bluetooth with Arduino/Raspberry Pi and write a program to turn LED ON/OFF when „1“/“0“ is received from smart phone using Bluetooth.
- Interface Servo motor with Arduino and write a program to control the same
- Interface Stepper motor with Arduino and write a program to control the same using potentiometer.
- Interface thermistor with Arduino for temperature measurement
- Measure temperature using thermocouple by interfacing it with Arduino
- Write a program to create TCP server on Arduino/Raspberry Pi and respond with humidity data to TCP client when requested.
- Write a program to create UDP server on Arduino/Raspberry Pi and respond with humidity data to UDP client when requested.

NOTE: Any 10 of the above 14 experiments are to be conducted

V SEMESTER	L	T	P	C
	-	0	4	2
20RB5S01 :: ROBOT CONTROL SOFTWARE (CPRog)				

COURSE OBJECTIVE

- To introduce different types of robotics and demonstrate them to identify different parts and components.
- To write programming for industrial operations.

COURSE OUTCOMES: Students are able to

CO1. Perform the programming operation by using loop conditions. [K3]

CO2. Perform the programming for bartender operation. [K3]

LIST OF EXPERIMENTS

1. Automation of Palletizing of work pieces
2. Automation of Bartender using If – Else, Loop Condition.
3. Automation of Pick and Arranging of boxes in a container in a 3×3 matrix format by using Variable Operations commands
4. Collaboration of Two robots.
5. Assembling of two different work pieces for a continuous process
6. Automation of industrial operation by using gantry robot.
7. Automation of industrial operation by using delta robot.
8. Automation of industrial operation by using SCARA robot
9. Automation of conveyor movement
10. Automation of packaging operation for different types of robot

V SEMESTER	L	T	P	C
	2	0	0	0
20BM5M01 :: ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE				

UNIT-I:

Introduction to traditional knowledge: Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, Indigenous Knowledge (IK), characteristics, traditional knowledge vis-a-vis indigenous knowledge, traditional knowledge Vs western knowledge traditional knowledge

UNIT-2:

Protection of traditional knowledge: The need for protecting traditional knowledge Significance of TK Protection, value of TK in global economy, Role of Government to harness TK.

UNIT-3:

Legal framework and TK: The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmer's Rights Act, 2001 (PPVFR Act); The Biological Diversity Act 2002 and Rules 2004, the protection of traditional knowledge bill, 2016.

UNIT-4:

Traditional knowledge and intellectual property: Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge

UNIT-5:

Traditional Knowledge in Different Sectors: Traditional knowledge and engineering, Traditional medicine system, TK in agriculture, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of TK

Text books:

1. Traditional Knowledge System in India, by Amit Jha, 2009.

Reference Books:

1. Traditional Knowledge System in India by Amit Jha Atlantic publishers, 2002.
2. "Knowledge Traditions and Practices of India" Kapil Kapoor1, Michel Danino2.

Web Links:

1. <https://www.youtube.com/watch?v=LZP1StpYEPM>
2. <http://nptel.ac.in/courses/121106003/>

V SEMESTER	L	T	P	C
	-	-	2	1.5
20RB5I01 :: INTERNSHIP I				

VI SEMESTER	L	T	P	C
	3	-	-	3
20RB6T01 :: ARTIFICIAL INTELLIGENCE IN ROBOTICS				

COURSE OBJECTIVES:

- Become familiar with basic principles of AI toward problem solving, inference, perception, knowledge representation, and learning.
- Elucidate the basic knowledge representation, problem solving, and learning methods of Artificial Intelligence
- Formalization and design of systems capable of automated reasoning.
- Implementation and application of machine learning techniques in prediction problems.

COURSE OUTCOMES: Students are able to

- CO1.** Identify problems that are amenable to solution by AI methods. [K1]
- CO2.** Explain different planning methods used in AI for acting in real world. [K3]
- CO3.** Analyse probabilistic reasoning based on uncertainty. [K4]
- CO4.** Explain the learning methods of AI. [K2]
- CO5.** Explain the usage of AI techniques in robots. [K2]

UNIT I INTRODUCTION

History, state of the art, need for AI in robotics, thinking and acting humanly, intelligent agents, structure of agents.

PROBLEM SOLVING: Solving problems by searching - informed search and exploration, constraint satisfaction problems, adversarial search, knowledge and reasoning, knowledge representation, first order logic.

UNIT II PLANNING

Planning with forward and backward State space search, partial order planning, planning graphs, planning with propositional logic, planning and acting in real world.

UNIT III REASONING

Uncertainty – probabilistic reasoning, filtering and prediction, hidden Markov models, Kalman filters, dynamic Bayesian networks, speech recognition, making decisions.

UNIT IV LEARNING

Forms of learning, knowledge in learning, statistical learning methods, reinforcement learning, communication, perceiving and acting, probabilistic language processing, perception.

UNIT V AI IN ROBOTICS

Robotic perception, localization, mapping, configuring space, planning uncertain movements, dynamics and control of movement, ethics and risks of artificial intelligence in robotics.

TEXT BOOKS

1. Stuart Russell, Peter Norvig, Stuart Russell, Peter Norvig, "Artificial Intelligence, a modern approach", 3rd edition, Prentice Hall, 2016.

- Wolfgang Ertel, "Introduction to Artificial Intelligence", 2nd edition, Springer, 2017

REFERENCE BOOKS:

- Miroslav Kubat, "An Introduction to Machine Learning", 3rd edition Springer, 2016
- Christopher M. Bishop, Christopher M. Bishop, "Pattern Recognition and Machine Learning" 1st edition, Springer, 2016.
- Stephen Lucci and Danny Kopec, "Artificial Intelligence in the 21st Century" 2nd Edition, Mercury Learning and Information, 2015.

WEB REFERENCES:

- <https://nptel.ac.in/courses/106105078>
- <https://nptel.ac.in/courses/106105079>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1		1								2	
CO2	3	2	3		1								2	
CO3	3	1	3		1								2	
CO4	2	3	3		3								2	
CO5	3	2	2		3			2					2	
Avg	2.8	2.2	2.4		1.8			0.4					2	

VI SEMESTER	L	T	P	C
	3	-	-	3
20RB6T02 :: PROGRAMMABLE LOGIC CONTROLLERS				

COURSE OBJECTIVES:

- To know the fundamentals of automation.
- To understand the concept of programmable logic controllers (PLC) and its programming using ladder diagram.
- To know the basics of HMI and Installations in PLC

COURSE OUTCOMES:

- CO1.** Identify and understand the automation concepts for industries.[K2]
- CO2.** Apply PLC architecture knowledge to select PLC for specific problems.[K3]
- CO3.** Use PLC Ladder diagram for simple applications.[K3]
- CO4.** Apply real time application using PLC.[K3]
- CO5.** Develop prototype for the real time application using PLC, with HMI. [K3]

UNIT I INTRODUCTION TO FACTORY AUTOMATION

History and developments in industrial automation-Vertical integration of industrial automation, Control elements in industrial automation, PLC introduction

UNIT II PROGRAMMABLE LOGIC CONTROLLERS

Basics of PLC, advantages, capabilities of PLC, architecture of PLC, scan cycle, types of PLC, types of I/O modules, power supplies and isolators, configuring a PLC, PLC wiring.

UNIT III PROGRAMMING OF PLC

General PLC programming- Procedures ,types of programming, programming on-off inputs/outputs simple process control programs using relay ladder logic, auxiliary commands and functions, PLC basic functions, register basics, timer functions, counter.

UNIT IV PLC INTERMEDIATE FUNCTIONS

Arithmetic functions, Comparison functions, Skip and MCR functions, Data move systems - PLC advanced intermediate functions, utilizing digital bits, sequencer functions, matrix functions, PLC advanced functions, alternate programming languages, analog PLC operation.

UNIT V HMI SYSTEMS

Necessity and role in industrial automation-Text display, Operator panels, touch panels, panel PCs, Integrated displays, Interfacing PLC to HMI.

TEXT BOOKS:

1. Frank D Petruzella, “Programmable Logic Controllers ”, 5th Edition, McGraw-Hill Education, 2016.
2. William Bolton, “Programmable Logic Controllers ”, 6th Edition, McGraw-Hill Education, 2016.

REFERENCE BOOKS:

1. Dag H. Hanssen, "Programmable Logic Controllers ", 1st Edition, Wiley Publisher, 2015.
2. Khalid Kamel, Eman Kamel, "Programmable Logic Controllers", McGraw-Hill Professional Publishing, 2013

WEB REFERENCES:

1. <https://archive.nptel.ac.in/courses/112/102/112102011/>
2. <https://archive.nptel.ac.in/courses/108/105/108105063/>
3. <https://archive.nptel.ac.in/courses/108/105/108105088/>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2			1			1			1	2	
CO2	3	3	2			1			1			1	2	
CO3	3	3	2			1			1			1	2	
CO4	3	3	2			1			1			1	2	
CO5	3	3	2			1			1			1	2	
Avg	3	3	2			1			1			1	2	

VI SEMESTER	L	T	P	C
	3	-	-	3
20RB6T03 :: MOBILE ROBOTS				

COURSE OBJECTIVES:

- To introduce the concept of mobile robots locomotion.
- To understand the mobile robot kinematics and dynamics.
- To expose the localization and mapping techniques.
- To know about motion control.
- To learn advanced mobile robots.

COURSE OUTCOMES:

Students are able to

CO1. Differentiate different types of robots. [K2]

CO2. Analyze the mobile robot kinematics and dynamics [K2]

CO3. Summarize the different types of localization approach [K3]

CO4. Design collisions free path planning. [K2]

CO5. Summarize the different types of Swarm robots, Cooperative and Collaborative robots. [K2]

UNIT I INTRODUCTION TO MOBILE ROBOTS

Introduction to mobile robots and mobile manipulators. Principle of locomotion and types of locomotion. Types of mobile robots: ground robots (wheeled and legged robots), aerial robots, underwater robots and water surface robots.

UNIT II KINEMATICS AND DYNAMICS

Kinematics of wheeled mobile robot, degree of freedom and maneuverability, generalized wheel model, different wheel configurations, holonomic and non-holonomic robots. Dynamics of mobile robot: Lagrange-Euler and Newton-Euler methods. Computer based dynamic (numerical) simulation of different wheeled mobile robots.

UNIT III LOCALIZATION AND MAPPING

Magnetic and optical position sensor, and mapping (SLAM), gyroscope, accelerometer, magnetic compass, inclinometer, tactile and proximity sensors, ultrasound rangefinder, laser scanner, infrared rangefinder, visual and motion sensing systems. Localization, Map based localization, Markov localization, Kalman filter localization Error propagation model, Probabilistic map based localization, Autonomous map building, Simultaneous localization

UNIT IV MOTION CONTROL

Collisions free path planning and sensor-based obstacle avoidance. Motion controlling methods, kinematic control, dynamic control and cascaded control.

UNIT V MODERN MOBILE ROBOTS

Introduction, Swarm robots, cooperative and collaborative robots, mobile manipulators, autonomous mobile robots.

TEXT BOOKS:

1. Kelly, A “Mobile Robotics: Mathematics, Models, and Methods”, Cambridge University Press, USA, 2013.
2. Dudek, M Jenkin, Computational Principles of Mobile Robotics, Cambridge University Press, USA, 2010.

REFERENCE BOOKS:

1. Siegwart, R Nourbakhsh, and Scaramuzza, “Introduction to Autonomous Mobile Robots”, MIT Press, USA, 2011.
2. Tzafestas, “Introduction to Mobile Robot Control, Elsevier”, USA, 2014.
3. Choset, Lynch, S. Hutchinson, G. Kantor, W. Burgard, L. E. Kavraki, and S. Thrun, “Principles of Robot Motion: Theory, Algorithms, and Implementations”, MIT Press, 2005.

WEB RESOURCES:

1. <https://journals.sagepub.com/doi/full/10.1177/1729881419839596>
2. <https://nptel.ac.in/courses/112106298>
3. <https://archive.nptel.ac.in/courses/112/106/112106298/>
4. <https://ftp.idu.ac.id/wp-content/uploads/ebook/tdg/DESIGN%20SISTEM%20DAYA%20GERAK/Designing%20Autonomous%20Mobile%20Robots%20Inside%20The%20Mind.pdf>
5. https://doc.lagout.org/science/0_Computer%20Science/8_Electronics%20%26%20Robotics/Autonomous%20Mobile%20Robots%20-%20Shuzhi%20Sam%20Ge%2C%20Frank%20L.%20Lewis.pdf

PO CO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	1	1	1						1	3	
CO2	3	1	1	1	1	1						1	3	
CO3	3	1	1	1	1	1						1	3	
CO4	3	1	1	1	1	1						1	3	
CO5	3	1	1	1	1	1						1	3	
Avg	3	1	1	1	1	1						1	3	

VI SEMESTER (PROFESSIONAL ELECTIVE II)	L	T	P	C
	3	-	-	3
20ME6E01 :: INDUSTRIAL ENGINEERING AND MANAGEMENT				

COURSE OBJECTIVES

1. To impart fundamental knowledge and skill sets required in the Industrial Management and Engineering profession, which include the ability to apply basic knowledge of mathematics, probability and statistics, and the domain knowledge of Industrial Management and Engineering.
2. To produce graduates with the ability to adopt a system approach to design, develop, implement and innovate integrated systems that include people, materials, information, equipment and energy.
3. To enable students to understand the interactions between engineering, business, technological and environmental spheres in the modern society.

COURSE OUTCOMES

Students are able to:

CO1. Explain management principles and integrate these principles into job situations.[K2]

CO2. Interpret the techniques of work study, and time study. [K2]

CO3. Explain layouts of manufacturing operations.[K2]

CO4. Explain the principles of material handling and materials management.[K2]

CO5. Explain the quality control techniques and decision-making concept.[K2]

UNIT I MANAGEMENT SCIENCE

Basic concepts of Management, Contribution of Taylor and Fayol to Scientific Management, Motivation and Control, Maslow's hierarchy of needs, Leadership styles, Managerial Grid.

UNIT II WORK STUDY

Introduction, Techniques of work study, Method study- procedure, recording techniques, Principles of motion economy, Micro-motion analysis, Work measurement – Time study, work/activity sampling, Predetermined motion time standards, Job evaluation and Merit rating- Procedure and Methods.

UNIT III PLANT LOCATION AND LAYOUT

Importance and factors affecting plant location, Single and Multi- facility plant location problems, Comparison between Urban and Rural Locations.

Plant layout: Need, Importance, Objectives, Principles and Advantages of good plant layout, Types of Plant layouts and applications, Material Flow pattern, Tools and Techniques of Plant Layout.

UNIT IV MATERIAL HANDLING AND MATERIALS MANAGEMENT:

Principles of material handling, Types of material handling equipment and selection.

Materials management: Objectives, Inventory control- Purpose, types, functions, basic EOQ, safety stock inventory control systems, selective control of inventory ABC and VED analysis, Inventory control system-periodic review system, Store Management and stores record, purchase management.

UNIT V DECISION MAKING

Introduction, Decision making environments, Decision tree analysis. Inspection and quality control: Types of Inspections, Statistical Quality Control techniques, acceptance sampling plan, Introduction to Total Quality Management, Quality Circles, ISO 9000 series procedures.

TEXT BOOKS:

1. Kumar Pravin, Industrial Engineering and Management, 2nd edition, Pearson India, 2015.
2. Martand T Telsang, Industrial Engineering and Production Management, 3rd Revised edition 2018, S. CHAND publishers.
3. S.C. Sharma, T.R. Banga, Industrial Engineering and Management, 1st edition, Khanna publishing house, India, 2019.

REFERENCE BOOKS:

1. Kaushik Kumar, Divya Zindani, Industrial Engineering and Management, 1st edition, IK International pvt.ltd, 2021.
2. O. P. Khanna, Industrial Engineering and Management, Revised Enlarged edition-1999, Dhanpat Rai Publications, 14th Print , 2011.

WEB REFERENCES:

1. <https://archive.nptel.ac.in/courses/112/107/112107143/>
2. <https://archive.nptel.ac.in/courses/112/107/112107292/>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						3		3			3	1	1	
CO2	2	2	2	2		3						1	2	
CO3	2	2	2	1		2	1					1	2	
CO4	2	1	1									1	2	
CO5	2					2		3				1	2	
Avg	1.6	1	1	0.6		2	0.2	1.2			0.6	1	1.8	

VI SEMESTER (PROFESSIONAL ELECTIVE II)	L	T	P	C
	3	-	-	3
20RB6E01 :: MACHINE LEARNING FOR ROBOTICS				

OBJECTIVES:

- To learn the concepts of machine learning
- To know about advanced and unsupervised learning, dimensionality concepts
- To understand the concepts of clustering techniques & neural networks in robots with case studies.

COURSE OUTCOMES:

Students are able to

- CO1** : Discuss about the basic concepts of machine learning (K1)
CO2 : Describe the types of trees and bias. (K4)
CO3 : Outline the supervised learning methods with various case studies. (K3)
CO4 : Explain the concepts of unsupervised learning. (K2)
CO5 : Summarize the applications of neural networks in robotic applications. (K2)

UNIT-I : INTRODUCTION

Machine learning, Varieties of Machine learning, Learning Input, Output functions: Types of learning, Input Vectors, Outputs, Training regimes, Noise, Performance Evaluation, hypothesis space and inductive bias, evaluation, cross-validation, Linear regression, Decision trees, over fitting.

UNIT-II : FOUNDATIONS OF SUPERVISED LEARNING

Decision trees and inductive bias, Geometry and nearest neighbors, Logistic regression, Perceptron, Binary classification.

UNIT-III : ADVANCED SUPERVISED LEARNING

Linear models and gradient descent, Support Vector machines, Naïve Bayes models and probabilistic modeling, Model selection and feature selection, Model Complexity and Regularization.

UNIT-IV : UNSUPERVISED LEARNING

Curse of dimensionality, Dimensionality Reduction, PCA, Clustering, K-means, Expectation Maximization Algorithm, Mixtures of latent variable models, Supervised learning after clustering, Hierarchical clustering.

UNIT-V : CLUSTERING & NEURAL NETWORKS

Clustering: k-means, adaptive hierarchical clustering, and Gaussian mixture model. Clustering-Based Robot Navigation and Control, Network Representation, Feed-forward Networks, Back propagation,

TEXT BOOKS:

1. Michalski, Carbonell, Tom Mitchell, „Machine Learning“, Springer, 2014.
2. Peter Flach, „Machine Learning: The Art and Science of Algorithms that make sense of data“, Cambridge, 2014.

REFERENCE BOOKS:

1. Judy Franklin, Tom Mitchell, Sebastin Thrun, “Recent Advances in Robot Learning: Machine Learning”, Springer, 2012.
2. Ethem Alpaydin, “Introduction to Machine Learning”, The MIT Press, 2004
3. David MacKay, „Information Theory, Inference and Learning Algorithms“, Cambridge, 2003
4. Bruno Apolloni, Ashish Ghosh, Ferda Alpasian, “Machine Learning and Robot Perception”, Springer, 2005.

WEB REFERENCES:

1. <https://archive.nptel.ac.in/courses/106/106/106106139/>
2. <https://www.udacity.com/course/artificial-intelligence-for-robotics--cs373>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3				1	1						1		
CO2	2		1		1						1	1		
CO3	1	1	1		3	1					1	2		
CO4	1	1	1		3	1					1	2		
CO5	2	1	1		3						1	2		
Avg	1.8	0.6	0.8		2.2	0.6					0.8	1.6		

VI SEMESTER (PROFESSIONAL ELECTIVE II)	L	T	P	C
	3	-	-	3
20RB6E02 :: DRONE TECHNOLOGY				

COURSE OBJECTIVES:

- To make the students to understand the basic concepts of UAV systems design.
- Ability to design UAV system
- Ability to identify different hardware for UAV

COURSE OUTCOMES: Students are able to

- CO1.** Explain the Unmanned Aircraft Systems and its components. [K2]
- CO2** Describe the characteristics of aircraft types and design standards. [K2]
- CO3.** Explain the functions and working of sensors and avionics hardware used in UAV. [K2]
- CO4.** Illustrate the communication systems used, payload levels and controls used in UAV. [K2]
- CO5.** Illustrate the recent advancements used in UAV. [K2]

UNIT I INTRODUCTION TO UAV

History of UAV – classification, introduction to Unmanned Aircraft Systems, models and prototypes, system composition, applications.

UNIT II THE DESIGN OF UAV SYSTEMS

Introduction to design and selection of the system, Aerodynamics and airframe configurations, Characteristics of aircraft types, Design standards and regulatory aspects - UK,USA and Europe, Design for stealth, Control surfaces, Specifications.

UNIT III AVIONICS HARDWARE

Autopilot, AGL-pressure sensors, Servos-accelerometer, Gyros-actuators, Power supply, Processor, integration, installation, configuration, and testing.

UNIT IV COMMUNICATION, PAYLOADS AND CONTROLS

Payloads, Telemetry-tracking, Aerial photography, Controls, PID feedback-radio control frequency range, Modems, Memory system, Simulation, Ground test, Analysis, Trouble shooting.

UNIT V THE DEVELOPMENT OF UAV SYSTEMS

Waypoints navigation, Ground control software, System ground testing, System in-flight testing, Future prospects and challenges-Case studies – Mini and micro UAVs.

TEXT BOOKS

1. Paul G. Fahlstrom, Thomas J. Gleason, “Introduction to UAV Systems”, 5th edition, Wiley, 2022.
2. Reg Austin “Unmanned Aircraft Systems UAV design, development and deployment”, Wiley, 1st edition, 2010.

REFERENCE BOOKS:

1. Rama K. Yedavalli, “Flight Dynamics and Control of Aero and Space Vehicles”, 2nd edition, Wiley, 2019.
2. R. Kurt Barnhart, Douglas M. Marshall, Eric Shappee, “Introduction to Unmanned Aircraft Systems” , 2nd edition, CRC Press, 2016
3. Kimon P. Valavanis, “Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy”, 2nd edition, Springer, 2010

WEB REFERENCES:

1. <https://www.techtarget.com/iotagenda/definition/drone>
2. <https://archive.nptel.ac.in/courses/101/104/101104073/>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3											1	1	
CO2	2	2	2			1					1	1	2	
CO3	2		1		1	1					1		1	
CO4	2		1	2	1	1					1	1	2	
CO5	2		2	2	1	1					1	1	2	
Avg	2.2	0.4	1.2	0.8	0.6	0.8					0.8	0.8	1.4	

VI SEMESTER (PROFESSIONAL ELECTIVE II)	L	T	P	C
	3	-	-	3
20RB6E03 :: AUTOMATION IN MANUFACTURING				

COURSE OBJECTIVES

- To learn about the automation systems and flow lines used in manufacturing industry.
- To learn about the assembly systems and automated material handling systems used in automated production system.
- To understand the concept of controls used in automated production lines.

COURSE OUTCOMES

Students are able to

- CO1** : Explain the process of automation and types (K2)
- CO2** : Interpret the well-defined task or operation is accomplished by an automated machine (K2)
- CO3** : Identify, formulate and solve algorithm related to localization, obstacle avoidance, and mapping. (K3)
- CO4** : Explain the automated material handling systems used in manufacturing establishment.[K2]
- CO5** : Describe the control methods and systems used in automated flow lines (K2)

UNIT-I

INTRODUCTION

Types and strategies of automation, pneumatic and hydraulic components, circuits, Automation in machine tools, Mechanical Feeding and tool changing and machine tool control.

UNIT-II

AUTOMATED FLOW LINES

Methods of work part transport, transfer mechanism, buffer storage, control function, design and fabrication consideration.

ANALYSIS OF AUTOMATED FLOW LINES: General terminology and analysis of transfer lines without and with buffer storage, partial automation, implementation of automated flow lines .

UNIT-III

ASSEMBLY SYSTEM AND LINE BALANCING

Assembly process and systems assembly line, line balancing methods, ways of improving line balance, flexible assembly lines.

