PONDICHERRY UNIVERSITY

B.Tech.

ROBOTICS AND AUTOMATION (R & A)

(for Affiliated Colleges)

REGULATIONS, CURRICULUM AND SYLLABUS
(for Affiliated Colleges)

(2023- 24)

PONDICHERRY UNIVERSITY

BACHELOR OF TECHNOLOGY PROGRAMMES

(EIGHT SEMESTERS)

REGULATIONS 2023-24

1. **Conditions for Admission:**

a) **Candidates for admission to the first semester of the 8 semester B.Tech. degree programme should be required to have passed:**

The Higher Secondary Examination of the (10+2) curriculum (Academic Stream) prescribed by the different State Boards/ Central Boards or any other examination equivalent there to with minimum of 45% marks (40% marks in case of candidates belonging to reserved category) in aggregate of subjects – Mathematics, Physics and any one of the following optional subjects: Chemistry / Biotechnology/ Computer Science / IT and equivalent/ Electronics/ Biology (Botany & Zoology) or Passed D.Voc Stream in the same or allied sector or an Examination of any University or Authority recognized by the Executive Council of the Pondicherry University as equivalent thereto.

b) **Candidates for admission through Lateral entry into second year (third semester)of the 8 semester B.Tech.degree programme should be required to have passed :**

Passed Minimum THREE years / TWO years (Lateral Entry) Diploma examination with at least 45% marks (40% marks in case of candidates belonging to reserved category) in ANY branch of Engineering and Technology.

OR

Passed B.Sc. Degree from a recognized University as defined by UGC, with at least 45% marks (40% marks in case of candidates belonging to reserved category) and passed 10+2 examination with Mathematics as a subject.

OR

Passed D.Voc. Stream in the same or allied sector.

(The Universities/colleges will offer suitable bridge courses such as Mathematics, Physics, Engineering drawing, etc., for the students coming from diverse backgrounds to achieve desired learning outcomes of the programme)

2. **Age Limit:**

As per applicable AICTE norms.

3. **Duration of Programme:**

The Bachelor of Technology degree programme shall extend over a period of 8 semesters spread over 4 academic years – two semesters constituting one academic year. The duration of each semester shall normally be 15 weeks excluding examinations.

4. Program Structure

The medium of instruction is English.

A student admitted to the B.Tech. programme in a particular branch of engineering will earn the degree in that branch by fulfilling all the requirements prescribed in the regulations during the course of study.

The student is also permitted to opt for earning an **Honors degree in the same discipline of Engineering or a Minor degree** in another discipline of engineering in addition to the degree in his own discipline of engineering. The student will be allowed to exercise this option at the end of first year based on his academic performance in the first year. The students admitted through lateral entry can exercise this option at the end of third semester, based on the GPA scored in the third semester examination.

The student opting for B.Tech. degree with **Honors or B.Tech. degree with Minor** is required to earn additional 20 credits starting from the third semester. The students admitted in the second year through lateral entry and opting for Honors / Minor degree will earn the additional 20 credits starting from the fourth semester.

5. Eligibility for the award of B.Tech. Degree:

No candidate shall be eligible for the award of the degree of Bachelor of Technology, unless he/she has undergone the course for a period of 8 semesters (4 academic years) / 6 semesters (3 academic years for Lateral Entry candidates) in the Faculty of Engineering and has passed the prescribed examinations in all the semesters. Details regarding the possible exit for a B.Tech. student – in line with one of the goals of the National Education Policy (NEP) 2020 are provided in section 13.

6. Branches of Study:

Branch I - Civil Engineering

Branch II– Mechanical Engineering

Branch III - Electronics & Communication Engineering

BranchIV-ComputerScience&Engineering

Branch V– Electrical & Electronics Engineering

Branch VI – Chemical Engineering

Branch VII - Electronics & Instrumentation Engineering

Branch VIII –Information Technology

Branch IX - Instrumentation & Control Engineering

Branch X– Biomedical Engineering

Branch XI - Robotics and Automation

Branch XII – Food Technology

Branch XIII- CSE (Internet of Things & Cyber security including Block chain Technology)

Branch XIV – ArtificialIntelligence and Machine Learning

Branch XV - ArtificialIntelligence and Data Science

or any other branch of study as and when offered. The branch allocation shall be ordinarily done at the time of admission of the candidate to the first semester.

7. Course Structure and Subjects of Study:

Definition of Credit:

1 Hour Lecture (L) per week	1 Credit
1 Hour Tutorial (T) per week	1 Credit
2 Hours Practical (P) per week	1 Credit

Range of Credits: The total credits of all the branches for the four-year B. Tech. degree Programme shall be in the range of160 to 172 (Minor variation is allowed as per AICTE guidelines). "Minor Degree or Honors will cumulatively require additional 20 credits in the specified area in addition to the credits essential for obtaining the Under Graduate Degree in Major Discipline".

The subjects of study shall include theory, practical courses and project work/internships as given in the curriculum and shall be in accordance with the prescribed syllabus.

The curriculum of every programme will have courses that are categorized as follows:

(i) Humanities, Social Sciences and Management Courses (HSM)

(ii) Basic Science Courses (BSC)

(iii) Engineering Science Courses (ESC)

(iv) Professional Core Courses (PCC)

(v) Professional Elective Courses (PEC)

(vi) Open Elective Courses (OEC)

(vii) Professional Activity Courses (PAC)

(viii) Mandatory non-Credit Courses (MCC)

Each course will have either one or more of three components namely Lecture (L), Tutorial (T) and Practice (P). Each course is assigned credits as detailed below:

(i) Theory courses will carry either 3 or 4 credits - 3 credits for courses with 3 lecture periods per week and 4 credits for courses with 3 lecture periods and 1 tutorial period per week.

(ii) All Elective courses including online courses will carry maximum 3 credits. The student can earn the credits towards the Open Elective Courses (OEC) by completing the online courses offered in NPTEL anytime between third and seventh semester on prior approval of the courses by the Academic Courses Committee of the Institute. Credits earned through the NPTEL courses will be confined to 2 or 3 credits and subject to a maximum of 9 credits during the entire programme of study.

(iii) Practical courses will normally carry either 1 or 1.5 credits – 1.5 credits for courses with 3 practice periods per week and 1 credit for courses with 2 practice periods per week.

(iv) Out of total credits required for successful completion of the degree, 14 to 22 credits can be assigned for Project work and/or Internship.

(v) Mandatory non-credit courses carry zero credit.

8. Examinations:

The theory and practical examinations shall comprise continuous internal assessment throughout the semester in all subjects as well as university examinations conducted by Pondicherry University at the end of the semester (November / December or April /May).

8.1. Evaluation Scheme

All Credit courses are evaluated for 100 marks comprising of Internal assessment and end-semester exam.

For Theory Course, the weightage of internal assessment is 40% and end semester examination is 60%

For Practical course, the weightage of internal assessment is 60% and end semester examination is 40%

For Project, the weightage of internal assessment is 60% and end semester examination is 40%

8.2. Internal Assessment (Theory)

Total Internal Assessment mark for a theory course is 40 marks. The breakup is as follows:

Criteria	Maximum Marks
a) Internal Assessment Tests	30
b) Percentage of Attendance	5

c) Assignment(s)	5
Total	**