UNIT-IV

AUTOMATED MATERIAL HANDLING

Types of equipment, functions, analysis and design of material handling systems, conveyor systems, automated guided vehicle systems.

AUTOMATED STORAGE SYSTEMS: Automated storage and retrieval systems; work in process storage, interfacing handling and storage with manufacturing.

UNIT-V

FUNDAMENTALS OF INDUSTRIAL CONTROLS

Review of control theory, logic controls, sensors and actuators, Data communication and LAN in manufacturing. Business process Re-engineering: Introduction to BPE logistics, ERP, Software configuration of BPE.

TEXT BOOKS:

1. Groover, M. P., Automation, Production Systems, and Computer-integrated Manufacturing, Pearson, 2018.
2. Frank Lamb, Industrial Automation hands on , Mc Graw Hill Education ,2013
3. Yoram Coreom, Computer control of Manufacturing Systems, New Age International Publishers, 2006.

REFERENCE BOOKS:

1. F. Gardner, R, Introduction to Plant Automation and Controls, 1st Edition, CRC Press, 2020.
2. Tien-Chien Chang, Richard A Wysk and Hsu-Pin Wang, Computer Aided Manufacturing, Pearson, 2009.
3. Radhakrishnan and Subramanian, CAD/CAM/CIM, 4th Edition, New Age Publications, 2018.

WEB REFERENCES:

1. <https://nptel.ac.in/courses/112104288>
2. <https://archive.nptel.ac.in/courses/112/103/112103293/#>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1		1		3	2	2		1		2		2	
CO2	1	1	3		3	1			1				2	
CO3	2	2	3		2	1			1				2	
CO4	1	2	2		2	1	1		1				2	
CO5	1	1							1				2	
Avg	1.2	1.2	1.8		2	1	0.6		1		0.4		2	

VI SEMESTER (PROFESSIONAL ELECTIVE II)	L	T	P	C
	3	-	-	3
20RB6E04 :: LINEAR INTEGRATED CIRCUITS				

COURSE OBJECTIVES:

- To understand the basic operation & performance parameters of differential amplifiers.
- To understand & learn the measuring techniques of performance parameters of Op-Amp.
- To learn the linear and non-linear applications of operational amplifiers.
- To Acquire skills required for designing and testing integrated circuits

COURSE OUTCOMES: Students are able to

- CO1.** Describe fundamental of IC Fabrication process. (K2)
- CO2.** Explain different applications based on operational amplifier. (K3)
- CO3.** Explain about Inverting and non-inverting amplifier. (K2)
- CO4.** Describe Basic principles of sinusoidal oscillators. (K2)
- CO5.** Explain basic linear regulator operations and applications of the LR. (K2)

UNIT- I

INTEGRATED CIRCUIT FABRICATION:

IC - classification, chip size and circuit complexity, fundamental of monolithic IC technology- epitaxial growth, masking and etching, diffusion of impurities, IC Package types and temperature ranges, Fabrication of diodes, Resistance and capacitance.

UNIT II

OPERATIONAL AMPLIFIER:

Differential amplifier- configurations and properties, OP-Amps - characteristics, block diagram, level translator, ideal and practical op-amp specifications, parameters, AC and DC characteristics of 741 op-amp & its features, Input & Output offset currents and voltages, slew rate, CMRR, PSRR.

UNIT III

LINEAR AND NON-LINEAR APPLICATIONS OF OP- AMPS:

Linear applications of op- amps, Inverting and non-inverting amplifier, Integrator and differentiator, Difference amplifier, AC amplifier, V to I, I to V converters, Non-linear applications of op- amps, Comparators, Triangular and Square wave generators.

UNIT-IV

SIGNAL GENERATION AND WAVEFORM SHAPING CIRCUITS:

Basic principles of sinusoidal oscillators, OP Amp RC Oscillators circuits, LC and crystal oscillators, Generation of square and triangular waveforms, 555 timer and Applications, Phase Locked Loops and Applications.

UNIT-V

LINEAR REGULATOR:

Linear regulator- introduction, basic linear regulator operation, general linear regulator considerations, linear power supply design examples, Elementary discrete linear regulator designs, Basic three-terminal fixed and variable regulators

TEXT BOOKS

1. D. Roy Choudhury and Shail B. Jain, Linear Integrated Circuits, 4th Edition, New Age International Pvt. Ltd, 2017.
2. Ramakant A, Gayakwad, Op-Amps and Linear Integrated Circuits, 5th Edition, Pearson, 2021.

REFERENCE BOOKS

1. S. Shalivahanan, and V.S. Kanchana Bhaskaran, Linear Integrated Circuits, 3rd Edition, Tata McGraw-Hill, 2018.
2. A. P. Godse U. A. Bakshi, Linear Integrated Circuits, 3rd Edition, Technical Publications, 2019.

WEB REFERENCE:

1. <https://nptel.ac.in/courses/108108111>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2		1	1						2	1
CO2	3	3	2	2		1	1						3	
CO3	3	3	2	2		1	1						3	1
CO4	3	3	2	2		1	1						3	
CO5	3	3	2	2		1	1						3	
Avg	3	3	2	2		1	1						2.8	0.4

VI SEMESTER : OPEN ELECTIVE - II	L	T	P	C
	3	-	-	3

20CE6001:: ENVIRONMENTAL POLLUTION AND CONTROL

Course Outcomes:

Students are able to

1. Identify the air pollutant causes and control devices. (K2)
2. Differentiate the treatment techniques used for sewage and industrial wastewater treatment methods. (K2)
3. Understand the fundamentals of solid waste management, practices adopted in his town/village and its importance in keeping the health of the city. (K2)
4. know the causes for noise pollution and ISO14000 standards. (K2)
5. know Treatment and management of hazardous waste. (K2)

SYLLUBUS**UNIT – I : Air Pollution**

Air pollution causes-control methods–particulate control devices – methods of controlling Gaseous Emissions – Air quality standards.

UNIT –II: Industrial wastewater Management

Strategies for pollution control – Volume and Strength reduction – Neutralization – Equalization – Proportioning – Common Effluent Treatment Plants – Recirculation of industrial wastes – Effluent standards.

UNIT – III : Solid Waste Management

Solid waste characteristics–basics of on-site handling and collection–separation and processing – Incineration-Composting-Solid waste disposal methods – fundamentals of landfilling.

UNIT – IV: Noise Pollution

Noise standards, Measurement and control methods – Reducing residential and industrial noise – ISO14000

UNIT – V: Hazardous Waste

Characterization – Nuclear waste – Biomedical wastes – Electronic wastes – Chemical wastes – Treatment and management of hazardous waste-Disposal and Control methods.

Text books

1. K. Sasi Kumar, S.A. Gopi Krishna ,”Solid Waste Management”,PHI New Delhi,2014.
2. D. Srinivasan, “Environmental Engineering”, PHI Learning Private Limited, New Delhi, 2011.

References books

1. Ruth F. Weiner and Robin Matthews , „Environmental Engineering,,, 4th Edition Elsevier, 2003.
2. J.G. Henry and G.W. Heinke,,,Environmental Science and Engineering,,– Pearson Education,2002
3. Mackenzie L Davis & David A Cornwell, “Environmental Engineering ,,McGraw Hill Publishing,2002.
4. Howard S. Peavy, Donald R. Rowe, Teorge George Tchobanoglus,”Environmental Engineering”, Mc-Graw-Hill Book Company, New Delhi, 1985.

E-Resources

1. <https://nptel.ac.in/courses/123105001>

VI SEMESTER : OPEN ELECTIVE - II	L	T	P	C
	3	-	-	3
20CE6002 :: DISASTER MANAGEMENT				

Course Outcomes:

Students are able to

1. identify the tools of integrating disaster management principles in disaster mitigation process. (K2)
2. discuss about different approaches needed to manage pre and post- disaster activities. (K2)
3. prepare the process of risk management and develop a basic understanding method for the role of public in risk management. (K2)
4. administer the role of technology in Disaster management. (K2)
5. conclude the planning strategies for education and community preparedness programmes. (K2)

SYLLUBUS

UNIT-I : Natural Hazards and Disaster management:

Introduction of DM – Inter disciplinary nature of the subject- Disaster Management cycle- Five priorities for action. Case study methods of the following: floods, draughts -Earthquakes- global warming, cyclones & Tsunamis- Post Tsunami hazards along the Indian coast - landslides.

UNIT-II: Man Made Disaster and their management along with case study methods of the following:

Fire hazards - transport hazard dynamics -Solid waste management- post disaster – Bio terrorism -threat in mega cities, rail and air craft’s accidents, and Emerging infectious diseases & Aids and their management.

UNIT-III: Risk and Vulnerability:

Building codes and land use planning - social vulnerability - environmental vulnerability - Macroeconomic management and sustainable development, climate change risk rendition - financial management of disaster - related losses.

UNIT-IV: Role of Technology in Disaster managements:

Disaster management for infra structures, taxonomy of infrastructure - treatment plants and process facilities- electrical substations- roads and bridges- mitigation programme for earth quakes -flowchart, geospatial information in agriculture drought assessment-multimedia technology in disaster risk management and training transformable indigenous knowledge in disaster reduction.

UNIT-V: Education and Community Preparedness

Education in disaster risk reduction-Essentials of school disaster education-Community capacity and disaster resilience-Community based disaster recovery -Community based disaster management and social capital- Designing resilience- building community capacity for action.

Text Books

1. Jagbir Singh , „Disaster Management - Future Challenges and Opportunities“ , I K International Publishing House Pvt. Ltd-2017
2. Tushar Bhattacharya, „Disaster Science & Management“, Tata McGraw Hill Education Pvt. Ltd., New Delhi.-2012.

References Books

1. Prof. R.B. Singh , “Disaster Management and Mitigation”, World Focus 2016.
2. Rajib shah & R. Krishnamurthy, „Disaster Management - Global Challenges and Local Solutions“ Universities press-2009.
3. H K Gupta , ‘Disaster Management‘, Universities press-2003

E-resources

1. <https://archive.nptel.ac.in/courses/105/104/105104183/>

VI SEMESTER : OPEN ELECTIVE - II	L	T	P	C
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20EE6001 :: FUNDAMENTALS OF ELECTRIC VEHICLES

COURSE OUTCOMES:

After successful completion of this course, students should be able to:

CO1	:	Illustrate different types of electric vehicles
CO2	:	Select suitable power converters for EV applications
CO3	:	Design HEV configuration for a specific application
CO4	:	Choose an effective method for EV and HEV applications
CO5	:	Analyse a battery management system for EV and HEV

SYLLABUS

UNIT-I	:	INTRODUCTION
Fundamentals of vehicles - Components of conventional vehicles - drawbacks of conventional vehicles – Need for electric vehicles - History of Electric Vehicles – Types of Electric Vehicles – Advantages and applications of Electric Vehicles		
UNIT-II	:	COMPONENTS OF ELECTRIC VEHICLES
Main components of Electric Vehicles – Power Converters - Controller and Electric Traction Motor – Rectifiers used in EVs – Bidirectional DC–DC Converters – Voltage Source Inverters – PWM inverters used in EVs.		
UNIT-III	:	HYBRID ELECTRIC VEHICLES
Evolution of Hybrid Electric Vehicles – Advantages and Applications of Hybrid Electric Vehicles – Architecture of HEVs - Series and Parallel HEVs – Complex HEVs – Range extended HEVs – Examples - Merits and Demerits.		
UNIT-IV	:	MOTORS FOR ELECTRIC VEHICLES
Characteristics of traction drive - requirements of electric machines for EVs – Different motors suitable for Electric and Hybrid Vehicles – Induction Motors – Synchronous Motors – Permanent Magnetic Synchronous Motors – Brushless DC Motors – Switched Reluctance Motors (Construction details and working only)		
UNIT-V	:	ENERGY SOURCES FOR ELECTRIC VEHICLES
Batteries - Types of Batteries – Lithium-ion - Nickel-metal hydride - Lead-acid – Comparison of Batteries - Battery Management System – Ultra capacitors – Flywheels – Fuel Cell – it’s working.		

TEXT BOOKS:

1. Iqbal Hussein - Electric and Hybrid Vehicles: Design Fundamentals - CRC Press - 2021.
2. Denton - Tom. Electric and hybrid vehicles. Routledge - 2020.

REFERENCE BOOKS:

1. Kumar - L. Ashok - and S. Albert Alexander. Power Converters for Electric Vehicles. CRC Press - 2020.
2. Chau - Kwok Tong. Electric vehicle machines and drives: design - analysis and application. John Wiley & Sons - 2015.
3. Berg - Helena. Batteries for electric vehicles: materials and electrochemistry. Cambridge university press - 2015.

VI SEMESTER : OPEN ELECTIVE - II	L	T	P	C
	3	-	-	3
20EC6001 :: MOBILE COMMUNICATION AND IT'S APPLICATIONS				

COURSE OUTCOMES:

Students are able to

- CO1.** Design Hexagonal shaped cells and how these are implemented in real world.
- CO2.** Explain different types of antenna systems in mobile communication.
- CO3.** Analyze Handoffs and different types of handoffs and Dropped call rates and their evaluation.
- CO4.** Describe the Parameters of Mobile multipath channels, Types of small scale fading.

UNIT-I

INTRODUCTION :

Evolution of Mobile Communications, Mobile Radio Systems around the world, First, Second, Third Generation Wireless Networks, Wireless Local Loop(WLL), Wireless LANs, Bluetooth, Personal Area Networks(PANs), A Simplified Reference Model, Applications.

UNIT-II

ELEMENTS OF MOBILE COMMUNICATIONS:

General description of the problem, concept of frequency channels, Co-channel Interference Reduction Factor, desired C/I from a normal case in a Omni directional Antenna system, Cell splitting, consideration of the components of Cellular system.

UNIT-III

THE MOBILE CONCEPT :

Introduction, Frequency reuse, Handoff strategies, Interference and System Capacity: Co- Channel Interference, Channel Planning, Adjacent Channel Interference, Power control for reducing interference, Trunking and Grade of Service, Cell Splitting, Sectoring.

UNIT-IV

MOBILE RADIO PROPAGATION :

Introduction, Free space propagation model, The three basic propagation models-Reflection, Diffraction and Scattering, Two-ray model, Outdoor propagation models, Indoor propagation models, Signal Penetration into building, Small scale multipath Propagation, Parameters of Mobile multipath channels, Types of small scale fading.

UNIT-V

FREQUENCY MANAGEMENT AND CHANNEL ASSIGNMENT:

Numbering and grouping, setup access and paging channels channel assignments to cell sites and mobile units, channel sharing and borrowing, sectorization, overlaid cells, non fixed channel assignment.

TEXTBOOKS:

1. Wireless Communications by Theodore S. Rappaport, principles and practice, 2nd Editions. (Unit-I, III, IV & V)
2. Mobile Cellular Communication by Gottapu Sasibhushana Rao, Pearson International, 2012.

(UNIT - I, II, III & IV)

3. Mobile Cellular Telecommunications – W.C.Y. Lee, Tata McGraw Hill, 2nd Edn., 2006. **(UNIT - V & VI)**

REFERENCES:

1. Wireless and Mobile Communications-Lee, McGraw Hill, 3rd Edition, 2006.
2. Wireless Communications and Networks-William Stallings, Pearson Education, 2004.

VI SEMESTER : OPEN ELECTIVE - II	L	T	P	C
	3	-	-	3
20ME6001 :: BASICS OF 3D PRINTING				

COURSEOBJECTIVES:

1. To explore technology used in additive manufacturing.
2. To acquire knowledge for selecting correct CAD formats in manufacturing process.
3. To understand the operating principles and limitations of liquid, solid and laser based additive manufacturing system.
4. To design the process of additive manufacturing including tools used for design.
5. To acquire knowledge on important process parameters for bio-manufacturing

COURSEOUTCOMES: Students are able to

- CO1: To impart the fundamentals of Additive Manufacturing Technologies for engineering applications [K2]
 CO2: Select and use correct CAD for parts in the manufacture of a 3D printed part. [K2]
 CO3: Explain the operating principles, capabilities, and limitations of liquid, solid and laser based additive manufacturing system. [K2]
 CO4: Enumerate the design process for additive manufacturing including tools used for design and some features required for design. [K2]
 CO5: Describe the important process parameters for bio-manufacturing and determine the suitable additive technique for bio-manufacturing, aerospace and manufacturing engineering. [K2]

UNIT I

INTRODUCTION

3D printing Overview, History, Need, Classification, Additive Manufacturing Technology in product development, Materials for Additive Manufacturing Technology.

UNIT II

REVERSE ENGINEERING

Basic Concept – 3D Scanning Digitization techniques, Model Reconstruction, Data Processing for Additive Manufacturing Technology, Part Orientation and support generation, Model Slicing, Tool path Generation.

UNIT III

ADDITIVE MANUFACTURING SYSTEMS

SOLID & LIQUID BASED- Classification, Stereo lithography Apparatus (SLA) - Principle, process, advantages, Fused Deposition Modeling – Principle, process, advantages.
 LASER BASED- Selective Laser Sintering – Principle, Process, advantages, Three Dimensional Printing – Principle, process, advantages – Laser Engineered Net Shaping (LENS).

UNIT IV

DESIGN FOR AM

Motivation, Design for Manufacturing and Assembly (DFMA)-concepts and objectives, AM unique capabilities, Exploring design freedoms, Design tools for AM-Part Orientation, Removal of Supports,

Hollowing out parts, Inclusion of Undercuts, Other Manufacturing Constraining Features, Interlocking Features, Reduction of Part Count in an Assembly, Identification of markings/numbers etc.

UNIT V

APPLICATIONS OF 3D PRINTING

Customized implants and prosthesis: Design and development, Bio-Additive Manufacturing- Computer Aided Tissue Engineering (CATE), Applications of 3D Printing in Aerospace, Automotive, Manufacturing and Architectural Engineering.

TEXTBOOKS:

1. Patri K. Venuvinod., and Weiy in Ma., Rapid prototyping Laser based and other Technologies, First Edition, Springer Science +Business Media, LLC, 2004.
2. Chua C.K., Leong K.F., and Lim C.S., Rapid prototyping: Principles and applications, Third Edition, World Scientific Publishers, 2016.
3. Gebhardt A, Rapid prototyping, Hanser Gardener Publications,2017.
4. Chee Kai Chua, Kah Fai Leong, 3D Printing and Additive Manufacturing: Principles and Applications, World Scientific Publishers, Fourth Edition of Rapid Prototyping, 2018.

REFERENCES:

1. LiouL.W.and LiouF.W.,Rapid Prototyping and Engineering applications:A toolbox for prototype development, CRC Press, 2017.
2. Kamrani A.K. and Nasr E.A., Rapid Prototyping: Theory and practice, Springer, 2016.
3. Hilton P.D. and Jacobs P.F., Rapid Tooling: Technologies and Industrial Applications, CRC press, 2015.

WEB REFERENCES:

1. <https://all3dp.com/>
2. <https://www.thingiverse.com/>
3. <https://additivemanufacturing.com/>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2	1							2	3	
CO2	2	1	2	3	2							3	3	
CO3	2	2	3	3	2							3	3	1
CO4	3	3	3	2	2							2	2	
CO5	3	3	2	3	2							2	2	1
Avg	2.4	2.2	2.4	2.6	1.8							2.4	2.6	0.4

1.

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	3	-	-	3
20ME6O02 :: FARM MACHINERY				

COURSE OBJECTIVES: The objectives of this course are

- To impart the students to understand the fundamentals of machinery in farming.
- To enable the students to acquire knowledge on tillage and equipment used.
- To introduce the students about various types of earth moving equipment.
- To enable the students to acquire knowledge on seeding and spraying equipment.
- To introduce the fundamentals of transplanting machinery and fertilizer equipment.

COURSE OUTCOMES: Students will be able to

- CO1. Explain various types of machinery in farming. [K2]
- CO2. Illustrate types of farm operation for craft cultivation with scientific understanding. [K2]
- CO3. Explain various types of earth moving equipment. [K2]
- CO4. Summarize various seeding methods and sprayer types. [K2]
- CO5. Explain transplanting methods and fertilizer equipment. [K2]

UNIT I

FARM MECHANIZATION:

Farm mechanization- objectives of farm mechanization, sources of farm power, classification of farm machines. Materials of construction and heat treatment. principles of operation and selection of machines used for production of crops, Field capacities of different implements and their economics, Problems on field capacities and cost of cultivation

UNIT II

TILLAGE EQUIPMENT:

Tillage equipment - classification and types of tillage, Primary tillage implements-mould board plough and its parts, disc plough, and other ploughs, Secondary tillage equipment- disc harrows, Implements- cultivators, intercultural implements. Forces acting on tillage tools, Problems on forces analysis, Draft measurement of tillage equipment, Draft and unit draft related problems.

UNIT III

EARTH MOVING EQUIPMENT

Earth moving equipment - terminology, construction and their working principles, shovels, bulldozers, trenches and elevators.

UNIT IV

SEED DRILLS AND SPRAYER:

Seeding - methods, types of seed metering mechanism, types of furrow openers. Calibration of seed drills, Adjustment of seed drills – objectives, uses of plant protection equipment
 Sprayers - types of sprayers and dusters, sprayer calibration and selection, Constructional features of different components of sprayers and dusters

UNIT V

TRANSPLANTING AND FERTILIZER:

Transplanting and fertilizer - transplanting methods, different types of transplanting machinery, working principle, adjustments in transplanting equipment

Fertilizer - application equipment, fertilizer meeting mechanism calibration of fertilizer equipment.

TEXTBOOKS

1. Fakir Chara Das, Kishore Chandra and Shishira Kanth, Farm Machinery and Equipment, 1st Edition, Akinik Publications, 2020
2. Triveni Prasad Singh, Farm Machinery, 1st Edition, Prentice Hall India Pvt, Limited, 2016.

REFERENCES

1. Surendra Singh, Farm Machinery Principal And Applications, 1st Edition, ndian Council of Agricultural Research, 2017
2. Smith H P, Farm Machinery and Equipment, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2007.

WEB REFERENCE:

1. <https://nptel.ac.in/courses/126105009>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2			1	2					1	1	
CO2	3	2	2			1	2					1	1	
CO3	3		2			1	2					1	1	
CO4	3		1			1	2					1	1	
CO5	3		2			1	2					1	1	
Avg	3	0.8	1.8			1	2					1	1	

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20EC6001:: FUNDAMENTALS OF SOFTWARE ENGINEERING				

COURSE OUTCOMES:

At the end of the course, the student should be able to

1. Identify, formulate the various software engineering concepts
2. different software development process models.
3. analyze and specify software requirements with various stakeholders of a software development project
4. Apply systematic procedure for software design and deployment.
5. Compare and contrast the various testing methods and art of debugging

UNIT I

SOFTWARE AND SOFTWARE ENGINEERING: The nature of Software: Define software (Software Characteristics), Software Application Domains, **Software Engineering:** Definition, Layered Technology, **Software Process:** Generic Process framework activities, Umbrella activities, Software Myths and Reality, Generic Process model, Capability Maturity Model Integration (CMMI).

UNIT-II

PROCESS MODELS: Process Assessment and improvement. Prescriptive Process models: Waterfall Model, Incremental Process Model, Evolutionary Process Models: Prototyping, Spiral model, The Unified Process. Personal and Team process models: Personal software process (PSP), Team software process (TSP), Product and Process,

UNIT-III

REQUIREMENTS ANALYSIS AND SPECIFICATION: Functional Requirements, Non- Functional Requirements, Software Requirements Document (Software Requirements Specification SRS), Requirements Specification, Requirements Engineering, Eliciting Requirements(elicitation), Developing Use cases, Validating Requirements, Requirements Management: Requirements Planning, Requirements Change management.

UNIT-IV

SOFTWARE DESIGN: Design process, **Design concepts:** Abstraction, Architecture, Patterns, Separation of Concerns, Modularity, Information hiding, Functional independence, Refinement, Aspects, refactoring, Object oriented design concepts, Design classes.

The Design Model: Data Design Elements, Architectural Design elements, Designing Class Based Components: Basic Design Principles, Component-Level Design guidelines, Cohesion and coupling.

User Interface Design: The Golden Rules

UNIT-V

TESTING: The strategies for Conventional Strategies: Unit Testing – Integration Testing. Test Strategies for Object-Oriented Software, Software testing fundamentals, white box testing- Basis path testing: Flow graph Notation, independent Program paths, Deriving test cases, Graph Matrices. control structure testing. black box testing: Graph Based Testing Methods, Equivalence Partitioning, Boundary value Analysis. Validation Testing, System Testing. Art of Debugging: The Debugging process.

TEXT BOOK:

1. Software Engineering, A practitioner's Approach- Roger S. pressman, 8th edition, McGraw-Hillinternational Edition, 2014.
2. Software Engineering, Ian Sommerville, 10th Edition, Pearson Education Asia, 2016.

REFERENCE BOOKS:

1. Software Engineering, Pankaj Jalote, A Precise Approach”, Wiley India, 2010.
2. Systems Analysis and Design- Shely Cash man Rosenblatt, 9th Edition, Thomson publications, 2016.
3. Software Project Management, Bob Hughes, Mike Cotterell and Rajib Mall, Fifth Edition, Tata McGrawHill, New Delhi, 2012.
4. <https://nptel.ac.in/courses/106101061/>

VI SEMESTER : OPEN ELECTIVE - II	L	T	P	C
	3	-	-	3
20CS6O02 :: FUNDAMENTALS OF COMPUTER NETWORKS				

COURSE OUTCOMES

At the end of the course students are able to

1. Differentiate network reference models such as OSI, TCP/IP
2. Classify various Data Link Layer protocols such as sliding window.
3. Distinguish various MAC sublayer protocols such as ALOHA, CSMA, CSMA/CD
4. Differentiate Network layer protocols IPv4 and IPv6
5. Distinguish various Transport layer protocols and its applications

UNIT 1:

Data communication Components: Representation of data and its flow of networks, Categories of Networks, Various Connection Topologies, Protocols and Standards, OSI network model, TCP/IP Protocol suit, addressing

UNIT 2:

Physical Layer: Transmission Media: Guided Media, Unguided Media

Data Link Layer: Error Detection and Error Correction -Fundamentals, Block coding, Hamming Distance, CRC, Flow Control and Error control protocols: Stop and Wait, Go back – N ARQ, Selective Repeat ARQ

UNIT 3:

Medium Access Sub Layer: Random Access, Multiple access protocols -Pure ALOHA, Slotted ALOHA, CSMA/CD, CDMA/CA. Controlled Access protocols: Reservation, Polling, Token passing

UNIT 4:

Network Layer: IPv4 address: Address Space, Notations, Classful Addressing, Classless Addressing, Network Address Translation (NAT) **IPv6 Addresses:** Structure, Address Space

Transport Layer: Process to Process Communication, User Datagram Protocol (UDP), Transmission Control Protocol (TCP)

UNIT 5:

Application layer:

Domain name system (DNS), E-mail, File Transfer Protocol (FTP), www and HTTP

Text Books:

1. Data Communication and Networking, 5th Edition, Behrouz A. Forouzan, McGrawHill, 2017
2. Computer Networks, 6th Edition, Andrew S. Tanenbaum, Pearson New International Edition, 2021.
3. Data and Computer Communication, 8th Edition, William Stallings, Pearson Prentice Hall India, 2007

Reference Books:

1. Internetworking with TCP/IP, Volume 1, 6th Edition Douglas Comer, Prentice Hall of India.
2. TCP/IP Illustrated, Volume 1, W. Richard Stevens, Addison-Wesley, United States of America.

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20BM6O01 :: STRESS AND WORK LIFE MANAGEMENT				

UNIT-I

Understanding stress: Meaning – Symptoms – Works Related Stress – Individual Stress –Reducing Stress – Burnout. Setting to Stress- Stress: Meaning - Approaches to stress, Good Stress Vs Bad Stress, The individual and work.

UNIT-II

Common stress factors time & career plateauing: Time Management – Techniques – Importance of planning the day – Time management schedule – Developing concentration – Organizing the Work Area – Prioritizing – Beginning at the start – Techniques for conquering procrastination – Sensible delegation – Taking the right breaks – Learning to say „No

UNIT-III

Introduction to Work-Life Balance - Importance of Work-Life Balance - Benefits of Work-Life Balance to Employees - Benefits of Work-Life Balance for Organization - Effects of Poor Work-Life Balance on Employees - Relation between Work-Life Balance & Stress - Outline for Work-Life Balance Planning- Approaches to Work-Life Balance planning - Process of Work-Life Balance - Steps of Work-Life Balance Planning

UNIT-IV

Work place humour: **Developing** a sense of Humour – Learning to laugh – Role of group cohesion and team spirit – Using humour at work – Reducing conflicts with humour.

UNIT-V

Self-development: Improving Personality – Leading with Integrity – Enhancing Creativity – Effective decision making – Sensible Communication – The Listening Game – Managing Self – Meditation for peace – Yoga for Life. Organization and Stress Management - Recognize the signs, Approaches to the problem, Providers Assistance.

References

1. Cooper, Managing Stress, Sage, 2011
2. Waltschafer, Stress Management, Cengage Learning, 4th Edition 2009.
3. Jeff Davidson, Managing Stress, Prentice Hall of India, New Delhi, 2012.
4. Juan R. Alascal, Brucata, Laurel Brucata, Daisy Chauhan. Stress Mastery. Pearson
5. Argyle. The Psychology of Happiness. Tata McGraw Hill. 2012
6. Bartlet. Stress – Perspectives & Process. Tata McGraw Hill. 2012
7. Handbook on Work –Life Balance-A New Approach, 2017, Dr. C Swarnalatha, Mrs.S. Rajalakshmi, Lulu Press.

VI SEMESTER : OPEN ELECTIVE - II	L	T	P	C
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20BM6O02 :: BANKING AND INSURANCE**Unit I**

Origin of banking: Definition, Types of deposits, Origin, and growth of commercial banks in India. India's Approach to banking Sector Reforms, International security standards in banking, Global Financial Crisis and India's banking Sector.

Unit II

Introduction to E-Banking-Impact of Information Technology on Banking Changing Financial Environment and IT as a strategic response Hardware and Software.

Unit III

Delivery Channels-ATM, EFTPOS, Phone Banking, Internet Banking, SMS Banking, Mobile Banking, Credit/Debit Cards, Smart Cards E-Commerce-Secure Electronic Transfer (SET), Payment Gateways (Credit card/Debit cards), Authentication of payments, etc.

Unit IV

Principles and Practice of Insurance-Introduction to Risk and Insurance, Types of Insurance-General and Life, Basic principles of General and Life Insurance,

Unit V

General insurance products, underwriting concepts, standard conditions and warranties with respect to Fire, Marine, Motor, Engineering and Miscellaneous products.

Reference Books:

1. Agarwal, OP, Banking & Insurance, Himalaya Publishing House, Mumbai
2. George E Rejda, Principles of Risk Management & Insurance, Pearson Education, New Delhi
3. Balachandran S., General Insurance, Insurance Institute of India, Mumbai
4. Arthur C., William Jr., Michael Smith, Peter Young, Risk Management and Insurance, Tata McGraw Hill Publishing Company, New Delhi
5. Tripathy Nalini Prava & Prabir Pal, Insurance Theory & Practice, Prentice Hall of India Pvt. Ltd., New Delhi
6. Balachandran S., Life Insurance, Insurance Institute of India, Mumbai

VI SEMESTER : OPEN ELECTIVE - II	L	T	P	C
	3	-	-	3
20MA6001 :: OPERATION RESEARCH				

COURSE OBJECTIVES:

1. Ability to understand and analyze managerial problems in industry so that they are able to use resources (capitals, materials, machines etc) more effectively.
2. Knowledge of formulating mathematical models for quantitative analysis of managerial problems in industry

UNIT—I

LINEAR PROGRAMMING:

Introduction-General formulation LPP- Formulation of LP problems - Graphical solution –Slack and Surplus and Artificial variables-simplex method (simple problems) - artificial variable techniques – twophase method, Big-M-method(simple problems) –Concept of Duality-general rules for converting any primal into its dual.

UNIT – II

TRANSPORTATION PROBLEM:

Introduction-mathematical formulation-Feasible, Basic Feasible and Optimum solution -Methods for initial basic feasible solution to transportation problem-optimal Test by u, v method(MODI)-Degeneracy in Transportation problems –.Unbalanced Transportation problems

UNIT – III

SEQUENCING PROBLEM:

Introduction –Johnson’s Algorithm for n jobs 2 machines- Optimal Solution for processing n jobs through two machines- processing n jobs through three machines - processing n jobs through m machines - processing two jobsthrough m machines

UNIT – IV

REPLACEMENT PROBLEMS:

Introduction – replacement policy for items whose maintenance cost increases with time, and money value is constant – Money value, present worth Factor and Discount Rate- replacement policy when maintenance cost increases with time and money valuechanges with constant rate – Individual Replacement Policy-group replacement of items that fail completely.

UNIT – V

WAITING LINES:

Introduction- transient and steady states-Probability Distributions in Queening systems-Kendall’s notation for Representing Queening models- Single channel-Poisson arrivalsExponential service times-with infinitepopulation model (M/M/1: FIFO/∞/∞)

INVENTORY:

Introduction – types of inventory models – Costs involved in Inventory problems-Variables in inventory problem-Classification of Inventory Models-Concept of EOQ-The EOQ model without shortage – Quantity Discounts-purchase inventory models with one price break - purchase inventory models with two price breaks-purchase inventory models with any number of price breaks-shortages are not allowed

COURSE OUTCOMES: Students can able to

- CO1: Formulate** the resourcemanagement problem andidentify appropriate methods to solve them. [K3]
- CO2: Apply**transportation model to optimize the industrial resources. [K3]
- CO3: Solve** sequencing problems using operation research techniques. [K3]
- CO4: Apply** thereplacement model to increase the efficiency of the system. [K3]

CO5: Apply the inventory and queuing model to increase the efficiency of the system. [K4]

.TEXT BOOKS:

1. Operations Research / S.D.Sharma, Ramnath co, Meerut
2. Operations Research, P.K.Gupta, D.S.Hira, S.Chand

REFERENCE BOOKS:

1. Operations Research / A.M.Natarajan, P.Balasubramani, A.Tamilarasi/Pearson Education.
2. Operations Research / R. Pannerselvam, PHI Publications.

VI SEMESTER : OPEN ELECTIVE - II	L	T	P	C
	3	-	-	3
20IT6001 :: INTRODUCTION TO CLOUD COMPUTING				

Course Outcomes:

Upon completion of the course, it is expected that student will be able to:

1. Articulate the main concepts, key technologies, strengths and limitations of cloud computing.
2. Learn the key and enabling technologies that help in the development of cloud.
3. Develop the ability to understand and use the architecture of compute and storage cloud, service and delivery models.
4. Explain the core issues of cloud computing such as resource management and security.
5. Evaluate and choose the appropriate technologies, algorithms and approaches for implementation and use of cloud.

UNIT-I:

Introduction: Introduction to Cloud Computing, Definition of Cloud, Evolution of Cloud Computing, Underlying Principles of Parallel and Distributed Computing, Cloud Characteristics, Elasticity in Cloud – On-Demand Provisioning.

UNIT-II:

Cloud Enabling Technologies: Service Oriented Architecture, REST and Systems of Systems, Web Services, Publish-Subscribe Model, Basics of Virtualization, Types of Virtualization, Implementation Levels of Virtualization, Virtualization Structures, Tools and Mechanisms, Virtualization of CPU, Memory, I/O Devices, Virtualization Support and Disaster Recovery.

UNIT-III:

Cloud Architecture, Services And Storage: Layered Cloud Architecture Design, NIST Cloud Computing Reference Architecture, Public, Private and Hybrid Clouds, IaaS, PaaS, SaaS, Architectural Design Challenges, Cloud Storage, Storage-as-a-Service, Advantages of Cloud Storage, Cloud Storage Providers, S3.

UNIT-IV:

Resource Management And Security In Cloud: Inter Cloud Resource

Management, Resource Provisioning and Resource Provisioning Methods, Global Exchange of Cloud Resources, Security Overview, Cloud Security Challenges, Software-as-a-Service Security, Security Governance, Virtual Machine Security, IAM, Security Standards.

UNIT-V:

Cloud Technologies And Advancements: Hadoop, MapReduce, Virtual Box, Google App Engine, Programming Environment for Google App Engine, Open Stack, Federation in the Cloud, Four Levels of Federation, Federated Services and Applications, Future of Federation.

Text Books:

1. Distributed and Cloud Computing, From Parallel Processing to the Internet of Things, Kai Hwang, Geoffrey C. Fox, Jack G. Dongarra, Morgan Kaufmann Publishers.
2. Cloud Computing: Implementation, Management and Security, Rittinghouse, John W., and James F. Ransome, CRC Press.

References:

1. Mastering Cloud Computing, Rajkumar Buyya, Christian Vecchiola, S. ThamaraiSelvi, Tata McgrawHill.
2. Cloud Computing - A Practical Approach, Toby Velte, Anthony Velte, Robert Elsenpeter, Tata McGrawHill.
3. Cloud Application Architectures: Building Applications and Infrastructure in the Cloud: Transactional Systems for EC2 and Beyond (Theory in Practice), George Reese, O'Reilly.

VI SEMESTER : OPEN ELECTIVE - II	L	T	P	C
	3	-	-	3
20IT6O02 :: E-COMMERCE				

COURSE OUTCOMES

After the completion of the course the students are able to

1. Define the fundamentals E-commerce framework.
2. Explain the basics of Consumer Oriented Electronic models.
3. Distinguish different electronic payment systems and their issues.
4. Demonstrate Inter-organizational and intra-organizational electronic commerce.
5. Explain advertising and marketing on the Internet, consumer search and resource discovery and key multimedia concepts.

UNIT-I

Electronic Commerce-Frame work, anatomy of E-Commerce applications, E-Commerce Consumer applications, E-Commerce organization applications.

UNIT-II

Consumer Oriented Electronic commerce - Mercantile Process models, Electronic payment systems - Digital Token-Based, Smart Cards, Credit Cards, Risks in Electronic Payment systems.

UNIT-III

Inter Organizational Commerce - EDI, EDI Implementation, Value added networks. Intra Organizational Commerce - work Flow, Automation Customization and internal Commerce, Supply chain Management.

UNIT-IV

Corporate Digital Library - Document Library, digital Document types, corporate Data Warehouses. Advertising and Marketing - Information based marketing, Advertising on Internet, on-line marketing process, market research.

UNIT-V

Consumer Search and Resource Discovery - Information search and Retrieval, Commerce Catalogues, Information Filtering.

Multimedia - key multimedia concepts, Digital Video and electronic Commerce, Desktop video processing, Desktop video conferencing.

Text Books:

1. Frontiers of electronic commerce – Kalakata, Whinston, Pearson.

References Books:

1. E-Commerce fundamentals and applications Hendry Chan, Raymond Lee, TharamDillon,Elizabeth Chang, John Wiley.
2. E-Commerce, S.Jaiswal – Galgotia.E-Commerce, Efrain Turbon, Jae Lee, David King, H.Michael Chang.
3. Electronic Commerce – Gary P.Schneider – Thomson.
4. E-Commerce – Business, Technology, Society, Kenneth C.Taudon, Carol GuyericoTraver.

VI SEMESTER : JOB ORIENTED ELECTIVE - II	L	T	P	C
	3	-	-	3
20CS6J01 :: AWS CLOUD PRACTITIONER				

Course outcomes:

After completing this course, students should be able to

1. Define AWS cloud and identify the Global Infrastructure components of AWS.
2. Demonstrate when to use Amazon EC2, AWS Lambda and AWS Elastic Beanstalk.
3. Differentiate Storage Services and demonstrate when to use AWS Database services.
4. Demonstrate Networking and Content Delivery Services.
5. Understand the Cloud economics and security.

UNIT 1:

CLOUD CONCEPTS OVERVIEW – Introduction to cloud computing, Cloud service models, Cloud computing Deployment models , Advantages of the cloud, Introduction to AWS.

AWS GLOBAL INFRASTRUCTURE OVERVIEW: AWS GLOBAL INFRASTRUCTURE, AWS Services and Service categories

UNIT 2:

COMPUTE – Compute services overview, Amazon EC2, Amazon EC2 pricing models, Benefits, use cases, four pillars of cost optimization, Container services, Introduction to AWS Lambda, Benefits of Lambda, Introduction to AWS Elastic Beanstalk, Benefits.

UNIT 3:

STORAGE: Amazon Elastic Block Store (EBS), Amazon Simple Storage Service (Amazon S3), Amazon Elastic File System (Amazon EFS), Amazon Simple Storage Service Glacier (Amazon S3 Glacier).

DATABASES: Amazon Relational Database Service (Amazon RDS), Amazon DynamoDB, Amazon RedShift, Amazon Aurora.

UNIT 4:

Networking and Content Delivery: Networking Basics, Amazon VPC, VPC Networking, VPC SECURITY, Amazon ROUTE-53, Amazon Cloud Front

UNIT 5:

CLOUD ECONOMICS AND BILLING: Fundamentals of pricing, AURI,PURI,NURI ,Total cost of Ownership (TOC).

AWS CLOUD SECURITY: AWS Shared Responsibility Model, AWS IAM (Identity and Access Management),Elastic Load Balancing (ELB), Amazon CloudWatch.

Web references and AWS LMS portal :

<https://aws.amazon.com/ec2>

<https://aws.amazon.com/ecs/>

<https://aws.amazon.com/about-aws/global-infrastructure/>

VI SEMESTER : JOB ORIENTED ELECTIVE - II	L	T	P	C
	3	-	-	3
20CS6J02 :: SOFTWARE TESTING TOOLS				

COURSE OUTCOMES:

At the end of the course students are able to

1. learn Manual testing techniques and software test levels
2. practice Java Programme for Selenium and Test frame works
3. learn Apache JMeter and Building a JMeter Test Plan
4. Running Multiple Scripts with JMeter and Different Types of JMeter Test Plans
5. practicing JIRA and Test Management In JIRA (Using Zephyr Plug-in)

UNIT-I:

Manual Testing : Software Development Life Cycle (Requirements Gathering, Analysis and Planning, Software Design, Coding/Implementation, Testing, and Release and Maintenance Phase)

Software Test Levels (Unit Testing, Integration Testing, System Testing, and Acceptance Testing)

- Software Test Types
- Software Test Design Techniques
- Software Test Life Cycle
- Software Documents
- Software Testing Standards
- Software Testing certification/s

UNIT-II:

‘Selenium with Java’ : Java Programme for Selenium (Data Types, Variables, Operators, Control Flow, Strings, Arrays, IO, Methods, Exception Handling, and Object-Oriented Programming.)

- Selenium WebDriver (Web/HTML Elements, Inspecting Web Elements, Locating Elements, Selenium WebDriver API commands, Wait statements, and Page Object Model.)
- TestNG Testing Framework (Create Test cases, Prioritise Test cases, Grouping Test Cases, Batch Testing, and Generating Test Results.)
- Automation Framework

UNIT-III:

JMeter:

- Introduction to Apache JMeter
- Elements of JMeter Test Plan
- Building a JMeter Test Plan
- Recording Tests Using JMeter
- Enhancements in Test Scripts

UNIT-IV:

JMeter Result Analysis

- Running Multiple Scripts with JMeter
- Different Types of JMeter Test Plans
- JMeter Distributed (Remote) Testing
- JMeter Functions, Variables and Regular Expressions
- JMeter Best Practices

UNIT-V:

Jira Tool Syllabus:

- Introduction of JIRA
- Getting started with JIRA
- Test Management In JIRA (Using Zephyr Plug-in)
- Defect Management In JIRA
- Advanced Search Using JQL
- Generating Reports In JIRA

Web references:

- <https://www.lambdatest.com/blog/selenium-with-java/>
- <https://www.gcreddy.com/2021/09/apache-jmeter-syllabus.html>
- <https://www.javatpoint.com/jira-tutorial>

VI SEMESTER : JOB ORIENTED ELECTIVE - II	L	T	P	C
	3	-	-	3
20IT6J01 :: FULL STACK DEVELOPMENT				

Course Outcomes:

At the end of the course students will be able to

1. Identify the Basics concepts of Web Page and Markup Languages
2. Develop web Applications using Scripting languages and Frameworks
3. Creating and Running Applications using PHP
4. Creating First Controller Working with and Displaying in AngularJS and Nested Forms with ng-form
5. Working with the Files in React JS and Constructing Elements with Data

Unit- 1: HTML

Web Essentials: Clients, Servers, and Communication. The Internet-Basic Internet Protocols- The World Wide Web-HTTP request message-response message-Web clients Web Servers. Markup Languages: XHTML, an introduction to HTML, History, Versions, Basics, XHTML Syntax and semantics some fundamentals of HTML Elements-Relative URLs-Lists-Tables-Frames-Forms-HTML 5.0

Unit- 2: Cascading Style Sheets (CSS)

Style Sheets: CSS-Introduction to Cascading Style Sheets- Features-Core Syntax-Style Sheets and HTML-Style Rule Cascading and Inheritance- Text Properties-Box Model Normal Flow Box Layout beyond the Normal Flow-CSS3.0, Introducing to Java Script, JavaScript basics, JavaScript objects, JSON.

Unit- 3: PHP

Introduction to PHP, Language Basics, Functions, Strings, Arrays. MYSQL Installation, Accessing MySQL Using PHP, Form Handling, Cookies, Sessions, and Authentication, Tables, Inserting Data into Tables, Selecting Data from a Table, Updating Table, Deleting data from Table, Webpage creation.

Unit- 4: Angular JS

Introducing Angular JS, Starting out with Angular JS, Basic AngularJS, Directives and Controllers, AngularJS Modules, Creating First Controller, working with and Displaying, Arrays, more Directives, working with ng-repeat, Unit Testing in AngularJS, Forms, inputs and Services, Working with ng-model, Working with Forms, Leverage Data-Binding and Models, Form Validation and States, Error Handling with Forms, ngModelOptions, Nested Forms with ng-form, Other Form Controls.

Unit- 5: React JS

Introduction to react, Obstacles and Roadblocks, keeping Up with the Changes, Working with the Files, Pure React, Page Setup, The Virtual DOM, React Elements, React DOM, Children, Constructing Elements with Data, React Components, DOM Rendering , Factories

Text Books:

1. Jeffrey C. Jackson, "Web Technologies--A Computer Science Perspective", Pearson Education, 2006
2. Robert. W. Sebesta, "Programming the World Wide Web", Fourth Edition, Pearson Education, 2007
3. Brad Green, Shyam Seshadri, AngularJS, Up and Running Enhanced Productivity with Structured Web Apps, Publisher O'Reilly Media
4. Alex Banks, Eve Porcello, Learning React, Functional Web Development with React and Redux
Publisher O'Reilly Media

Reference Books:

1. Bert Bates, Kathy Sierra, Head First Java, 2nd Edition Publisher O'Reilly Media, Inc

VI SEMESTER : JOB ORIENTED ELECTIVE - II	L	T	P	C
	3	-	-	3
20IT6J02 :: BLOCK CHAIN TECHNOLOGY				

Course Outcomes

After the completion of the course the students are able to

CO1 Discover the secure and efficient transactions with crypto-currencies

CO2 Experiment with cryptocurrency trading and crypto exchanges

CO3 Explain bitcoin usage and applications

CO4 Develop private block chain environment and develop a smart contract on Ethereum

CO5 Build the hyper ledger architecture and the consensus mechanism applied in the hyperledger

Unit-I**CRYPTOCURRENCY AND BLOCKCHAIN- INTRODUCTION:**

Blockchain- An Introduction, Distinction between databases and blockchain, Distributed ledger. Blockchain ecosystem - Consensus Algorithms & Types, Blockchain structure, Distributed networks- Distributed Applications (DApps) – Web 3.0 - DApps Ecosystems. Working - Permissioned and permission-less Blockchain – Cross Chain Technologies. – IOT & Blockchain - Digital Disruption in Industries – Banking, Insurance, Supply Chain, Governments, IP rights, Creation of trustless Ecosystems – Block chain as a Service – Open Source Block chains

Unit-II

CRYPTO CURRENCIES: Crypto Currencies - Anonymity and Pseudonymity in Cryptocurrencies - Digital Signatures - Cryptocurrency Hash Codes -Need for Crypto Currencies – Crypto Markets – Explore Crypto Currency Ecosystems - ICOs – Crypto Tokens - Atomic Swaps – Crypto Currency Exchanges – Centralised and Decentralized Crypto exchanges – Regulations on Crypto Currencies & exchanges – Downside of non-regulated currencies – crypto Scams – Exchange hacks

Unit-III

BITCOIN: Bitcoin – history- Bitcoin- usage, storage, selling, transactions, working- Invalid Transactions Parameters that invalidate the transactions- Scripting language in Bitcoin- Applications of Bitcoin script- Nodes and network of Bitcoin- Bitcoin ecosystem

Unit-IV

ETHEREUM: The Ethereum ecosystem, DApps and DAOs - Ethereum working- Solidity- Contract classes, functions, and conditionals- Inheritance & abstract contracts- Libraries- Types & optimization of Ether- Global variables- Debugging- Future of Ethereum- Smart Contracts on Ethereum- different stages of a contract deployment- Viewing Information about blocks in Blockchain- Developing smart contract on private Blockchain- Deploying contract from web and console

Unit-V

HYPERLEDGER: Hyperledger Architecture- Consensus- Consensus & its interaction with architectural layers
Application programming interface- Application model -Hyperledger frameworks- Hyperledger Fabric -Various ways to create Hyperledger Fabric Block chain network- Creating and Deploying a business network on Hyperledger Composer Playground- Testing the business network definition- Transferring the commodity between the participants

TEXT BOOKS

1. Mastering Bitcoin: Unlocking Digital Cryptocurrencies, by Andreas M Antonopoulos 2018
2. Henning Diedrich, Ethereum: Block chains, Digital Assets, Smart Contracts, Decentralized Autonomous Organizations-2016

ONLINE REFERENCES

1. <https://www.coursera.org/learn/ibm-blockchain-essentials-for-developers>
2. <https://museblockchain.com/>
3. <https://www.provenance.org/>
4. <https://www.coursera.org/learn/blockchain-basics>
5. <https://steemit.com/>
6. <https://101blockchains.com><https://followmyvote.com/>

VI SEMESTER	L	T	P	C
	-	-	3	1.5
20RB6L01 :: ROBOT PROGRAMMING LAB				

COURSE OBJECTIVES:

- The main objective of this lab is to perform kinematics analysis of robot by using MATLAB programming
- Perform industrial applications of robot by using simulation software.

COURSE OUTCOMES:

At the end of the course the students are able to:

CO1. Solve problems of kinematics by writing programs in MATLAB.[K4]

CO2. Perform industrial applications of robot by using different simulation softwares.[K4]

LIST OF EXPERIMENTS:

1. Forward kinematics of robots.
2. Inverse kinematics of robots.
3. Inverse dynamics of robots.
4. Forward dynamics of robots.
5. Pick And Place operation by industrial robot.
6. Material handling operation by industrial robot.
7. Edge Deburring Process By Industrial Robot.
8. Surface Deburring Process By Industrial Robot.
9. Color Based Pick And Place Operation Using Vision System.
10. Palletizing operation by industrial robot.

Software Packages to be provided for above experiments

MATLAB, SIMULINK , MotoSim EG-VRC, Robot Studio, Fanuc roboguide, CIROS simulation softwares.

VI SEMESTER	L	T	P	C
	-	-	3	1.5
20RB6L02 :: ARTIFICIAL INTELLIGENCE BASED PROGRAMMING LAB				

COURSE OBJECTIVE

- To impart necessary skills to write Artificial Intelligence based programs using Python /Java /C++/ Prolog /Lisp

COURSE OUTCOMES

Students are able to

- CO1. Design and develop basic AI example problems such as water jug, tic-tac-toe e [K4]
- CO2. Implement Simulation for Annealing Algorithm. [K4]
- CO3. Program towers of Hanoi and A* Algorithm. [K4]
- CO4. Design and develop Expert systems. [K4]
- CO5. Implement MDP Concepts and Reinforcement Learning examples. [K4]

LIST OF EXPERIMENTS

1. Implementation of DFS for water jug problem.
2. Implementation of BFS for tic-tac-toe problem.
3. Implementation of TSP using heuristic approach.
4. Implementation of Simulated Annealing Algorithm.
7. Implementation of Hill-climbing to solve 8- Puzzle Problem.
8. Implementation of Towers of Hanoi Problem.
9. Implementation of A* Algorithm.
10. Implementation of Hill Climbing Algorithm.
11. Implementation Expert System with forward chaining.
12. Implementation Expert System with backward chaining.
13. Implement Reinforcement Learning examples.
14. Implement MDP concepts.

VI SEMESTER	L	T	P	C
	-	-	3	1.5
20RB6L03 :: PLC LAB				

COURSE OBJECTIVES

To impart knowledge on

1. Developing automation systems using PLC
2. The drive systems used in Industrial applications
3. Simulation Software for Industrial Robots

COURSE OUTCOMES

Students are able to:

- | | |
|--|------|
| CO1. Develop Ladder diagrams for PLC Programming | [K4] |
| CO2. Work with basic logic operations in PLC | [K4] |
| CO3. Work with simple Automation Systems using PLC | [K4] |
| CO4. Interface of motors with PLC | [K4] |

LIST OF EXPERIMENTS

1. Develop Ladder diagrams for PLC Programming
2. Different applications of Push buttons.
3. Basic logic operations, AND, OR, NOT functions
4. Working of different types of Timers.
5. Working of different types of Counters.
6. Latching and Unlatching
7. Speed Control of DC Motor Using PLC
8. Bottle Filling System Using PLC
9. Traffic light control using PLC
10. Pressure control using PLC
11. Automatic indication of water tank level.
12. Traffic lights indication.
13. Interlocking
14. Forward and Reverse direction control of Motors.

VI SEMESTER	L	T	P	C
	-	-	4	1.5

20HS6S01 :: ADVANCED COMMUNICATION SKILLS LAB

At the end of the course students will be able to prepare themselves for their career which may require them to listen and speak in English both for their professional and interpersonal communication in the globalized context.

Course objectives

- Analyzing a topic of discussion and relating to it.
- Planning and executing an assignment creatively.
- Presenting ideas coherently within a stipulated time.
- Communicating ideas effectively in prescribed oral activities.
- Applying relevant writing formats for resume and presentations.
- Facing interviews with confidence.

Course outcomes

At the end of the course students will be able to

- Gather ideas and organize information relevantly and coherently
- Participate in group discussions and face interviews with confidence
- Write Resume with covering letter
- Make oral presentations and public speaking
- Take part in social and professional communication.

SYLLABUS

The following course content is prescribed for the **Advanced English Communication Skills Lab:**

UNIT I

Communication Skills

- Introduce Yourself
 - JAM
 - J2M
- Identifying one's career objective, projecting strengths and skills, organization of ideas within given time.

UNIT II

Interaction Skills

- Body Language
- Role- Plays

- Students start a conversation - Respond appropriately and relevantly in different situations with right body language.

UNIT III

Oral Skills

- Presentations
- Public Speaking
- Planning preparation and presentation - organization of ideas with clarity , coherence and style.

UNIT IV

Writing Skills

- Covering Letter
- Resume Writing
- To communicate the ideas relevantly and coherently in writing.

UNIT V

Team Work Skills

- Group Discussion
- Dynamics of Group Discussion - Modulation of voice, Body language , relevance , fluency and coherence.

UNIT VI

Interview Skills

- Pre-interview planning, opening strategies, answering strategies, interview through tele and video conference.

Reference Books:

1. Ashraf Rizvi- Effective Technical Communication - McGraw Hill Education- 2017.
2. MadhaviApte - A Course in English Communication – Prentice - Hall of India- 2007.
3. Dr. ShaliniVerma - Body Language – Your Success Mantra- S. Chand- 2006.
4. Sunita Mishra &C.Murali Krishna- Communication Skills for Engineers - Pearson Education - 2007.

VI SEMESTER	L	T	P	C
	-	-	3	1.5
20BM6M01 :: PROFESSIONAL ETHICS AND INTELLECTUAL PROPERTY RIGHTS				

COURSE OUTCOMES:

Students are able to

CO1. Identify the professional roles played by an engineer and illustrate the process of Social experimentation

CO2. Determine Engineer's responsibilities and rights towards the society

CO3. Analyze various aspects of Intellectual Property Rights and recognize the process of protecting the copyrights

CO4. Describe the registration process of Patents and trademarks and also demonstrate the concept of trade secrets and cybercrimes

UNIT-I

ENGINEERING ETHICS:

Importance of Engineering Ethics—Professional and Professionalism –Professional Roles to be played by an Engineer –Professional Ethics.

UNIT-II

ENGINEERING AS SOCIAL EXPERIMENTATION :

Role of engineering in knowledge society- Knowledge acquired – Conscientiousness – Relevant Information Engineers as Managers, Consultants, and Leaders.

ENGINEERS' RESPONSIBILITY FOR SAFETY AND RISK: Role and importance of Safety and risk Types of Risks –Threshold Levels for Risk– Risk Benefit Analysis.

UNIT-III

ENGINEERS' RESPONSIBILITIES AND RIGHTS:

Collegiality-Conflict of Interest-solving conflict problems – Ethical egoism-Collective bargaining - Confidentiality-Acceptance of Bribes/Gifts--Occupational Crimes-industrial espionage-Whistle Blowing types of whistle blowing.

UNIT IV

INTELLECTUAL PROPERTY AND COPY RIGHTS:

Introduction to Intellectual Property Law - Types of Intellectual Property – Infringement, Copyrights: Introduction to Copyrights – Principles of Copyright – Rights Afforded by Copyright Law –Copyright Formalities and Registration.

UNIT-V

PATENTS AND TRADEMARKS:

Introduction to Patent Law –Rights under Patent Law – Patent Requirements – Patent Application Process and Granting of Patent – Double Patenting – Patent Cooperation Treaty. Trademarks:Introduction to Trade Mark – Trade Mark Registration Process – Trade Markmaintenance – Likelihood of confusion

TEXT BOOKS:

1. M.Govindarajan, S.Natarajan and V.S.SenthilKumar- “Engineering Ethics and Human Values” by PHI Learning Pvt. Ltd-2009.
2. Deborah E.Bouchoux, “Intellectual Property”. Cengagelearning , NewDelhi, BS Publications (Press)
3. PrabhuddhaGanguli,, Intellectual Property Rights” Tata Mc-Graw – Hill, New Delhi

VII SEMESTER (PROFESSIONAL ELECTIVE III)	L	T	P	C
	3	-	-	3
20RB7E01 :: ROBOT OPERATING SYSTEMS				

COURSE OBJECTIVES:

- To know the basics of Robot Operating Systems (ROS) and its architecture.
- To understand the knowledge on the hardware interfacing aspects
- To apply the applications of ROS in real world complex applications

COURSE OUTCOMES: Students are able to

- CO1.** Describe the need for ROS and its significance. [K2]
- CO2.** Summarize the Linux commands used in robotics. [K2]
- CO3.** Discuss about the concepts behind navigation through file system. [K2]
- CO4.** Explain the concepts of Node debugging. [K2]
- CO5.** Discuss the issues in hardware interfacing. [K2]

UNIT I INTRODUCTION TO ROS

Introduction –ROS equation, history, distributions, difference from other meta operating systems, ROS framework, operating systems.

UNIT II INTRODUCTION TO LINUX COMMANDS

UNIX commands - file system, redirection of input and output, file system security, changing access rights, process commands, and compiling, building and running commands, handling variables.

UNIT III ARCHITECTURE OF OPERATING SYSTEM

File system – Packages, stacks, messages, services, catkin workspace, working with catkin work space, working with ROS navigation and listing commands.

UNIT IV COMPUTATION GRAPH LEVEL

Navigation through file system, understanding of nodes, topics, services, messages, bags, master parameter server.

UNIT V DEBUGGING, VISUALIZATION & HARDWARE INTERFACE

Debugging of nodes, topics, services, messages, bags, parameter, visualization using Gazebo, Rviz , URDF modelling, Xacro , launch files.

Hardware Interface: Sensor Interfacing, Sensor drivers for ROS, Actuator interfacing, motor drivers for ROS.

TEXT BOOKS

1. Lentin Joseph, “Robot Operating Systems (ROS) for Absolute Beginners, 1st edition, Apress, 2018.
2. Aaron Martinez, Enrique Fernandez, “Learning ROS for Robotics Programming”, 2nd edition, Packt Publishing Ltd, 2013.

REFERENCE BOOKS

1. Anis Koubaa, “Robot Operating System (ROS) – The Complete Reference (Vol.3), Springer, 2018.
2. Kumar Bipin, “Robot Operating System Cookbook”, Packt Publishing, 2018.
3. Wyatt Newman, “A Systematic Approach to learning Robot Programming with ROS”, CRC Press, 2017

WEB REFERENCES

1. <https://www.geeksforgeeks.org/introduction-to-ros-robot-operating-system/>
2. <https://www.toptal.com/robotics/introduction-to-robot-operating-system>
3. <https://roboticsbiz.com/robot-operating-system-ros-explained/>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3				1							2	2	
CO2	3		2		1							2	2	
CO3	3		2		1							2	2	
CO4	3		2		1							2	2	
CO5	3		2		1							2	2	
Avg	3		1.6		1							2	2	

VII SEMESTER (PROFESSIONAL ELECTIVE III)	L	T	P	C
	3	-	-	3
20RB7E02 :: CLOUD ROBOTICS				

COURSE OBJECTIVES:

- Provide an overview of tele robotics
- Understand the concept of networked tele robotic systems
- Provide knowledge on the functions of online robots

COURSE OUTCOMES: Students are able to

- CO1.** Discuss about the basic principles of tele robotics.[K2]
- CO2.** Describe the concepts of wired and wireless communication for networked tele robotic systems. [K2]
- CO3.** Explain the fundamentals of robot manipulation and tele operation. [K2]
- CO4.** Interpret the software architecture and interface for networked robot systems on the web. [K2]
- CO5.** Discuss the performance of mobile robots controlled through the web.[K2]

UNIT 1: INTRODUCTION

Tele Robotics-Overview and background, Brief history, Development of tele robots, Limitations and Characteristics of programmable robots, Latest development and current trends of cloud robotics computing

UNIT 2: COMMUNICATIONS AND NETWORKING

Internet, wired communication links, wireless links, properties of networked tele robotic, building a networked tele robotic system, state command presentation, command execution, state generation and collaborative control

UNIT 3: FUNDAMENTALS OF ONLINE ROBOTS

Introduction – Robot Manipulators, tele operation, tele operation on a local network, tele operation via a constrained link, Robotics and human automation by cloud computing

UNIT 4: ONLINE ROBOTS

Introduction to net worked robot system on the web – Software architecture and design, interface design, System components, Architectures of the internet of things

UNIT 5: REMOTE MOBILITY

Autonomous mobile robot on the web – Mobile mini robots, performance of mobile robots controlled through web, handling latency in internet based tele operation

TEXT BOOKS:

1. Bruno Siciliano, Oussama Khatib, “Springer Handbook of Robotics”, 1st Edition, Springer Science and Business, 2016.
2. Ken Goldberg, Roland Siegwart, “Beyond Webcams – An Introduction to Online Robots”, 1st Edition, MIT Press,2010

REFERENCE BOOKS:

1. Joao Pedro, Carvalho Rosa, “Cloud Robotics – Distributed Robotics using Cloud Computing”, 1st Edition, Coimbra, 2016.
2. AnisKoubaa, ElhadiShakshuki, “Robots and Sensor Clouds”, 1st Edition, Springer, 2015.

WEB REFERENCES:

1. http://tiutic.org/pdf/vol-I/Vol1_Article%204.pdf
2. <https://cupdf.com/document/cloud-robotics.html?page=4>
3. <https://www.mdpi.com/2218-6581/7/3/47/htm>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1	1	1				1		1	2	
CO2	3	3	2	1	1	1				1		1	2	
CO3	3	3	2	1	1	1				1		1	2	
CO4	3	3	2	1	1	1				1		1	2	
CO5	3	3	2	1	1	1				1		1	2	
Avg	3	3	2	1	1	1				1		1	2	

VII SEMESTER (PROFESSIONAL ELECTIVE III)	L	T	P	C
	3	-	-	3
20RB7E03 :: NEURAL NETWORKS AND FUZZY SYSTEMS				

COURSE OBJECTIVES:

- To acquire knowledge about on neural networks and its applications.
- To enumerate the convolutional neural networks.
- To learn classical logic and fuzzy logic concepts.
- To learn features of membership function.

COURSE OUTCOMES: Student are able to

- CO1. Explain the types of neural networks. [K2]
- CO2. Explain the applications of neural networks. [K2]
- CO3. Explain the concepts of deep learning and convolutional neural networks and applications of fuzzy logic controllers. [K2]
- CO4. Explain the fundamentals of classical logic and fuzzy logic concepts. [K2]
- CO5. Explain the Characterize the fuzzy membership functions. [K2]

UNIT I

INTRODUCTION TO NEURAL NETWORKS : Differences between biological and artificial neural networks ,typical architecture, common activation functions, McCulloch - pitts neuron, simple neural nets for pattern classification, linear separability -Hebb net, perceptron, adaline, madaline - architecture, algorithm, and simple applications.

UNIT II

NEURAL NETWORK APPLICATIONS: Training algorithms for pattern association - Hebb rule and delta rule, hetero associative, auto associative and iterative auto associative net, bidirectional associative memory, Introduction to neural network controllers.

UNIT III

DEEP LEARNING AND CONVOLUTION NEURAL NETWORKS: Evolution of deep learning, impact of deep learning, motivation for deep architecture, applications, deep learning in computer vision, convolutional neural networks, popular CNN architecture, applications.

CASE STUDIES: Inverted pendulum, CMAC, robotics, image compression, and control systems, fuzzy logic-mobile robot navigation, auto tuning PID Controller.

UNIT IV

CLASSICAL AND FUZZY SETS AND RELATIONS: Properties and operations on classical and fuzzy sets, crisp and fuzzy relations - cardinality, properties and operations, composition, tolerance and equivalence relations, simple problems.

UNIT V

MEMBERSHIP FUNCTIONS: Features of membership function, standard forms and boundaries, fuzzification, membership value assignments, fuzzy to crisp conversions, defuzzification methods.

TEXT BOOKS:

1. Rajasekaran, VijayalakshmiPai, “Neural Networks, Fuzzy Systems and Evolutionary Algorithms”, 1st edition, PHI Learning, 2017.
2. Timothy J. Ross, „Fuzzy Logic with Engineering Applications“, 3rd edition ,Tata McGraw Hill, 2011.

REFERENCE BOOKS:

1. George.J.Klir, „Fuzzy Sets and Fuzzy Logic – Theory and Applications“, 2nd edition, Pearson, 2015.
2. Jacek M. Zurada, „Introduction to Artificial Neural Systems“, 2nd edition, Jaico Publishing home, 2016.
3. Shigeo Abe, “Neural Networks and Fuzzy Systems”, 1st edition, Springer,2012.

WEB REFERENCES

1. <https://archive.nptel.ac.in/courses/127/105/127105006/>
2. https://www.academia.edu/703095/Artificial_Neural_Networks_Web_course

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3				1	1	1			1		1	1	
CO2	3				1	1	1			1		1	1	
CO3	3				1	1				1		1	1	
CO4	3				1	1	1			1		1	1	
CO5	3				1	1	1			1		1	1	
Avg	3				1	1	0.8			1		1	1	

VII SEMESTER (PROFESSIONAL ELECTIVE III)	L	T	P	C
	3	-	-	3
20ME7E01 :: MECHANICAL VIBRATIONS				

COURSE OBJECTIVES:

- To understand various levels of vibrations and remedies for each of them.
- To understand the fundamental knowledge on vibrating systems.
- To understand how to model the physical vibrating systems mathematically and the basic behavior of vibration measuring instruments and their industrial applications.

COURSE OUTCOMES: Students are able to

CO1: Summarize the basic concepts of vibrations and analyze simple free damped and undamped vibrations. [K4]

CO2: Analyze the response of damped and undamped systems subjected to harmonic excitation. [K4]

CO3: Analyze the response of systems subjected to forced vibrations with different kinds of loads. [K4]

CO4: Evaluate the vibration response of multi degrees of freedom systems. [K3]

CO5: Evaluate the vibration response of continuous systems. [K3]

UNIT – I

FUNDAMENTALS OF VIBRATIONS AND FREE VIBRATIONS

Basic concepts of vibration, Classification of vibrations, Vibration analysis procedure, spring elements, Mass or inertia elements, damping elements, Harmonic analysis. Free vibration of an undamped translational system, free vibration of an undamped torsional system, Stability conditions, Raleigh's energy method, free vibration with viscous damping, coulomb damping, hysteretic damping.

UNIT – II

HARMONICALLY EXCITED VIBRATIONS

Introduction, Equation of motion, Response of an undamped system under harmonic force, Response of a damped system under harmonic force, Response of a damped system under harmonic motion of the base, Response of a damped system under rotating unbalance, Forced vibration with coulomb damping, hysteresis damping.

UNIT – III

FORCED VIBRATION AND TWO DEGREES OF FREEDOM

Vibration Under General Forcing Conditions: Introduction, Response under a general periodic force, Response under a periodic force of irregular form, Response under a non-periodic force, Convolution integral, Vibration Measurement- Vibrometers, velocity meters – accelerometers, Two Degree of Freedom Systems- Introduction, equation of motion for forced vibration, Free vibration analysis of an undamped system, Torsional system, Coordinate coupling and principal coordinates, Forced vibration analysis.

UNIT – IV

MULTI-DEGREE OF FREEDOM SYSTEMS AND NUMERICAL METHODS

Introduction, Modeling of Continuous systems as multi degree of freedom systems, Using Newton's second law to derive equations of motion, Influence coefficients, Free and Forced vibration of undamped systems, Forced vibration of viscously damped systems. Introduction to experimental model analysis. Determination of Natural Frequencies and Mode Shapes: Introduction, Dunkerley's formula, Rayleigh's method, Holzer's method, Matrix iteration method, Jacobi's method.

UNIT – V CONTINUOUS SYSTEMS

Exact and approximate solutions, Transverse vibration of a spring or a cable, Longitudinal vibration of bar or rod, Torsional vibration of a bar or rod, Lateral vibration of beams, critical speed of rotors. Case studies on formulation and response calculation.

TEXT BOOKS:

1. Singiresu S Rao , “Mechanical Vibrations ”, 4th Edition, Pearson education , 2011.
2. Schmitz T.L, “Mechanical Vibrations Modeling And Measurement”, 2nd Edition, Springer, 2021

REFERENCES:

1. G.K. Grover, “Mechanical Vibrations ”, 7th Edition, Nem Chand & Bros , 2014.
2. W.T. Thomson, “Theory of Vibrations ”, 5th Edition, Addison-Wesley Publishing, 2003.

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1. <https://www.purdue.edu/freeform/me563/animations/>
2. <https://personal.math.ubc.ca/~israel/m215/vibrate/vibrate.html>
3. <https://archive.nptel.ac.in/courses/112/107/112107212/>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3							3	3	
CO2	3	3	2	3	3							3	3	
CO3	3	3	3	3	3							3	3	
CO4	3	3	3	2	2							3	2	
CO5	3	3	2	3	3							3	2	
Avg	3	3	2.6	2.8	2.8							3	2.6	

VII SEMESTER (PROFESSIONAL ELECTIVE III)	L	T	P	C
	3	-	-	3

20ME7E02 :: TOTAL QUALITY MANAGEMENT

COURSE OBJECTIVES:

1. To understand the concept of Quality
2. To understand the principles of quality, customer focus and satisfaction.
3. To understand statistical process control.
4. To implement TQM tools and techniques.
5. To implement quality systems.

COURSE OUTCOMES: Students are able to

CO1: Explain the concept of Total Quality Management and discriminate product and service quality (K2)

CO2: Analyze various principles of Total Quality Management that are practically applicable. (K4)

CO3: Illustrate different Statistical Quality Control methods. (K4)

CO4: Distinguish various tools and techniques of Total Quality Management and Recognize the importance of six sigma in Quality Management (K4)

CO5: Evaluate the various ISO standards that are used for testing the quality of a product in the present scenario (K4)

UNIT I INTRODUCTION

Introduction - Need for quality, Evolution of quality, Definitions of quality, Dimensions of product and service quality, Basic concepts of TQM, TQM Framework, Contributions of Deming, Barriers to TQM.

UNIT II TQM PRINCIPLES

Leadership, Strategic quality planning, Quality Councils, Employee involvement, Motivation, Empowerment, Team and Teamwork, Quality Circles, Recognition and Reward, Performance appraisal, Continuous process improvement, PDCA cycle, 5S, Kaizen

Customer focus and satisfaction

The importance of customer satisfaction and loyalty- Crating satisfied customers, Understanding the customer needs, Process Vs. Customer, internal customer conflict, quality focus, Customer Satisfaction

UNIT III STATASTICAL PROCESS CONTROL

Significance of statistical process control (SPC), Construction of control charts for variables and attributed, Process capability – significance and measurement, concepts of process capability. Business process Improvement (BPI)– principles, applications, reengineering process, benefits and limitations

UNIT IV TQM TOOLS AND TECHNIQUES

The seven traditional tools of quality, New management tools, Six sigma- concepts, methodology, applications to manufacturing, service sector including IT, Bench marking- reason to benchmark, benchmarking process, FMEA - stages, types. Control Charts, Process Capability, Quality Function Development (QFD), Taguchi quality loss function, Total Productive Maintenance (TPM)– Concepts, Terotechnology, Improvement Needs, Performance Measures.

UNIT V QUALITY SYSTEMS

Need for ISO 9000, ISO 9001-2008 Quality System, Elements, Documentation, Quality Auditing, QS 9000, ISO 14000, Concepts, Requirements and Benefits, TQM Implementation in manufacturing and service sectors. Quality awards

TEXTBOOKS:

1. Besterfield Dale H., Besterfield Carol, Besterfield Glen H., Besterfield Mary, Urdhwareshe Hemant, Urdhwareshe Rashmi, Total Quality Management (TQM), 5th Edition, Pearson Publication, 2018.
2. Dr. Gunmala Suri and Dr. Puja Chhabra Sharma, Total Quality Management, 1st Edition, Wiley India- 2013.

REFERENCE BOOKS:

1. Poornima M. Charantimath, Total Quality Management, 3rd Edition, Pearson Education, 2017.
2. Subburaj Ramasamy, Total Quality Management, 1st Edition, McGraw Hill, 2009.

WEB REFERENCE:

1. <https://archive.nptel.ac.in/courses/110/104/110104080/>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2			2							2		3	
CO2	2			2		2		2	3		2		3	
CO3	2			2									3	
CO4	2			2	2						2		3	
CO5	2			2			2						3	
Avg	2			2	0.4	0.4	0.4	0.4	0.6		1.2		3	

VII SEMESTER (PROFESSIONAL ELECTIVE IV)	L	T	P	C
	3	-	-	3
20RB7E04 :: MEDICAL ROBOTICS				

COURSE OBJECTIVES:

- Identify and describe different types of medical robots and their potential applications.
- Know basic concepts in kinematics, Dynamics, and control relevant to Medical Robotics.
- Develop the Analytical and Experimental skills necessary to Design and Implement robotic assistance for both minimally invasive surgery and Image-guided interventions.
- Be familiar with the state of the art in applied medical robotics and medical robotics research.

COURSE OUTCOMES:

Students are able to

CO1: Interpret MIS procedure and to aware of the state-of art in surgical and oncology robotics.[K2]

CO2: Describe about the fundamentals of tracking systems and components used in medical robots.[K2]

CO3: Explain the challenges in the design of a medical robotic system for surgical application.[K2]

CO4: Describe the various applications of assistive robots in medical rehabilitation.[K2]

CO5: Interpret the design, development, and evaluation of a medical robotic system.[K2]

UNIT I: INTRODUCTION

Types of medical robots, navigation, motion replication, imaging, rehabilitation and prosthetics, state of art of robotics in the field of healthcare.

UNIT II: LOCALIZATION AND TRACKING

Position sensors requirements, tracking, mechanical linkages, optical, sound-based, electromagnetic impedance based in bore MRI tracking, video matching, fiber optic tracking systems, hybrid systems.

UNIT III: SURGICAL ROBOTICS

Minimally invasive surgery and robotic integration, surgical robotic sub systems, synergistic control, control modes, radio surgery, orthopaedic surgery, urologic surgery and robotic imaging, cardiac surgery, neurosurgery, case studies.

UNIT IV: REHABILITATION

Rehabilitation for limbs, brain-machine interfaces, steerable needles, case studies, robots in medical care assistive robots, types of assistive robots, case studies.

UNIT V: DESIGN OF MEDICAL ROBOTS

Characterization of gestures to the design of robots, design methodologies, technological choices, security.

TEXT BOOKS:

1. Paula Gomes, Medical robotics Minimally invasive surgery, 1st edition, Woodhead publishing,2012.
2. Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, Robot Modelling and Control,1st edition, Wiley Publishers,2005.

REFERENCE BOOKS:

1. Achim Schweikard, Floris Ernst, Medical Robotics, , 1st edition, Springer, 2016.
2. Jocelyne Troccaz, Medical Robotics, 1st edition, Wiley-ISTE, 2013.
3. Vanja Bonzovic, Medical Robotics, Intechopen Education publishing, Austria, 2008.

WEB REFERENCES:

1. <https://interestingengineering.com/15-medical-robots-that-are-changing-the-world>
2. https://www.researchgate.net/publication/215716407_Medical_Robotics

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2			1	1	1					1	1	
CO2	2	3			1	1	1					1	1	
CO3	1	2	3	2	1	1						1	2	
CO4	3				1	1	1					1	1	
CO5	2	3	3	2	1	1	1					1	1	
Avg	2.2	2	1.2	0.8	1	1	0.8					1	1.2	

VII SEMESTER (PROFESSIONAL ELECTIVE IV)	L	T	P	C
	3	-	-	3
20RB7E05 :: MICRO ROBOTICS				

COURSE OBJECTIVES:

- To learn the micro machining and the principles of micro systems.
- To learn the various flexures, actuators and sensor systems.
- To enumerate the implementation of micro robots.
- To learn the micro fabrication and micro assembly.
- To acquire knowledge about on implementation of micro robots.

COURSE OUTCOMES: Student are able to

CO1. Explain the principles of micro systems and micro machining. [K2]

CO2. Analyze the effects of scaling laws on physical and electrical properties and the materials to be used to MEMS. [K2]

CO3. Explain the characteristics of various flexures, actuators and sensor systems and principle of micro fabrication and micro assembly. [K2]

CO4. Explain the specification of micro robots and its applications. [K2]

CO5. Explain the various methods of implementation of micro robots. [K2]

UNIT I

INTRODUCTION: MST (Micro System Technology), Micro machining, Working principles of micro systems, Applications of micro systems.

UNIT II

SCALING LAWS AND MATERIALS FOR MEMS: Introduction, scaling laws, scaling effect on - physical properties, electrical properties, physical forces, Physics of adhesion Silicon-compatible material system- shape memory alloys, material properties-piezo resistivity, piezoelectricity and thermoelectricity.

UNIT III

FLEXURES, ACTUATORS AND SENSORS: Elemental flexures-flexure systems, mathematical formalism for flexures. Electrostatic actuators, piezo-electric actuators, magneto-strictive actuators, Electromagnetic sensors, optical-based displacement sensors, motion tracking with microscopes.

Micro fabrication and micro assembly: Micro-fabrication principles, design selection criteria for micro machining, packaging and integration aspects, micro-assembly platforms and manipulators.

UNIT IV

MICRO ROBOTICS: Introduction, Task specific definition of micro-robots - Size and Fabrication Technology based definition of micro robots - Mobility and Functional-based definition of micro-robots - Applications for MEMS based micro-robots.

UNIT V

IMPLEMENTATION OF MICRO ROBOTS: Arrayed actuator principles for micro-robotic applications, micro-robotic actuators - design of locomotive micro-robot devices based on arrayed actuators.

Micro-robotics devices: micro-grippers and other micro-tools - micro conveyors - Walking MEMS Micro-robots, Multi-robot system, Micro-robot powering, Micro-robot communication.

TEXT BOOKS:

1. Mohamed Gad-el-Hak, “The MEMS Handbook”, 2nd edition, CRC Press, New York, 2019
2. Yves Bellouard, “Micro robotics Methods and Applications”, 1st edition, CRC Press, Massachusetts, 2013.

REFERENCE BOOKS:

1. Nicolas Chaillet, Stephane Regnier, “Micro robotics for Micro manipulation”, 2nd edition, Wiley, 2013.
2. VikasChoudhry, Krzystof, “MEMS: Fundamental Technology and Applications”, 1st edition, CRC Press, 2013.
3. Nadim Maluf and Kirt Williams, „An Introduction to Micro electro mechanical systems Engineering”, 2nd edition, Artech House, MA, 2010.

WEB REFERENCES:

1. <https://nptel.ac.in/courses/112101099>
2. <https://nptel.ac.in/courses/112107289>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1				1		2	2		2				1	
CO2	2	2	1	1	2	1	1		1				1	
CO3	3	3	3	2	2	2	2						1	
CO4			1	2	2	2	-		1				1	
CO5		2	2	2	2	2	1		2				1	
Avg	1	1.4	1.4	1.6	1.6	1.8	1.2		1.2				1	

VII SEMESTER (PROFESSIONAL ELECTIVE IV)	L	T	P	C
	3	-	-	3

20RB7E06 :: AUTOMOTIVE EMBEDDED SYSTEMS

COURSE OBJECTIVES:

1. To introduce the basic components of modern automotive systems.
2. Understand the application of microcontrollers in ECU design and the In-Vehicle communication protocols.
3. To provide an overview of the Automotive Open Systems Architecture (AUTOSAR)

COURSE OUTCOMES:

The Student are able to:

- CO1.** Describe the function of basic components used in modern automotive systems. [K2]
CO2. Discuss about the applications of microcontrollers in ECU design. [K2]
CO3 . Summarize the various In-Vehicle Communication Protocols and their features. [K2]
CO4. Outline the diagnostic protocols and their functions. [K2]
CO5. Illustrate the practical applications of Automotive Open Systems Architecture (AUTOSAR). [K2]

UNIT I AUTOMOTIVE EMBEDDED SYSTEMS

Introduction to Modern Automotive Systems, Evolution of Electronics and Software in automobiles, ECUs and their application areas in Automotive, Engine Management Systems, Body & Comfort Electronics Systems, Infotainment Systems, Advanced Driver Assistance Systems and V2X Systems, Autonomous Driving Systems, Current Trends and Challenges.

UNIT II MICRO CONTROLLERS IN ECU DESIGN

Overview of AURIX Micro Controller, Architecture, Memory Map, Lock Step etc., Peripherals used in Automotive Applications, GTM, QSPI, DSADC etc., AURIX Safe T-Lib, Real time Operating Systems and Scheduling Concepts, Practical Experiments using AURIX Eval Kit.

UNIT III IN-VEHICLE COMMUNICATION PROTOCOLS

Overview of In Vehicle Communication Protocols, CAN, LIN, Flex Ray, MOST, Ethernet, Controller Area Network (CAN), CANalyzer Fundamentals, CAPL Scripting, Panel Simulation.

UNIT IV IN-VEHICLE DIAGNOSTICS

Overview of Diagnostic Protocols, KWP 2000 ,Diagnostics on CAN, Structure of diagnostic services, addressing schemes, Data Segmentation, Message flows, UDS- Introduction, adaptation for CAN, bus systems, Structure of UDS.

UNIT V AUTOSAR (AUTOMOTIVE OPEN SYSTEMS ARCHITECTURE)

Platform Based Development, AUTOSAR Overview, AUTOSAR RTE, BSW, SWC, AUTOSAR Methodology & Workflow, AUTOSAR Tools Overview, Practical Experiments using AUTOSAR Tools. Automotive quality, safety and security standards: Common Failures in Automotive Systems, ASPICE Development Process, MISRA C Standard, ISO 26262 Functional Safety Standard, SAE J3061 Security Standard.

TEXT BOOKS:

1. Ronald K Jurgen: “Distributed Automotive Embedded Systems” SAE International, 2007.

2. Williams. B. Ribbens, “Understanding Automotive Electronics”, 7th Edition, Elsevier Inc, 2012.

REFERENCE BOOKS:

1. Robert Bosch: “Automotive Handbook”, 6th Edition, John Wiley and Sons, , 2004.
2. Ronald K Jurgen: “Automotive Electronics Handbook”, 2nd Edition , McGraw-Hill, , 1999.
3. Nicolas Nivet, Francoise Simonot, “Automotive Embedded Systems Handbook”, CRC Press, 2017.
4. Kevin Roebuck, ”AUTOSAR – Automotive Open System Architecture – High Impact Strategies”, Tebbo publishers, 2011.
5. Dominique Paret, “Multiplexed Networks for Embedded Systems”, SAE International, 2007.

WEB REFERENCES:

1. https://onlinecourses.nptel.ac.in/noc20_cs14/preview
2. <https://youtu.be/39LWFdY5SXY>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3					1	1					2		2
CO2	3					1	1					2		2
CO3	3					1	1					2		2
CO4	3					1	1					2		2
CO5	3					1	1					2		2
Avg	3					1	1					2		2

VII SEMESTER (PROFESSIONAL ELECTIVE IV)	L	T	P	C
	3	-	-	3

20RB7E07 :: SUPPLY CHAIN MANAGEMENT

COURSE OBJECTIVES:

1. To understand the fundamentals of concept of supply chain management.
2. To find the sourcing and transportation in supply chain management.
3. To make optimization models for supply chain management.
4. To acquire the current trends in supply chain management.
5. To discern the Supplier and customer relationship management.

COURSE OUTCOMES: Students are able to

- CO1. Explain fundamental supply chain management concepts. [K2]
 CO2. Apply sourcing and transportation model in chain supply management [K3]
 CO3. Develop optimization models for supply chain management [K3]
 CO4. Explain the current supply chain recent trends. [K2]
 CO5. Determine information system developments. [K3]

UNIT I

INTRODUCTION TO SCM: Supply Chain –Fundamentals, importance, decision phases, Process View of a Supply Chain: Push/Pull and Cycle Views, Supply Chain performance, Strategic Fit and Scope, Supply Chain Drivers and Metrics.

UNIT II

SOURCING: In-Sourcing and Out-Sourcing, Types of purchasing strategies, Supplier Evaluation Selection, Third Party Logistics, Supplier Quality Management, Creating a world-class supply base and World Wide Sourcing.

TRANSPORTATION: Modes of Transportation in a Supply Chain Management, Design option for Transportation Network, Role of IT in Transportation.

UNIT III

NETWORK DESIGN IN SUPPLY CHAINS: Factors Influencing the Network Design Decision, Framework for Network Design Decisions, Models for Facility Location and Capacity Location – Gravity Location Models, Supply Chain Network Optimization Models.

UNIT IV

RECENT TRENDS: E-Business, Framework and role of Supply Chain in e-business and b2b practices, Internal Supply Chain Management, Fundamentals of transaction management and Supply Chain in IT Practice. Block chain Technology-Introduction, Decentralization, Centralization, Decentralization-Distributed consensus, Consensus with- out identity using a block chain.

UNIT V

INFORMATION SYSTEM DEVELOPMENTS: Role of IT in a Supply Chain, Supply Chain IT framework, Supplier relationship management, Customer Relationship Management, Future of IT in Supply Chain Management, Introduction to block chain technology, Decentralization-Centralization, Decentralization-Distributed consensus, Consensus with- out identity using a block chain

TEXTBOOKS:

1. Monczka et al., Purchasing and Supply Chain Management, 4th Edition, South-Western Cengage Learning, 2022.
2. Sunil Chopra and Peter Meindl, Supply Chain Management –Strategy Planning and Operation, 6th Edition Indian Reprint, Pearson Education, 2016.

REFERENCE BOOKS:

1. Altekar Rahul V, Supply Chain Management –Concept and cases, 8th Edition, Prentice Hall India, 2016.
2. Ballou Ronald H, Business Logistics and Supply Chain Management, 5th Edition, Pearson Education, 2007.
3. Shapiro Jeremy F, Modeling the Supply Chain, 2nd Edition, Cengage Learning, 2006

WEB REFERENCES:

1. <https://archive.nptel.ac.in/courses/110/106/110106045/>
2. <https://www.edx.org/learn/supply-chain-management>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1										1	1	
CO2	3	3	2	2	2	1					2	3	2	
CO3	3	3	2	2	2	1					1	3	2	
CO4	2	1		1	1	1					3	2	3	
CO5	2	1		1	1	1					3	2	3	
Avg	2.4	1.8	0.8	1.2	1.2	0.8					1.8	2.2	2.2	

VII SEMESTER (PROFESSIONAL ELECTIVE IV)	L	T	P	C
	3	-	-	3
20ME7E09 :: INDUSTRY 4.0				

COURSE OBJECTIVES:

- To understand the basics, drivers and enablers of Industry 4.0
- To learn about the smartness in smart manufacturing factories, smart devices, smart cities and smart services.
- To learn about the different enabling technologies and its role in establishing Industry 4.0
- To study different design principles of Industry 4.0
- To understand the impact of Industry 4.0 on different sectors and challenges in implementing Industry 4.0.

COURSE OUTCOMES:

Students are able to

CO1 Explain the basics of Industry 4.0, its drivers, enablers, and difference between Industry 4.0 factories with today's factory. [K2]

CO2. Describe the idea of IoT, IIoT, smart manufacturing factories, smart devices, smart cities and smart services. [K2]

CO3. Analyze different technologies enabling Industry 4.0 with some case studies. [K3]

CO4. Distinguish different design principles and define cloud manufacturing and connected factories [K2]

CO5 Explain the impact of Industry 4.0 in different sectors including challenges in implementing Industry 4.0. [K2]

UNIT-1

INTRODUCTION TO INDUSTRY 4.0

Introduction, Various Industrial Revolutions, Digitalization and the Networked Economy, Drivers, Enablers, Comparison of Industry 4.0 Factory and Today's Factory, Trends of Industrial Big Data and Predictive Analytics for Smart Business Transformation.

UNIT-2

ROAD TO INDUSTRY 4.0

Internet of Things (IoT) & Industrial Internet of Things (IIoT) & Internet of Services, Big data, Value chains in Manufacturing companies, Smart factories, Smart Devices and Products, Smart Logistics, Smart Cities, smart services, Predictive Analytics, Case studies.

UNIT-3

TECHNOLOGIES FOR ENABLING INDUSTRY 4.0

Cyber Physical Systems, Robotic Automation and Collaborative Robots, Support System for Industry 4.0, Mobile Computing, Cyber Security, Augmented / Virtual reality, Artificial Intelligence, System integration, digital twin, 3D printing, Case studies.

UNIT-4

INDUSTRY 4.0 DESIGN PRINCIPLES

Introduction to Industry 4.0 design principles – Interoperability, Communication systems and standards for Industry 4.0 , virtualization, Decentralization, Modularity, real time capability, information transparency – Foundation of Industry 4.0 - Cloud Manufacturing and the connected factories

UNIT-5 IMPACT OF INDUSTRY 4.0

Impact of Industry 4.0 on – service and business models, IT security, manufacturing, machine safety, product life cycle, socio economic factors, textile industries, healthcare industries, real estate industries, maritime industries, tourism industries - Compelling Forces and Challenges in implementing Industry 4.0. Case studies.

TEXT BOOKS:

1. Alasdair Gilchrist, “Industry 4.0: The Industrial Internet of Things”, Apress, 2016
2. Bruno S.Sergi, Elena G.popkova, et al. “ Understanding Industry 4.0: AI, The internet of things, and the future of work”, 2019, Emerald publishing limited.

REFERENCE BOOKS:

1. Kaushik kumar, DivyaZindani, J. Paulo Davim, “ Digital manufacturing and assembly systems in Industry 4.0”, CRC Press, Taylor and Francis group, 2020.
2. Antonio sartal, Diego Carou, J.PauloDavim, “ Enabling technologies for the successful deployment of Industry 4.0, CRC press, 2020.
3. Alp Ustundag, Emrecavikcan, “ Industry 4.0 : Managing the digital transformation”, springer internation publishing , 2018.

WEB REFERENCE:

1. <https://archive.nptel.ac.in/courses/106/105/106105195/>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2				1							3	2	
CO2	2				2							3	2	
CO3	2				2							3	2	
CO4	2		2		2							3	2	
CO5	2	2			2							3	2	
Avg	2	0.4	0.4		1.8							3	2	

VII SEMESTER (PROFESSIONAL ELECTIVE V)	L	T	P	C
	3	-	-	3

20RB7E08 :: ROBOTICS AND AUTOMATION IN FOOD INDUSTRY

COURSE OBJECTIVES:

1. To introduce the need for robotics and automation in food industry
2. Provide an overview of the sensors and gripper mechanisms for food sector.
3. Understanding the various applications of automation in food industry.

COURSE OUTCOMES:

The Students are able to:

- CO1:** Explain the characteristics of robots used in food industry. [K2]
- CO2:** Identify the applications of sensors in food industry. [K2]
- CO3:** Demonstrate the different types of gripper mechanisms. [K2]
- CO4:** Illustrate the use of sensor networks and quality control in food sector. [K3]
- CO5:** Explain the advanced methods for control of food process. [K2]

UNIT-I

INTRODUCTION

Process Control Systems and Structure in the Food Industry, Process Control Methods, Robotics in the food industry, Automation, Specification for a food sector robot, future trends.

UNIT-II

SENSORS AND AUTOMATION

Sensors for automated food process control, Special Considerations, Measurement Methods, Device Integration, Applications, Machine Vision, Optical Sensors, SCADA in food industry.

UNIT-III

GRIPPER TECHNOLOGY

Gripper Challenges in food industry, Gripping Physics, Pinching and enclosing grippers, Penetrating Grippers, Suction Grippers, Surface Effect Grippers, Selection of appropriate gripping mechanism.

UNIT-IV

SENSOR NETWORKS AND INTELLIGENT QUALITY CONTROL SYSTEMS

Wireless sensor networks, applications in agriculture and food production, future trends, intelligent control systems using fuzzy logic.

UNIT-V

ADVANCED METHODS FOR CONTROL OF FOOD PROCESSES

Introduction, Case Study of Bio conversion in a batch fed reactor, Design of PID Controller for fed batch process, Real time optimization.

APPLICATIONS: Case Study, Bulk sorting, Food chilling and processing, meat processing, poultry industry, sea food processing, confectionary.

TEXT BOOKS:

1. Darwin Caldwell, “Robotics and Automation in the Food Industry-Current and Future Technologies” Wood head publishing, 2013.
2. Moore.C.A., “Automation in Food Industry”, 2nd Edition, Springer, 2012.

REFERENCE BOOKS:

1. Selwyn Piramuthu and Wie Zhou “RFID and Sensor Network Automation in the Food Industry”, 6th Edition, Wiley Blackwell, 2016.
2. Luo Zongwei, “Robotics, Automation and Control in Industrial and Service Settings”, Advances in Civil and Industrial Engineering, 2015.
3. Jonathan Love, “Process Automation Handbook: A Guide to Theory and Practice”, Springer, 2007.
4. Fellows. P. J. “Food Processing Technology: Principles and Practice”, Wood head Publishing, 2016.
5. Gauri S. Mittal, “Computerized Control Systems in the Food Industry”, 1st Edition, CRC Press, 2019.

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1. <https://www.robots.com/articles/advantages-of-robots-in-food-manufacturing>
2. <https://archive.nptel.ac.in/courses/112/101/112101099/>
3. <https://archive.nptel.ac.in/courses/126/105/126105015/>

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

VII SEMESTER (PROFESSIONAL ELECTIVE V)	L	T	P	C
	3	-	-	3

20RB7E09 :: FIELD AND SERVICE ROBOTICS

COURSE OBJECTIVES:

- To learn the applications and current trend in field and service robot
- To learn the path planning algorithms inside a field/service robot for navigation
- To familiarize the concept on planning and navigation.
- To understand the applications of field robots in mining, agriculture.
- To learn the concepts about the humanoid robots.

COURSE OUTCOMES:

Students are able to

CO1 : Describe the applications and current trend in field and service robot (K1)

CO2 : Analyze the challenges in the localization of robot. (K4)

CO3 : Identify, formulate and Implement the required mapping and path planning methods. (K3)

CO4 : Describe the role of robots in civilian, military and other applications. (K2)

CO5 : Analyze the concepts of balancing legged robots and interaction interface concepts for humanoid robot. (K2)

UNIT-I INTRODUCTION

History of service robotics, Present status and future trends, Need for service robots – applications, examples and specifications of service and field robots, Non-conventional Industrial robots.

UNIT-II LOCALIZATION

Introduction - Bayes filter, Kalman Filter, Extended Kalman Filter, Information Filter, Histogram Filter, Particle Filter, Challenges of Localization, Map Representation, Probabilistic Map based Localization, Monte Carlo localization Landmark based navigation, Globally unique localization Positioning beacon systems, Route based localization.

UNIT-III MAPPING, PLANNING AND NAVIGATION

Metrical maps, Grid maps, Sector maps, Hybrid Maps, SLAM. Planning And Navigation, Introduction - Path planning overview, Global path planning, A* Algorithm, local path planning, Road map path planning, Cell decomposition path planning, Potential field path planning, Obstacle avoidance, Path control.

UNIT – IV FIELD ROBOTS

Ariel robots-Collision avoidance-Robots for agriculture, mining, exploration, underwater, civilian and military applications, nuclear applications, Space applications.

UNIT-V HUMANOID

Wheeled and legged, Legged locomotion and balance, Arm movement, Gaze and auditory orientation control,

Facial expression, Hands and manipulation, Sound and speech generation, Motion capture/Learning from demonstration, Human activity recognition using vision, touch, sound, Vision, Tactile Sensing, Models of emotion and motivation. Performance, Interaction, Safety and robustness, Applications, Case studies.

TEXT BOOKS:

1. Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza, “Introduction to Autonomous Mobile Robots”, Bradford Company Scituate, USA, 2011.
2. Riadh Siaer, “The future of Humanoid Robots- Research and applications”,Intech Publications, 2012.

REFERENCE BOOKS:

1. Sebastian Thrun, Wolfram Burgard, Dieter Fox, “Probabilistic Robotics”, MIT Press, 2005.
2. Karsten Berns, Ewald Von Puttkamer, “Autonomous Land Vehicles Steps towards Service Robots”, Vieweg Teubner Springer, 2009.
3. Howie Choset, Kevin Lynch Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki, and Sebastian Thrun, “Principles of Robot Motion-Theory, Algorithms, and Implementation”, MIT Press, Cambridge, 2005.
4. Bruno Siciliano, Oussama Khatib, Springer Hand book of Robotics, Springer, 2008

WEB REFERENCES:

1. <https://archive.nptel.ac.in/courses/112/108/112108298/>
2. <https://www.sciencedirect.com/science/article/pii/S1474667016391959>
3. <https://www.automate.org/a3-content/service-robots-field-robots>
4. <https://builtin.com/robotics/farming-agricultural-robots>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		2					1				1	2	
CO2	3		2					1				1	2	
CO3	3		2					1				1	2	
CO4	3		2					1				1	2	
CO5	3		2					1				1	2	
Avg	3		2					1				1	2	

VII SEMESTER (PROFESSIONAL ELECTIVE V)	L	T	P	C
	3	-	-	3

20RB7E10 :: VIRTUAL REALITY AND AUGMENTED REALITY

COURSE OBJECTIVES

- To learn the basic concepts of virtual reality and its benefits.
- To understand the use of geometric modelling in virtual reality environment.
- To learn the hardware and software used in VR.
- To know about the working of augmented reality and its concepts.
- To learn the AR content and its applications.

COURSE OUTCOMES

Students are able to

CO1. Adopt various principles and concepts of Virtual Reality and its Application. [K2]

CO2. Apply appropriate method of Geometric Modelling. [K3]

CO3. Analyse various VR Hardware and Software. [K3]

CO4. Describe the concepts of Augmented Reality. [K2]

CO5. Define Augmented Reality Contents and its Applications [K2].

UNIT I INTRODUCTION TO VIRTUAL REALITY

Virtual Reality & Virtual Environment: Introduction – Computer graphics – Real time computer graphics – Flight Simulation – Virtual environments – requirement – Benefits of Virtual Reality - Historical development of VR : 3D Computer Graphics - Human Factors – Vision - Vision and Display Technology – Hearing – Tactile - Equilibrium.

UNIT II GEOMETRIC MODELING

Geometric Modelling : Introduction – From 2D to 3D – 3D space curves – 3D boundary representation – Other modelling strategies – Geometrical Transformations: Introduction – Frames of reference – Modelling transformations – Instances – Picking – Flying – Scaling the VE – Collision detection – A Generic VR system : Introduction – The virtual environment – The Computer environment – VR Technology – Model of interaction – VR System.

UNIT III VR HARDWARE, SOFTWARE AND APPLICATIONS

Introduction-Computers-Tracking-Input Devices-Output Devices-Glasses-Displays-Audio-VR-Software Features-Web-based VR-Division's dVISE, Blueberry 3D-Boston Dynamics-Multigen- Introduction Industrial-Training Simulators-Entertainment-VR Centres.

UNIT IV INTRODUCTION TO AUGMENTED REALITY

Introduction to Augmented Reality-Definition and Scope-A Brief History of AR-Examples-Related Fields Augmented Reality Concepts-How does AR Work-Concepts Related AR-Ingredients of an AR-AR Hardware and Software-Major Hardware Components for AR Systems- Major Software Components for AR Systems.

UNIT V AR CONTENT, INTERACTION AND ITS APPLICATIONS

AR Content-Introduction-What is Content-Creating Visual Content-Creating Audio Content-Creating Content for Other Senses-Representation and Perceptual Issues-AR Interaction-Introduction-What is Interaction-Mobile AR-AR Applications-Introduction-Application Areas-Collaborative AR-Applying AR to a Problem-Evaluating AR Applications-Example AR Applications-The Future of Augmented Reality.

TEXT BOOKS:

1. John Vince, Virtual Reality Systems, Pearson Education Asia, 2016.
2. John Vince, Introduction to Virtual Reality, Springer London, 2016.
3. Dieter Schmalstieg, Tobias Hollerer, Augmented Reality-Principles and Practice, Pearson Education, 2016.
4. Alan B. Craig, Understanding Augmented Reality Concepts and Applications, Elsevier -Morgan Kaufmann Publications, 2013.

REFERENCE BOOKS:

1. Adams, “Visualizations of Virtual Reality”, Tata McGraw Hill, 2000.
2. Grigore C. Burdea, Philippe Coiffet , Virtual Reality Technology , Wiley-Inter science, First Edition,1994.
3. Alan B Craig, William R Sherman and Jeffrey D Will, “Developing Virtual Reality Applications: Foundations of Effective Design”, Morgan Kaufmann, 2009.

WEB REFERENCES

1. <https://archive.nptel.ac.in/courses/121/106/121106013/>
2. <https://codereality.net/ar-for-eu-book/>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3				1							2	1	
CO2	3				1							2	1	
CO3	3				1							2	1	
CO4	3				1							2	1	
CO5	3				1							2	1	
Avg	3				1							2	1	

VII SEMESTER (PROFESSIONAL ELECTIVE V)	L	T	P	C
	3	-	-	3

20RB7E11 :: MICRO ELECTRO MECHANICAL SYSTEMS**COURSE OBJECTIVE:**

1. To introduce the students about different materials used for MEMS.
2. To impart knowledge about mechanical sensors and actuators.
3. To learn about thermal sensors and actuators.
4. To understand magnetic sensors and actuators.
5. To impart knowledge about micro-opto-electro mechanical systems

COURSE OUTCOMES: Students will be able to

- CO1. Explain various micro electro mechanical system components. [K2]
 CO2. Demonstrate mechanical sensors and actuators.
 CO3. Explain thermal sensors and actuators. [K2]
 CO4. Describe magnetic sensors and actuators. [K2]
 CO5. Explain micro-opto-electro mechanical systems. [K2]

UNIT – I

INTRODUCTION: 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.

UNIT – II

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 – III

THERMAL SENSORS AND ACTUATORS: Thermal energy basics and heat transfer processes, thermistors, thermos devices, thermocouple, micro machined thermocouple probe, Peltier effect heat pumps, thermal flow sensors, micro hot plate gas sensors, MEMS thermos 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 – IV

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, magnetic MEMS actuators, by directional micro actuator, feedback circuit integrated magnetic actuator, large force reluctance actuator, magnetic probe based storage device.

UNIT – V

MICRO-OPTO-ELECTRO MECHANICAL SYSTEMS: 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.

TEXT BOOKS:

1. Mahalik N P, MEMS, McGraw-Hill Education (India) Pvt Limited, 2013.
2. Rai - Choudhury P, MEMS and MOEMS Technology and Applications, PHI Learning Private Limited, 2009.
3. Nadim Maluf, An Introduction to Micro Electro Mechanical System Design, Artech House, 2004.

REFERENCES:

1. Tai-Ran Hsu, MEMS and Micro Systems: Design and Manufacture, TMH Publishers.2017
2. Chang Liu Foundation of MEMS, , Prentice Hall Ltd,2014.
3. Gerald Urban, Bio-MEMS (Micro systems), Springer.2006
4. Mohamed Gad el Hak, MEMS Handbook, CRC Press, 2002.

WEB REFERENCES:

1. <https://nptel.ac.in/courses/117105082>
2. <https://lecturenotes.in/subject/134/micro-electro-mechanical-systems>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	2	1		1				1			2	
CO2	2	2	3	2	2	2				1			3	1
CO3	2	2	3	1		2				2		1	1	
CO4	2	2	3	2	3	2	1					1	3	
CO5	2	2	2	2	3	2	1					1	3	
Avg	1.8	2	2.6	1.6	1.6	1.8	0.4			0.8		0.6	2.4	0.2

VII SEMESTER (PROFESSIONAL ELECTIVE V)	L	T	P	C
	3	-	-	3

20ME7E14 :: OPTIMIZATION TECHNIQUES

COURSE OBJECTIVES:

- To understand the concepts of optimization and its types.
- To get the knowledge of solving single variable and multivariable engineering optimization with constraints problem.
- To solve problems using constrained and unconstrained optimization techniques.
- To understand integer programming methods.
- To solve different design and manufacturing optimization problems.

COURSE OUTCOMES: Students are able to

CO1: Explain the optimization problem and its applications. [K2]

CO2: Classify classical optimization techniques. [K3]

CO3: Apply constrained and unconstrained optimization techniques using various methods [K3]

CO4: Explain integer programming methods. [K2]

CO5: Apply evolutionary algorithms for solving design and manufacturing optimization problems. [K3]

UNIT-I INTRODUCTION

Optimization, Historical development, Engineering applications of optimization, Design vector and constraints, Constraint surface, Objective function, Classification of optimization problems.

UNIT-II CLASSICAL OPTIMIZATION TECHNIQUES

Single variable optimization with and without constraints, Multivariable optimization without constraints, Method of Lagrange multipliers, Kuhn Tucker conditions, Merits and demerits of classical optimization techniques

UNIT-III CONSTRAINED AND UNCONSTRAINED OPTIMIZATION TECHNIQUES

Characteristics of constrained problem methods of feasible directions - basic approach in the penalty function method, Unconstrained optimization techniques- pattern search method- Rosen Brock's method of rotating coordinates- Simplex method.

UNIT-IV INTEGER PROGRAMMING

Graphical representation, Gomory's cutting plane method, Bala's algorithm for zero-one programming problem, Integer nonlinear programming.

UNIT-V EVOLUTIONARY ALGORITHMS

An overview of evolutionary algorithms, Simulated annealing algorithm, Genetic algorithm, Particle swarm optimization, Ant colony optimization, Tabu Search.

TEXT BOOKS:

1. S.S. Rao, Engineering Optimization, 3rd Edition, New Age Publishers, 2017.
2. CE Ebeling, An Introduction to Reliability and Maintainability Engineering, 3rd Edition, Waveland Printers Inc, 2017
3. Jasbir Arora, Optimal design, 3rd Edition, Mc Graw Hill (International) Publishers, 2018.

REFERENCE BOOKS:

1. D.E.Goldberg, Genetic algorithms in Search, Optimization, and Machine learning, 13th Edition, Addison Wesley Publishers, 2017.
2. Kalyanmoy Deb, Multi objective Genetic algorithms, 2nd Edition, PHI Publishers, 2013.
3. Kalyanmoy Deb, Multi-objective optimization using evolutionary algorithms, 3rd Edition, John Wiley Publications, 2001.

WEB REFERENCE:

1. <https://archive.nptel.ac.in/courses/111/105/111105039/>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3										1	1	
CO2	3	3			2	1						2	1	
CO3	3	3	2		3	1					2	3	2	
CO4	3	3	2		3	1					2	2	1	
CO5	3	3	2		2	1					2	2	3	
Avg	3	3	1.2		2	0.8					1.2	1.8	1.6	

VII SEMESTER : OPEN ELECTIVE - III	L	T	P	C
	3	-	-	3
20CE7001 :: SOLID WASTE MANAGEMENT				

Course Outcomes:

Students are able to

1. Recall classification of solid waste generated.
2. Know the collection systems of solid waste of a town.
3. Analyze the importance of transfer and transport of solid waste.
4. Apply the knowledge in processing of solid waste.
5. Design treatment of municipal solid waste and landfill.

SYLLUBUS:

UNIT- I

Introduction to Solid Waste Management:

Goals and objectives of solid waste management, Classification of Solid Waste – Factors Influencing generation of solid waste - sampling and characterization – Future changes in waste composition, major legislation, monitoring responsibilities.

UNIT- II

Collection of Solid Waste:

Type and methods of waste collection systems, analysis of collection system optimization of collection routes– alternative techniques for collection system.

UNIT- III

Transfer and Transport:

Need for transfer operation, compaction of solid waste - transport means and methods, transfer station types and design requirements.

UNIT- IV

Processing and Treatment:

Processing of solid waste – Waste transformation through combustion and composting, anaerobic methods for materials recovery and treatment – Energy recovery – biogas generation and cleaning– Incinerators.

UNIT- V

Disposal of Solid Waste:

Methods of Disposal, Landfills: Site selection, design and operation, drainage and leachate collection systems –designated waste landfill remediation.

Text/ Reference books:

1. George Tchobanoglous, Frank Kreith , Integrated Solid Waste Management- McGraw Hill Publication, 1993.
2. R.Saravanan, R.Dinesh Kumar, A.Suriya , Muncipal solid waste management, Lakshmi publications- 2015.
3. Vesilind, P.A., Worrell, W., Reinhart, D.,“Solid Waste Engineering”, Cenage learning, New Delhi, 2004.

VII SEMESTER : OPEN ELECTIVE - III	L	T	P	C
	3	-	-	3
20CE7002 :: BUILDING PLANNING AND DRAWING				

COURSE OUTCOMES

Students are able to

1. Understand the building bye-laws, plan various buildings as per the building by-laws.
2. Plan the individual rooms with reference to functional and furniture requirements.
3. prepare different sign conventions and bonds
4. Learn the skills of drawing building elements like doors and windows.
5. Develop the skills of Drawing Plans, Sections and Elevations of different buildings.

SYLLABUS:

UNIT-I

BUILDING BYELAWS AND REGULATIONS: Introduction - terminology - objectives of building Bye laws - floor area ratio - floor space index - principles under laying building bye laws - classification of buildings - open space requirements - built up area limitations- height of buildings- wall thickness - lightening and ventilation requirements.

UNIT -II

RESIDENTIAL AND PUBLIC BUILDINGS

Residential buildings: Minimum standards for various parts of buildings -requirements of different rooms and their grouping- characteristics of various types residential buildings.

Public buildings: Planning of educational institutions, hospitals, dispensaries, office buildings, banks, industrial buildings, hotels & motels, buildings for recreation.

UNIT-III

SIGN CONVENTIONS AND BONDS : Brick, stone, plaster, sand filling, concrete, glass, steel, cast iron, copper alloys, aluminum alloys etc., lead, zinc, tin etc., earth, rock, timber and marbles. English bond and Flemish bond- odd and even courses for one, one-half, two and two & half brick walls in thickness at the junction of a corner.

UNIT- IV

DOORS, WINDOWS, VENTILATORS AND ROOFS: Panelled door, panelled and glassed door, glassed windows, paneled windows, swing ventilators, fixed ventilators, coupled roof, collar roofs. King Post truss, Queen Post truss Sloped and flat roof buildings: drawing plans, Elevations and Cross Sections of given sloped roof buildings.

UNIT-V

PLANNING AND DESIGNING OF BUILDINGS: Draw the Plan, Elevation and sections of a Residential & Public buildings from the given line diagram.

TEXT /REFERENCE BOOKS:

1. Y.S. Sane., Planning and Design of buildings, 2010.
2. Gurucharan Singh and Jagadish Singh , Planning, designing and scheduling, 2015.
3. M. Chakravarthi., Building planning and drawing, 2015.
4. „A“ Series & „B“ Series of JNTU Engineering College, Anantapur.
5. Shah and Kale , Building drawing, 2013.

VII SEMESTER : OPEN ELECTIVE - III	L	T	P	C
	3	-	-	3
20EE7001 :: ENERGY AUDITING, CONSERVATION AND MANAGEMENT				

COURSE OUTCOMES:

After successful completion of this course, students should be able to:

CO1	:	Understand the principles of energy audit
CO2	:	Explain the role of Energy Manager and Energy Management program.
CO3	:	Design a energy efficient motors and good lighting system
CO4	:	Evaluate the methods to improve the power factor
CO5	:	Estimate the computational techniques with regard to economic aspects.

SYLLABUS

UNIT-I	:	PRINCIPLES OF ENERGY AUDIT
Energy audit- definitions - concept - types of audit - energy index - cost index - pie charts – Sankey diagrams and load profiles - Energy conservation schemes and energy saving potential - Energy audit of industries- energy saving potential - energy audit of process industry - thermal power station - building energy audit– Numerical problems.		
UNIT-II	:	ENERGY MANAGEMENT
Principles of energy management - organizing energy management program - initiating – planning - controlling - promoting - monitoring - reporting. Energy manager - qualities and functions – language - Questionnaire – check list for top management.		
UNIT-III	:	ENERGY EFFICIENT MOTORS AND LIGHTING
Energy Efficient Motors: Energy efficient motors - factors affecting efficiency - loss distribution - constructional details - characteristics – variable speed - RMS - voltage variation-voltage unbalance-over motoring-motor energy audit. Lighting : lighting system design and practice - lighting control - lighting energy audit.		
UNIT-IV	:	POWER FACTOR IMPROVEMENT AND ENERGY INSTRUMENTS
Power factor – methods of improvement - location of capacitors - Power factor with non-linear loads - effect of harmonics on p.f - p.f motor controllers – Energy Instruments- watt meter - data loggers - thermocouples - pyrometers - lux meters - tongue testers.		
UNIT-V	:	ECONOMIC ASPECTS AND COMPUTATION
ECONOMIC ASPECTS: Economics Analysis depreciation Methods - time value of money - rate of return - present worth method - replacement analysis - lifecycle costing analysis. COMPUTATION ASPECTS: Calculation of simple payback method - net present value method- Power factor correction - lighting – Applications of life cycle costing analysis - return on investment.		

TEXT BOOKS:

1. Energy management by W.R.Murphy & G.Mckay Butter worth - Heinemann publications - 1982.
2. Energy management hand book by W.CTurner - John wiley and sons - 1982.

REFERENCE BOOKS:

1. Energy efficient electric motors by John.C.Andreas - Marcel Dekker Inc Ltd-2nd edition – 1995.
2. Energy management by Paul o" Callaghan - Mc-graw Hill Book company-1st edition – 1998.
Energy management and good lighting practice : fuel efficiency- booklet12

VII SEMESTER : OPEN ELECTIVE - III	L	T	P	C
	3	-	-	3
20EC7001 :: INTRODUCTION TO GLOBAL POSITIONING SYSTEMS				

COURSE OUTCOMES:

After completion of this course, the students are able to,

CO1: Describe global navigation satellite systems (K1)

CO2: Understand GNSS Satellite signal characteristics (K2)

CO3: Develop GNSS Receiver (K3)

CO4: Analyze the impact of various error sources on the precision of positioning. (K4)

UNIT I : FUNDAMENTALS OF SATELLITE NAVIGATION:

Concept of Ranging using Time of arrival Measurements: Two-Dimensional Position Determination, Principle of Position Determination via Satellite-Generated Ranging signals, Fundamentals of satellite orbits: Orbital Mechanics, Constellation Design, Positioning determination using Ranging codes: Determining Satellite-to-User Range, **Indian Developed GNSS-** Indian Regional Navigation Satellite System (IRNSS) : NavIC and its applications, GPS-Aided Geo-Augmented Navigation (GAGAN)

UNIT II : GLOBAL POSITIONING SYSTEM SEGMENTS:

Space Segment Description: GPS Satellite Constellation Description, Constellation Design Guidelines, Space Segment Phased Development, Control Segment: Current Configuration, CS Planned Upgrades , User Segment: GPS Set Characteristics, GPS Receiver Selection

UNIT-III : GPS SATELLITE SIGNAL CHARACTERISTICS:

Modulations for Satellite Navigation: Modulation Types, Multiplexing Techniques, Signal Models and Characteristics, Legacy GPS Signals: Frequencies and Modulation Format, Power Levels, Autocorrelation Functions and Power Spectral Densities, Cross-Correlation Functions and CDMA Performance, Navigation Message Format.

UNIT-IV : GNSS RECEIVER:

Acquisition: Single Trial Detector, Tong Search Detector, M of N Search Detector, Combined Tong and M of N Search Detectors, FFT-Based Techniques, Direct Acquisition of GPS Military Signals, Vernier Doppler and Peak Code Search, carrier tracking, code tracking: Carrier Loop Discriminator, sequence of initial receiver operation.

UNIT-V: GNSS ERRORS: Introduction, Measurement errors: satellite clock error, ephemeris error, relative effects, atmospheric effects, receiver noise and resolution, multipath and shadowing effects, hardware bias errors, Pseudo range error budgets.

TEXTBOOKS:

1. Elliott D. Kaplan, Christopher J. Hegarty, Understanding **GPS/GNSS** principles and applications, third edition, artech house publishers, Boston, 2017
2. G S Rao, Global Navigational satellite system, Tata McGraw-Hill education private Ltd, New Delhi, 2015.

REFERENCES:

1. ISRO-IRNSS-ICD-SPS-1.1, Bangalore, 2017
2. Bhatta, B. “. Global Navigation Satellite Systems: Insights Into GPS, Glonass, Galileo, Compass, and Others”, BS Publications, New Delhi, 2015.

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1. <https://archive.nptel.ac.in/courses/105/107/105107194/>
2. https://d1.amobbs.com/bbs_upload782111/files_33/ourdev_584835O21W59.pdf

VII SEMESTER : OPEN ELECTIVE - III	L	T	P	C
	3	-	-	3
20BM7001 :: INDUSTRIAL SOCIOLOGY AND PSYCHOLOGY				

UNIT I: Industrial Sociology: Nature and Scope of Industrial Sociology-Development of Industrial Sociology, Factors of social change – the technological factors, the cultural factors, effects of technology on major social institutions, social relations in industry.

UNIT II: Group Dynamics: Concept- factors influencing individual behaviour- Work Teams & Groups, Group Behavior, Group formation & development, Decision Making by Individuals, Groups Decision making process-techniques.

UNIT III: Industrial Psychology: Nature and Meaning of Industrial Psychology, Role of Industrial Psychology, Organizational Attitude, Motivation at work-Theories of Motivation (Theory X and Y, McClelland's Theory, Maslow's Need Theory, Herzberg's Two Factor Theory), Cultural Differences in Motivation.

UNIT IV: Organizational Design and Leadership: Organizational Design & Structure- organizational design-process, Structural differentiations, factors influencing design of organizations, Leadership-concept, types, Leadership vs. Management, Leadership Theories, Emerging issues in Leadership.

UNIT V: Organizational Conflicts and Change management: - Causes and Consequences of Conflict- Conflict handling techniques, Managing Change, Forces for change in Organization, Resistance to change.

TEXT BOOKS:

1. Nelson, Quick and Khandelwal, ORGB : An innovative approach to learning and teaching Organizational Behaviour. A South Asian Perspective, Cengage Learning, 2012
2. Luthans, Fred, Organizational Behavior, McGraw Hill, 2008.
3. Stephen P. Robins, Organisational Behavior, PHI Learning / Pearson Education, 11th edition, 2008.

REFERENCES BOOKS:

1. Schneider Engno V., Industrial Sociology 2nd Edition, McGraw Hill Publishing Co., New Delhi,2011.
2. Ivancevich, Konopaske & Maheson, Organisational Behaviour & Management, 7th edition, Tata McGraw Hill, 2008.
3. L.M.Prasad.,Organisational Behaviour, 5th Edition, Sulthan Chand & Sons.,2014

VII SEMESTER : OPEN ELECTIVE - III	L	T	P	C
	3	-	-	3
20ME7001 :: BIO-MECHANICAL ENGINEERING				

COURSE OBJECTIVES: The main objectives of this course are

- To make the student familiar with fundamentals of bio mechanics.
- To gain knowledge about musculoskeletal system.
- To impart knowledge about linear kinetics and angular kinetics
- Make the student to illustrate the mathematical models used in the analysis of biomechanical systems

COURSE OUTCOMES: Students are able to

- CO1: Explain about fundamentals of Bio mechanics. [K2]
- CO2: Describe the mechanics of musculoskeletal system. [K2]
- CO3: Relate the concept of kinetics with human motion. [K3]
- CO4: Explain mechanical analysis of human motion. [K3]
- CO5: Analyze human movements. [K4]

UNIT-I

INTRODUCTION TO BIO MECHANICS

Principles of mechanics in human movement, Qualitative and quantitative Analysis, Key mechanical concepts of mechanics and basic units, Nine fundamentals of biomechanics, Nine principles for application of Biomechanics.

UNIT-II

MECHANICS OF MUSCULOSKELETAL SYSTEM

Principles of joint motions, Muscle structures, Mechanical method of muscle action analysis, Tissue loads and forces, Biomechanics of bones and ligaments, Three mechanical characters of muscle, stretch-shortening cycle (SSC).

UNIT-III

LINEAR KINETICS AND ANGULAR KINETICS

Vector analysis of angle of pull and muscle angle pull, Contact forces, Impulse-Momentum Relationship, Force-Time Principle, Work-Energy relationship, Segmental interaction principle, Torque, Equilibrium, Center of gravity and Principle of balance.

UNIT-IV

MECHANICAL ANALYSIS OF HUMAN MOTION

Linear kinematics - linear kinematic analysis, position and displacement, velocity and speed, acceleration, differentiation and integration, kinematics of running, kinematics of projectiles, equations of constant acceleration, Angular kinematics - angular motion, measurements of angles, types of angles, representation of angular motion vectors, lower extremity joint angles, relationship between angular and linear motion, angular kinematics of running.

UNIT-V

APPLICATIONS OF MEDICAL REHABILITATION

Qualitative analysis of kicking technique, batting, catching, throwing techniques, injury risk assessment, equipment design for strength training, Injury mechanics, injury prevention.

TEXT BOOKS:

1. Ronald L. Huston, Principles of Biomechanics, 1st edition CRC Press, 2019
2. Joseph E. Muscolino, “Kinesology”, 3rd edition, Mosby, 2016.
3. Subrata Pal, “Textbook of Biomechanics”, 1st edition, Springer US, 2016.

REFERENCE BOOKS:

1. Duane Knudson, “Fundamentals of Biomechanics”, 2nd edition, Springer, 2013.
2. Ajay Bahl, “Basics of Biomechanics”, 1st edition, Jaypee Brothers Medical Publishers, 2010.
3. Robert frost, “Applied Kinesiology”, 1st edition, North Atlantic Books, 2013
4. David A. Winter, “Biomechanics and Motor Control of Human Movement”, John Wiley & sons, 2009.

WEB REFERENCE:

1. <https://archive.nptel.ac.in/courses/112/105/112105305/>
2. <https://archive.nptel.ac.in/courses/112/106/112106248/>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2			1						2	2	
CO2	3	2	2			1						2	2	
CO3	3	2	2			1						2	2	
CO4	3	2	2			1						2	2	
CO5	3	1	1			1						2	2	
Avg	3	1.8	1.8			1						2	2	

VII SEMESTER : OPEN ELECTIVE - III	L	T	P	C
	3	-	-	3
20CS7001 :: FULL-STACK DEVELOPMENT				

COURSE OUTCOMES:

At the end of the course, the student should be able to:

1. Design simple web pages using markup languages like HTML and CSS.
2. Create dynamic web pages using DHTML and java script that is easy to navigate and use.
3. Create web pages using AngularJS.
4. Build web applications using Servlet and JSP.
5. Understand various operations on Mongo Database.

UNIT-I: HTML and CSS

HTML: An Introduction to HTML, Basic XHTML Syntax and Semantics, Basic HTML Elements: Images, Links, Lists, Tables, Forms, Frames, Division and Spanning, HTML 5.0.

CSS: Levels of Style sheets, Style specification formats, Selector forms, CSS Colors and Backgrounds, CSS Text and Font Properties, The Box Model, CSS Margins, Padding, and Borders Conflict Resolution.

UNIT-II: Client-Side Scripting using Java Script and DOM

Java Script: The Basics of Java Script, Objects, Primitive operations and Expressions, Screen output and Keyboard input, Control statements, Object Creation and modification, Arrays, functions, Constructors, Pattern matching using Regular Expressions, DHTML: Positioning moving and Changing Elements.

DOM: Introduction to the Document Object Model DOM, HTML DOM Event Handling, Modifying Element Style, Document Tree, DOM Event Handling

UNIT-III: Angular JS

Introduction to AngularJS: Expressions, Modules, Data Binding, Scopes, Directives & Events, Controllers, Filters, Services, HTTP, Tables, Select, Fetching Data from MySQL.

UNIT-IV: Servlet and JSP

Servlet: Servlet Basics, Need of Server Side Programming, Servlet Life Cycle, Servlet Hello World Application, Web.xml Structure, Servlet Directives- include(), forward(), sendRedirect(), HttpServletRequest and HttpServletResponse in Servlet, Servlet and JDBC Integration.

JSP: JSP Basics, JSP Scripting Elements(Declaration, Expression, Scriptlet), Directive Elements(page, include, taglib), Action Elements(jsp:forward,jsp:include,jsp:useBean), JSP Implicit Objects.

UNIT-V Mongo DB

Introduction to Mongo DB: Mongo DB Environment, Create Database, Drop Database, Create Collection, Drop Collection, Read Operations, Write Operations.

Text Books:

1. Programming the World Wide Web, Robert W. Sebesta, 7ed, Pearson.
2. Web Technologies, Uttam K Roy, Oxford
3. Head First Servlet and JSP
4. Node.js, MongoDB, and AngularJS Web Development by Brad Dayley

Reference Books:

1. Web Technologies, HTML, JavaScript, PHP, Java, JSP, XML and AJAX, Black book, Dream Tech.
2. An Introduction to Web Design, Programming, Paul S Wang, Sanda S Katila, Cengage
3. Pro Angular JS by Adam Freeman
4. MEAN Web Development by Amos Q. Haviv

VII SEMESTER : OPEN ELECTIVE - IV	L	T	P	C
	3	-	-	3
20CE7003 :: INTRODUCTION TO WATERSHED MANAGEMENT				

Course Outcomes:

Students are able to

1. Analyze watershed characteristics to take appropriate management action.
2. Quantify soil erosion and design control measures.
3. Apply land grading techniques for proper land management.
4. Suggest suitable harvesting techniques for better watershed management.
5. Apply appropriate models for watershed management.

SYLLUBUS:

UNIT-I: Introduction:

Concept of watershed development, objectives of watershed development, need for watershed development, Characteristics of Watersheds: Size, shape, physiography, slope, climate, drainage, land use, vegetation, geology and soils, hydrology and hydrogeology, socio-economic characteristics.

UNIT-II: Principles of Erosion:

Types and causes of erosion, factors affecting erosion, estimation of soil loss due to erosion. Measures to Control Erosion: Contour techniques, ploughing, furrowing, trenching, bunding, terracing, gully control, check dams, rock-fill dams, brushwood dam, Gabion.

UNIT-III: Water Harvesting:

Techniques of rain water harvesting- rain water harvesting from roof top, surface flow harvesting, farm ponds and dugout ponds, percolation tanks.

UNIT-IV: Land Management:

Land use and Land capability classification, management of forest, agricultural, grassland and wild land, Reclamation of saline and alkaline soils.

UNIT-V: Watershed Modeling:

Data of watershed for modeling, model calibration and validation, advances of watershed models. Integrated and multidisciplinary approach for watershed management.

Text/ References books:

1. Abrar Yousuf and Manmohanjit Singh, „Watershed Hydrology, Management and Modeling“, Taylor & Francis Ltd; 1st edition, 2021.
2. Das MM and M.D Saikia , „Watershed Management“, PHI Learning Pvt. Ltd, 2013.
3. Murthy VVN , „Land and Water Management“, Kalyani Publications, 2007.
4. Murthy J V S, „Watershed Management“, New Age International Publishers, 2006.
5. Wurbs R A and James R A „Water Resource Engineering“, Prentice Hall Publishers, 2002.

VII SEMESTER : OPEN ELECTIVE - IV	L	T	P	C
	3	-	-	3
20EE7002 :: INTRODUCTION TO PROGRAMMABLE LOGIC CONTROLLER				

COURSE OUTCOMES:

After successful completion of this course, students should be able to:

CO1	:	Illustrate I/O modules of PLC systems and ladder diagrams
CO2	:	Demonstrate various types registers and programming instructions.□
CO3	:	Examine various types of PLC functions and its applications
CO4	:	Assess different data handling functions and its applications.
CO5	:	Describe the analog operations and PID modules

SYLLABUS

UNIT-I	:	INTRODUCTION TO PLC SYSTEMS
I/O modules and interfacing - CPU processor - programming Equipment - programming formats - construction of PLC ladder diagrams - Devices connected to I/O Modules. Digital logic gates - programming in the Boolean algebra system - conversion examples Ladder Diagrams for process control: Ladder diagrams & sequence listings - ladder diagram construction and flowchart for spray process system		
UNIT-II	:	PLC PROGRAMMING & REGISTERS
PLC Programming: Input instructions - outputs - operational procedures - programming examples using contacts and coils. Drill press operation. PLC Registers: Characteristics of Registers - module addressing - holding registers - Input Registers - Output Registers.		
UNIT-III	:	PLC FUNCTIONS
Timer functions & Industrial applications - counters - counter function industrial applications - Arithmetic functions - Number comparison functions - number conversion functions		
UNIT-IV	:	DATA HANDLING FUNCTIONS
SKIP - Master control Relay - Jump - Move - FIFO - FAL - ONS – CLR & Sweep functions and their applications. Bit Pattern and changing a bit shift register – sequence functions and applications - controlling of two-axis & three axis Robots with PLC - Matrix functions		
UNIT-V	:	ANALOG PLC OPERATION
Analog modules & systems - Analog signal processing - Multi bit Data Processing - Analog output Application Examples - PID principles - position indicator with PID control - PID Modules - PID tuning - PID functions.		

TEXT BOOKS:

1. Programmable Logic Controllers- Principles and Applications by John W. Webb & Ronald A. Reiss - Fifth Edition – PHI.
2. Programmable Logic Controllers- Programming Method and Applications –JR.Hackworth & nF.D Hackworth Jr. –Pearson - 2004

REFERENCE BOOKS:

1. Introduction to Programmable Logic Controllers- Gary A. Dunning - 3rd edition – Cengage Learning - 2005.
2. Programmable Logic Controllers –W.Bolton - 5th Edition - Elsevier publisher - 2009.

VII SEMESTER : OPEN ELECTIVE - IV	L	T	P	C
	3	-	-	3
20BM7O02 :: BUSINESS SKILL DEVELOPMENT				

UNIT- I

Communication in Business Objectives of communication - The Process of Human Communication – Types of Communication-Written, Oral, Visual, Audio Visual - Developing Listening Skills – Types, essentials of good listening and tips.

UNIT -II

Managing Organizational Communication– Formal and Informal Communication – Intra- personal–Inter-Personal Communication-Communication Models - Johari Window, Transactional Analysis, and Social Exchange theory. Role of emotion, barriers to interpersonal communication- Gateways to effective interpersonal communication.

UNIT -III

Nonverbal communication and Body language: Kinesics, Proxemics, Paralanguage, Haptics, handshakes, Appropriate body language and Mannerisms for interviews: business etiquettes- cultural effects of communication. Communication styles.

UNIT- IV

Business Correspondence- Essentials of Effective Business Correspondence, Norms for business letters- Letter for different kinds of situations- Business Letter and Forms, Resume writing, Meeting, Telephonic Communication – Use of Technology in Business Communication.

UNIT -V

Report Writing and Presentation skills – Formal and Informal Reports-Reports and Proposals Prerequisites for effective presentation -Types and Stages of presentation – Communication skills for group discussion and interviews-interview techniques.

Text / Reference Books

1. K Bhardwaj, Professional Communication, IK Int Pub House, New Delhi
2. Rayudu, CS: “Communication”, Himalaya Publishing House, Mumbai.
3. Krizan: “Essentials of Business Communication”, Cengage Learning, New Delhi.
4. Urmila Rai & S.M. Rai, Business Communication, Himalya Publishers,
5. Dalmar Fisher: “Communication in Organizations”, JAICO Publishing House, New Delhi, 2007.
6. Paul Turner: “Organisational Communication”, JAICO Publishing House, New Delhi.
7. Meenakshi Rama: “Business Communication”, Oxford University Press, New Delhi.

VII SEMESTER : OPEN ELECTIVE - IV	L	T	P	C
	3	-	-	3
20EC7002 :: REMOTE SENSING				

COURSE OUTCOMES:

After Completion of this course, students are able to

CO1: Understand the subject of satellite communication and remote sensing with the core knowledge of space and satellite, communication and the international space laws.

CO2: Comprehend different remote sensing signaling techniques, capable of interpreting signature of satellite communication from bodies like soil, vegetation and ocean.

CO3: Analyze various components used in satellite communication and remote sensing applications.

CO4: Acquire and keep abreast of designing satellite remote sensing system and also analyze the sensor data for drawing inference and conclusions.

UNIT I

Introduction: Historical background, International space laws, Advantages of space based observations, Global coverage, Multi scale observation, repeat observation immediate transmission and digital format, Source of information on remote sensing region.

UNIT II

Principles of remote sensing: Fundamentals of remote sensing signals, The electromagnetic spectrum, Terms and units of measurements, EM radiation laws, Spectral signature in the solar spectrum, vegetation reflectance, soil reflectance, water in the solar spectrum, The thermal infrared domain, characteristics of EM radiation in thermal infrared, Thermal properties of vegetation, Soils thermal domain, thermal signature of water and snow, The microwave region, Atmospheric interaction.

UNIT III

Sensors and remote sensing satellite: Type of sensors, Resolution of sensor systems, spatial, spectral, radiometric, temporal, angular - resolution, passive sensors, photographic cameras, cross and along track - scanners, active sensors, Radar and Lidar, satellite remote missions, Satellite orbits, Landsat programs, SPOT satellites, IRS program, High resolution commercial satellites, Polar orbiting meteorological satellites, Terra Aqua, Geostationary meteorological satellites.

UNIT IV

Basis for interpretations of remote sensing images: Constraints in using remote sensing data, types of interpretation, Costs of data acquisitions, end-user requirements, Thematic classification, Generation of biophysical variables, Change detection, spatial patterns, organization of remote sensing project, interpretation phase, presentation of study cases.

UNIT V

Characteristic of photographic images, Feature identification, criteria for visua interpretation, Brightness, color, texture, spatial contexts, shadows, spatial patterns, shap and size, stereoscopic view, period of acquisition, elements of visual analysis, Geometric characteristics of satellite image, Color composites,

Multitemporal approaches.

TEXTBOOKS:

1. Emilio Chuvieco, “Fundamentals of Satellite Remote Sensing”, CRC press, Edition,2009.

REFERENCES:

- 1.C. H. Chen, “Signal Processing for Remote Sensing”, CRC press, Edition-2007.
2. R. N Mutagi, “Satellite Communication Principles and Applications”, Oxford University press, 2016.
3. Enrico Del Re, and Marina Ruggieri, “Satellite communications and navigation systems”, Springer.

VII SEMESTER : OPEN ELECTIVE - IV	L	T	P	C
	3	-	-	3
20ME7002 :: GREEN ENGINEERING SYSTEM				

COURSE OBJECTIVES

- To understand the basic concept of solar energy.
- To gain knowledge about renewable energy.
- To learn about the best energy efficient systems.
- To impart knowledge about energy efficient processes

COURSE OUTCOMES: Students are able to

CO1: Recognize the energy scenario and explain solar radiation conversion and collection phenomena. [K3]

CO2: Illustrate solar energy storage methods and applications and also explain the principles of wind energy, classification, conversion and applications [K4]

CO3: Explain the principle, classification, conversion and applications of Bio mass, geothermal energy and ocean energy. [K3]

CO4: Describe the importance of energy efficient systems and interpret working of a few mechanical and electrical efficient systems. [K2]

CO5: Identify the need of energy efficient processes and analyze their significance in view of their importance in the current scenario and their potential future applications. [K4]

UNIT – I

INTRODUCTION: Energy chain and common forms of usable energy – Present energy scenario – World energy status – Energy scenario in India, Traditional energy systems, Renewable energy – sources and features.

SOLAR RADIATION:

Role and potential of new and renewable sources, the solar energy option, Environmental impact of solar power, structure of the sun, the solar constant, sun-earth relationships, coordinate systems and coordinates of the sun, extraterrestrial and terrestrial solar radiation, solar radiation on tilted surface, instruments for measuring solar radiation and sun shine, solar radiation data, numerical problems. Photo voltaic energy conversion – types of PV cells, I-V characteristics.

SOLAR ENERGY COLLECTION: Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors.

UNIT – II

SOLAR ENERGY STORAGE AND APPLICATIONS: Different methods, sensible, latent heat and stratified storage, solar ponds, solar applications- solar heating/cooling technique, solar distillation and drying, solar cookers, central power tower concept and solar chimney

WIND ENERGY: Sources and potentials, horizontal and vertical axis windmills, performance characteristics, betz criteria, types of winds, wind data measurement.

UNIT – III

BIO-MASS: Principles of bio-conversion, anaerobic/aerobic digestion, types of bio-gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking, bio fuels, I.C. engine operation and economic aspects.

GEOTHERMAL ENERGY: Resources, types of wells, methods of harnessing the energy, potential in India.

OCEAN ENERGY: OTEC, Principles of utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques, mini-hydel power plants, and their economics.

UNIT – IV

ENERGY EFFICIENT SYSTEMS:

ELECTRICAL SYSTEMS: Energy efficient motors, energy efficient lighting and control, selection of luminaire, variable voltage variable frequency drives (adjustable speed drives), controls for HVAC (heating, ventilation and air conditioning), demand site management.

MECHANICAL SYSTEMS: Fuel cells- principle, thermodynamic aspects, selection of fuels & working of various types of fuel cells, environmental friendly and energy efficient compressors and pumps

GREEN BUILDINGS: Definition features and benefits.

UNIT – V

ENERGY EFFICIENT PROCESSES: Environmental impact of the current manufacturing practices and systems, benefits of green manufacturing systems, selection of recyclable and environment friendly materials in manufacturing, design and implementation of efficient and sustainable green production systems - vegetable based cutting fluids, zero waste manufacturing.

TEXT BOOKS:

1. Sukhatme S.P. and J. K. Nayak, Solar Energy – Principles of Thermal Collection and Storage, Tata McGraw Hill, 2018.
2. Khan B.H., Non-Conventional Energy Resources, Tata McGraw Hill, New Delhi, 2015.
3. Green Manufacturing Processes and Systems, Edited by J. Paulo Davim, Springer 2016.

REFERENCES:

1. Alternative Building Materials and Technologies, K. S. Jagadeesh, B.V. Venkata Rama Reddy and K. S. Nanjunda Rao, New Age International (P) Ltd.
2. Principles of Solar Engineering, Yogi Goswami, Frank Krieth and John F Kreider, Taylor and Francis
3. Non-Conventional Energy , Ashok V Desai, Wiley Eastern
4. Renewable Energy Technologies, Ramesh & Kumar, Narosa
5. Non-Conventional Energy Sources, G. D. Rai, Kanna Publishers, New Delhi, 2018.

WEB REFERENCE:

1. <https://archive.nptel.ac.in/courses/112/104/112104225/>
2. <https://archive.nptel.ac.in/courses/105/102/105102195/>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	2	1	3	3	-	-	2	3	2	-	3
CO2	3	3	1	2	1	3	3	-	-	2	3	2	-	3
CO3	3	3	1	2	1	3	3	-	-	2	3	2	-	3
CO4	3	3	1	2	1	3	3	-	-	2	3	2	-	3
CO5	3	3	1	2	1	3	3	-	-	2	3	2	-	3
Avg	3	3	1	2	1	3	3	-	-	2	3	2	-	3

VII SEMESTER : OPEN ELECTIVE - IV	L	T	P	C
	3	-	-	3
20CS7002 :: SOFTWARE TESTING TECHNIQUES				

COURSE OUTCOMES:

At the end of the course, the student should be able to:

1. Design simple web pages using markup languages like HTML and CSS.
2. Create dynamic web pages using DHTML and java script that is easy to navigate and use.
3. Create web pages using AngularJS.
4. Build web applications using Servlet and JSP.
5. Understand various operations on Mongo Database.

UNIT-I: HTML and CSS

HTML: An Introduction to HTML, Basic XHTML Syntax and Semantics, Basic HTML Elements: Images, Links, Lists, Tables, Forms, Frames, Division and Spanning, HTML 5.0.

CSS: Levels of Style sheets, Style specification formats, Selector forms, CSS Colors and Backgrounds, CSS Text and Font Properties, The Box Model, CSS Margins, Padding, and Borders Conflict Resolution.

UNIT-II: Client-Side Scripting using Java Script and DOM

Java Script: The Basics of Java Script, Objects, Primitive operations and Expressions, Screen output and Keyboard input, Control statements, Object Creation and modification, Arrays, functions, Constructors, Pattern matching using Regular Expressions, DHTML: Positioning moving and Changing Elements.

DOM: Introduction to the Document Object Model DOM, HTML DOM Event Handling, Modifying Element Style, Document Tree, DOM Event Handling

UNIT-III: Angular JS

Introduction to AngularJS: Expressions, Modules, Data Binding, Scopes, Directives & Events, Controllers, Filters, Services, HTTP, Tables, Select, Fetching Data from MySQL.

UNIT-IV: Servlet and JSP

Servlet: Servlet Basics, Need of Server Side Programming, Servlet Life Cycle, Servlet Hello World Application, Web.xml Structure, Servlet Directives- include(), forward(), sendRedirect(), HttpServletRequest and HttpServletResponse in Servlet, Servlet and JDBC Integration.

JSP: JSP Basics, JSP Scripting Elements(Declaration, Expression, Scriptlet), Directive Elements(page, include, taglib), Action Elements(jsp:forward,jsp:include,jsp:useBean), JSP Implicit Objects.

UNIT-V Mongo DB

Introduction to Mongo DB: Mongo DB Environment, Create Database, Drop Database, Create Collection, Drop Collection, Read Operations, Write Operations.

Text Books:

1. Programming the World Wide Web, Robert W. Sebesta, 7ed, Pearson.
2. Web Technologies, Uttam K Roy, Oxford
3. Head First Servlet and JSP
4. Node.js, MongoDB, and AngularJS Web Development by Brad Dayley

Reference Books:

1. Web Technologies, HTML, JavaScript, PHP, Java, JSP, XML and AJAX, Black book, Dream Tech.
2. An Introduction to Web Design, Programming, Paul S Wang, Sanda S Katila, Cengage
3. Pro Angular JS by Adam Freeman
4. MEAN Web Development by Amos Q. Haviv

VII SEMESTER : OPEN ELECTIVE - IV	L	T	P	C
	3	-	-	3
20IT7001 :: INTRODUCTION TO SOFTWARE PROJECT MANAGEMENT				

Course Outcomes:

Upon the completion of the course students will be able to:-

1. Apply the process to be followed in the software development life-cycle models.
2. Apply the concepts of project management & planning.
3. Implement the project plans through managing people, communications and change
4. Conduct activities necessary to successfully complete and close the Software projects
5. Implement communication, modeling, and construction & deployment practices in software development.

UNIT – I:

Conventional Software Management: The waterfall model, conventional software Management performance.

Evolution of Software Economics: Software Economics, pragmatic software cost estimation.

Improving Software Economics: Reducing Software product size, improving software processes, improving team effectiveness, improving automation, Achieving required quality, peer inspections.

UNIT – II:

The Old Way and The New: The principles of conventional software Engineering, principles of modern software management, transitioning to an iterative process.

Life Cycle Phases: Engineering and production stages, inception, Elaboration, construction, transition phases.

Artifacts of The Process: The artifact sets, Management artifacts, Engineering artifacts, programmatic artifacts.

UNIT – III:

Model Based Software Architectures: A Management perspective and technical perspective.

Work Flows of the Process: Software process workflows, Iteration workflows.

Checkpoints of the Process: Major mile stones, Minor Milestones, Periodic status assessments.

UNIT – IV:

Iterative Process Planning: Work breakdown structures, planning guidelines, cost and schedule estimating, Iteration planning process, Pragmatic planning.

Project Organizations and Responsibilities: Line-of-Business Organizations, Project Organizations, evolution of Organizations.

UNIT – V:

Process Automation: Automation Building blocks, The Project Environment.

Project Control and Process Instrumentation: The seven core Metrics, Management indicators, quality indicators, life cycle expectations, pragmatic Software Metrics, Metrics automation.

Project Estimation and Management: COCOMO model, Critical Path Analysis, PERT technique, Monte Carlo approach (Text book 2)

Text Books:

1. Software Project Management, Walker Royce, Pearson Education, 2005.
2. Software Project Management, Bob Hughes, 4th edition, Mike Cotterell, TMH.

Reference Books:

1. Software Project Management, Joel Henry, Pearson Education.
2. Software Project Management in practice, Pankaj Jalote, Pearson Education, 2005.
3. Effective Software Project Management, Robert K.Wysocki, Wiley,2006.

B. TECH VII SEM (Humanities and Social Science Elective)	L	T	P	C
	3	0	0	3

20HS7T01 :: UNIVERSAL HUMAN VALUES : UNDERSTANDING HARMONY

COURSE OUTCOMES:

Students are able to

- CO1:** Understand the need, basic guidelines, content and process of value education; explore the meaning of happiness and prosperity.
- CO2:** Distinguish between the Self and the Body, understand the meaning of Harmony in the Self the Co-existence of Self and Body.
- CO3:** Analyze the value of harmonious relationship based on trust and respect in life and profession
- CO4:** Examine the role of a human being in ensuring harmony in society and nature.
- CO5:** Apply the understanding of ethical conduct to formulate the strategy for ethical life and profession.

SYLLABUS

UNIT 1: INTRODUCTION-BASIC HUMAN ASPIRATION

Understanding the need, basic guidelines, content and process for Value Education-Self-Exploration, its content and process - „Natural Acceptance“ and „Experiential Validation“ as the mechanism for self exploration-Continuous Happiness and Prosperity the basic requirements for fulfillment of aspirations of every human being with their correct priority- Understanding Happiness and Prosperity correctly-Method to fulfill the above human aspirations: understanding and living in harmony at various levels.

UNIT 2: HARMONY IN THE HUMAN BEING

Understanding human being as a co-existence of the sentient „I“ and the material „Body“, Understanding the needs of Self („I“) and „Body“ - Sukh and Suvidha, Understanding the Body as an instrument of „I“- Understanding the characteristics and activities of „I“ and harmony in „I“.

UNIT 3: HUMAN-HUMAN RELATIONSHIPS

Understanding values in human-human relationship-Meaning of justice-Nine universal values in relationship-Meaning of trust and respect-Difference between respect and differentiation-Harmony in society-undivided society-from family to world family.

UNIT 4: NATURE AND EXISTENCE

Self exploration – self awareness and self evaluation- Self realization-Understanding and contemplation in the Self - Realization of Co-existence- Understanding of harmony in Nature and contemplation of participation of Human in development of harmony.

UNIT 5: IMPLICATIONS OF HARMONY ON PROFESSIONAL ETHICS

Basis for Humanistic Education-Humanistic Constitution and Humanistic Universal Order- Case studies of typical holistic technologies-management models-Production systems-Strategy for transition from the present state to universal human order.

TEXT BOOKS:

1. R R Gaur, R Sangal, G P Bagaria, “A Foundation Course in Human Values and Professional Ethics”, Excel Books, 2010.

REFERENCES

1. A.N. Tripathi, “Human Values”, New Age Intl. Publishers, New Delhi, 2004.

2. Mahadev Desai, Shriman Narayan, “The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi”, Navajivan Mudranalaya, Ahemadabad, India.1925
3. A Nagaraj, Jeevan Vidya: Ek Parichaya, Jeevan Vidya Prakashan, Amarkantak, 1999.
4. P. L. Dhar& R. R. Gaur, “Science & Humanism – towards a unified worldview”, Commonwealth Publishers, New Delhi-1990.
5. J. C. Kumarappa, “Economy of Permanence – (a quest for social order based on non-violence)”, Sarva-Seva-Sangh-Prakashan, Varansi, India-2010.

VII SEMESTER : SKILL COURSE	L	T	P	C
	-	-	4	3

20RB7S01 :: ROBOSTUDIO

COURSE OBJECTIVE:

The objective of this course is to familiarize students with the fundamentals of robot programming, illustrated with examples and practical exercises using industrial robots.

COURSE OUTCOMES: Students will be able to

CO1. Construct a simulation station and attach tooling to robot simulation [K3]

CO2. Develop knowledge in programming for performing various operations. [K3]

LIST OF EXPERIMENTS

1. Fundamental of Robot Studio Software.
2. Creating a basic station for a industrial robot.
3. Programming a basic station for a industrial robot.
4. Creating path and synchronize with virtual Controller.
5. Simulation of Robot Station.
 - i) Play the Station.
 - ii) Video Recording for reference.
6. Program for loading and unloading operations on 6 DOF Articulated robot.
7. Program for palletizing application on Industrial robot.
8. Program for conveyor belt application on Industrial robot.
9. Program for deburring and assembly application on Industrial robot.
10. Program for welding applications on Industrial robot.

VII SEMESTER	L	T	P	C
	-	-	-	3
20RB7I01 :: INTERNSHIP II				

VIII SEMESTER	L	T	P	C
	-	-	-	8
20RB8P01 :: PROJECT WORK, SEMINAR AND INTERNSHIP IN INDUSTRY				

IV SEMESTER (MINOR COURSES)	L	T	P	C
	3	1	-	4
20ME4N01 :: MECHANICS OF SOLIDS				

COURSE OBJECTIVE:

1. The student will acquire the fundamental concepts of deformable bodies.
2. The student will be able to draw the shear force and bending moment diagrams for various beams.
3. The student will acquire the knowledge to sketch both stress distribution for bending and shear loads for different sections.
4. The student will compute beam deflections under transverse loads using various methods.
5. The student will compute stress in thin cylinder thick cylinder and spheres due to external and internal pressure.

COURSE OUTCOMES: Students are able to

- CO1. Calculate stresses and strains in structural members subjected to various types of loadings. [K3]
 CO2: Sketch the Shear force and bending moment diagrams of beams subject to combination of loads. [K3]
 CO3: Determine and Sketch the stress distribution in section of the beam subjected to Bending and Shear loads. [K3]
 CO4: Determine the Shear stresses and Modulus of rigidity, Slope and Deflection in shafts.[K3]
 CO5: Evaluate stresses in thin and thick cylinders. [K4]

UNIT -I

SIMPLE STRESSES AND STRAINS: Introduction, Stress, Strain, Types of Stresses, Elasticity and Elastic Limit, Hook’s Law, Elastic Moduli, Modulus of Elasticity, Factor of Safety, Constitutive Relationship between Stress and Strain. Elastic Constants: Introduction, Longitudinal Strain, Lateral Strain, Poisson’s Ratio, Volumetric Strain, Volumetric Strain of a Cylindrical Rod, Sphere and Rectangular block Bulk Modulus, Expression for Young’s Modulus in Terms of Bulk Modulus.

Principal Stresses and Strains: Introduction, Principal Planes and Principal Stresses, Methods of determining stresses on Oblique Section - Analytical Method, Graphical Method, Mohr’s Circle.

UNIT -II

SHEAR FORCE AND BENDING MOMENT: Introduction, Types of Beams, Types of Loads, Sign Conventions for Shear Force and Bending Moment, Shear Force and Bending Moment diagram for a Cantilever, simply supported, Over hanging beams with different loads and combination of loads, Point loads, UDL, UVL and couple. Relation between Load, Shear Force and Bending Moment.

UNIT -III

FLEXURAL STRESSES: Introduction, Pure Bending or Simple Bending, Theory of Simple Bending, Expression for Bending Stress, Neutral Axis and Moment of resistance, Bending Stresses in Symmetrical Sections, Section Modulus, Section Modulus for Various Shapes of Beam Sections, Bending Stress in Unsymmetrical Sections

Shear Stresses: Introduction, Shear Stress at a Section, Shear Stress Distribution for Different Sections like Rectangular, Circular, Triangular, I, T and Angle sections.

UNIT -IV

DEFLECTION OF BEAMS: Introduction, Deflection and Slope of a Beam Subjected to Uniform Bending Moment, Relation between Slope, Deflection and Radius of Curvature, Deflection of a Simply Supported, cantilever Beams Carrying point load and UDL using Macaulay's Method and Moment Area Method. Double integration Method

Torsion:

Introduction, Shear Stress Produced in a Circular, Maximum Torque Transmitted by a Circular Solid Shaft and Hollow Circular Shafts, Power Transmitted by Shafts, Expression for Torque in Terms of Polar Moment of Inertia, Polar Modulus, Strength of a Shaft of Varying Sections, Combined Bending and Torsion.

UNIT -V

THIN CYLINDERS AND SPHERES: Introduction, Stresses in a Thin Cylindrical Vessel Subjected to Internal Pressure, Circumferential Stress, Longitudinal Stress, Efficiency of a Joint, Effect of Internal Pressure on the Dimensions of a Thin Cylindrical Shell, Thin Spherical Shells,

Thick Cylinders: Introduction, Stresses in a Thick Cylindrical Shell, Stresses in Compound Thick Cylinders. Columns and struts: Rankine theory

TEXT BOOKS:

1. R.K.Bansal, A Text Book of Strength of Materials: Mechanics of Solids, 6 th Edition, Laxmi Publications, 2018.
2. R K Rajput, Strength of Materials, 6th Edition, S. Chand Publishing, 2015.
3. James and Gere, Mechanics of materials , 6th edition, Cengage Learning publications, 2010
4. Popov E, Solid Mechanics, 2 nd Edition, Prentice Hall India Learning Private Limited, 2002.

REFERENCES:

1. S.S. Rattan, Strength of Materials ,Mc-Graw Hill Private Limited, 3 rd Edition , New Delhi, 2017
2. Ferdinand P. Beer, E. Russell Johnston Jr. , John T. DeWolf, David F. Mazurek , Mechanics of Materials, 7th Edition, 2014.
3. Stephen P. Timoshenko, James M. Gere, Mechanics of Materials, 2 nd Edition, C B S Publishers, 2011.
4. R. K Bansal, Strength of Materials, Laxmi Publications, New Delhi, Revised 4 th Edition, 2010.

WEB REFERENCES:

3. <https://nptel.ac.in/courses/112102284>
4. <https://nptel.ac.in/courses/112107147>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1								1	3	
CO2	2	2	2	1		2						1	3	
CO3	3	2	1	2		2						1	3	
CO4	3	1	2	1								1	3	
CO5	3	1	1	1		1						1	3	
Avg	3	1.8	1.6	1.2		1						1	3	

V SEMESTER (MINOR COURSES)	L	T	P	C
	3	1	-	4

20RB5N01 :: FUNDAMENTALS OF INDUSTRIAL ROBOTICS

COURSE OBJECTIVE:

1. Understand classification of robots and basic components
2. Get acquainted with performing spatial transformations and solve kinematics of the robot.
3. Get acquainted with performing spatial transformations and solve Dynamics of the robot.
4. Analysis skills associated with trajectory planning and programming a robot.
5. Understand the present & future applications of a robot and working of sensors, drive systems.

COURSE OUTCOMES: Students will be able to

- CO1.** Demonstrate the classification and basic components of robots. [K2]
- CO2.** Apply various motion analysis principles to solve problems involving Manipulator Kinematics. [K3]
- CO3.** Apply Jacobian and Lagrangian principles to solve manipulator Dynamics Problems. [K3]
- CO4.** Program a robot to perform tasks in industrial applications [K3]
- CO5.** Explain working of sensors and various applications of Robots in industry. [K2]

UNIT – I

INTRODUCTION: History of robots, Classification of robots, Present status and future trends. Basic components of robotic system. Basic terminology- accuracy, repeatability, resolution, Degree of freedom. Mechanisms and transmission, End effectors, Grippers-different methods of gripping, Mechanical grippers-slider crank mechanism, screw type, rotary actuators, cam type gripper, magnetic grippers, vacuum grippers, air operated grippers, Specifications of robot.

UNIT – II

MOTION ANALYSIS: Homogeneous transformations as applicable to rotation and translation, problems– Euler Angles.

MANIPULATOR KINEMATICS: D-H Notations, joint coordinates and world coordinates, Forward and inverse kinematics, problems of simple robotic manipulators.

UNIT – III

MANIPULATOR DYNAMICS: Differential transformation of manipulators, Jacobians, Lagrange, Euler and Newton, Euler formulations, Problems.

ROBOT CONTROLS: Point to point control, Continuous path control, Intelligent robot, Control system for robot joint, Control actions, Feedback devices, Encoder, Resolver, LVDT, Motion Interpolations, Adaptive control.

UNIT – IV

TRAJECTORY PLANNING: Trajectory planning: Joint space scheme- cubic polynomial fit, obstacle avoidance in operation space-cubic polynomial fit with via point, blending scheme.

INTRODUCTION TO ROBOTIC PROGRAMMING: On-line and off-line programming, programming examples.

UNIT – V

SENSORS: Internal sensors- Position sensors, & Velocity sensors, External sensors-Proximity sensors, Tactile Sensors, & Force or Torque sensors.

ROBOT APPLICATIONS IN MANUFACTURING: Material Transfer, Machine loading and un-loading operations, processing operations - spot and continuous arc welding & spray painting, Assembly operations, Inspection, Safety in robotics, Training, maintenance.

DRIVE SYSTEM: hydraulic, pneumatic and electric systems

TEXT BOOKS:

1. Industrial Robotics -Mikell P. Groover, Mitchell Weiss, Roger N. Nagel, Nicholas G. Odrey/TATA McGraw-Hill Education 1986
2. Robotics and Control - R.K. Mittal, I. J. Nagrath / Tata Mc Graw Hill Publishing Company Ltd 2003
3. Introduction to Robotics / John J. Craig/ Pearson 2019

REFERENCES:

1. Robotics, control Sensing, vision and intelligence - K.S. Fu, R.C.Gonzalez, C.S.G Lee / Tata Mc Graw Hill Education. 1987
2. Introduction to Robotics – Analysis, Systems, Applications – Saeed B. Niku / Pearson Education 2011
3. Robot Analysis – Mechanics of Serial and Parallel Manipulators - Lung-Wen Tsai, John-Wiley Publications, New York.1999

WEB REFERENCES:

1. <https://archive.nptel.ac.in/courses/112/105/112105249/>
2. <https://archive.nptel.ac.in/courses/112/108/112108298/>
3. <https://archive.nptel.ac.in/courses/112/107/112107289/>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3											1	2	
CO2	3	3	2									1	2	
CO3	3	2	2									1	2	
CO4	3	2	2									1	2	
CO5	3											1	2	
Avg	3	1.4	1.2									1	2	

VI SEMESTER (MINOR COURSES)	L	T	P	C
	3	1	-	4

20RB6N01 :: FUNDAMENTALS OF CNC MACHINES

COURSE OBJECTIVES:

- The main objective of this course is that the students will learn the importance of CNC machines.
- To understand the different types of CNC Machines and their features.
- By undergoing this subject the students will learn to use the CNC machines efficiently for manufacturing desired products and knowledge of programming and use of CNC tooling.

COURSE OUTCOMES: Students are able to

CO1: Explain the construction features of CNC machine tools.

CO2: Illustrate the various types of Accessories and feedback devices used in CNC machines.

CO3: Explain the working of Position transducer as well as Control systems and Interfaces.

CO4: Analyze the Automatically Programming Tool Language and develop a program on different examples

CO5: Analyze the CNC Programming tools and develop a program on different examples.

UNIT – I

Introduction to CNC Machine tools: Evolution of Computerized control in manufacturing, Components, Working principle of CNC, DNC and Machining centers.

Constructional features of CNC machine tools: Introduction, Spindle drives, Transmission belting, axes feed drives, Slide ways, Ball screws.

UNIT – II

Accessories: Work tables, Spindles, Spindle heads, Beds and Columns, Tooling – Automatic Tool changer (ATC).

Feedback devices: Introduction, Digital incremental displacement measuring systems, Incremental rotary encoders, Digital absolute measuring system.

UNIT –III

Electro-magnetic analogue position transducers: Principle, advantages, characteristics, Synchros, Synchro-Resolvers, Inductos, Laser interferometer.

Control Systems and interface: Open and closed loop systems, Microprocessor based CNC systems, block diagram of typical CNC system, description of hard ware and soft interpolation systems, Standard and optional features of CNC control systems.

UNIT – IV

APT programming: APT language structure, APT geometry, Definition of point, time, vector, circle, plane, patterns and matrices. APT motion commands: setup commands, point-to point motion commands, continuous path motion commands, post processor commands, control commands, Macro subroutines, Part programming preparation for typical examples.

UNIT – V

CNC Programming: Part programming fundamentals, Preparatory functions, Miscellaneous functions, Programming number, Canned cycles, Tool length compensation, Cutter Radius compensation, Sub Programs, Part programming preparation for typical examples.

TEXT BOOKS:

1. RadhaKrishnanan, “Computer Numerical Control Machines” New Central Book Agency, 1st edition, 2013.
2. Yoram Koren, “Computer Control of manufacturing systems” McGraw Hill Education, 1st edition, 2017
3. P N RAO, “CAD/CAM Principles and Applications” McGraw Hill Education, 3rd edition, 2017

REFERENCES:

1. Peter Smid, “CNC Programming Hand book” 2nd edition, 2003.
2. B S V Ramarao, “Optimization of Computer Numerical Control Machine output parameters” LAP Lambert Academic Publishing, 1st edition, 2020.

WEB REFERENCES:

3. <https://archive.nptel.ac.in/courses/112/105/112105211/>
4. <https://archive.nptel.ac.in/courses/112/105/112105306/>

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

VII SEMESTER (MINOR COURSES)	L	T	P	C
	3	1	-	4
20RB7N01 :: AUTOMATION IN MANUFACTURING				

COURSE OBJECTIVES

- To learn about the automation systems and flow lines used in manufacturing industry.
- To learn about the assembly systems and automated material handling systems used in automated production system.
- To understand the concept of controls used in automated production lines.

COURSE OUTCOMES

Students are able to

- CO1** : Explain the process of automation and types (K2)
- CO2** : Interpret the well-defined task or operation is accomplished by an automated machine (K2)
- CO3** : Identify, formulate and solve algorithm related to localization, obstacle avoidance, and mapping. (K3)
- CO4** : Explain the automated material handling systems used in manufacturing establishment.[K2]
- CO5** : Describe the control methods and systems used in automated flow lines (K2)

UNIT-I

INTRODUCTION

Types and strategies of automation, pneumatic and hydraulic components, circuits, Automation in machine tools, Mechanical Feeding and tool changing and machine tool control.

UNIT-II

AUTOMATED FLOW LINES

Methods of work part transport, transfer mechanism, buffer storage, control function, design and fabrication consideration.

ANALYSIS OF AUTOMATED FLOW LINES: General terminology and analysis of transfer lines without and with buffer storage, partial automation, implementation of automated flow lines .

UNIT-III

ASSEMBLY SYSTEM AND LINE BALANCING

Assembly process and systems assembly line, line balancing methods, ways of improving line balance, flexible assembly lines.

UNIT-IV

AUTOMATED MATERIAL HANDLING

Types of equipment, functions, analysis and design of material handling systems, conveyor systems, automated guided vehicle systems.

AUTOMATED STORAGE SYSTEMS: Automated storage and retrieval systems; work in process storage, interfacing handling and storage with manufacturing.

UNIT-V

FUNDAMENTALS OF INDUSTRIAL CONTROLS

Review of control theory, logic controls, sensors and actuators, Data communication and LAN in manufacturing. Business process Re-engineering: Introduction to BPE logistics, ERP, Software configuration of BPE.

TEXT BOOKS:

4. Groover, M. P., Automation, Production Systems, and Computer-integrated Manufacturing, Pearson, 2018.
5. Frank Lamb, Industrial Automation hands on , Mc Graw Hill Education ,2013
6. Yoram Coreom, Computer control of Manufacturing Systems, New Age International Publishers, 2006.

REFERENCE BOOKS:

1. F. Gardner, R, Introduction to Plant Automation and Controls, 1st Edition, CRC Press, 2020.
2. Tien-Chien Chang, Richard A Wysk and Hsu-Pin Wang, Computer Aided Manufacturing, Pearson, 2009.
3. Radhakrishnan and Subramanian, CAD/CAM/CIM, 4th Edition, New Age Publications, 2018.

WEB REFERENCES:

1. <https://nptel.ac.in/courses/112104288>
2. <https://archive.nptel.ac.in/courses/112/103/112103293/#>

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1		1		3	2	2		1		2		2	
CO2	1	1	3		3	1			1				2	
CO3	2	2	3		2	1			1				2	
CO4	1	2	2		2	1	1		1				2	
CO5	1	1							1				2	
Avg	1.2	1.2	1.8		2	1	0.6		1		0.4		2	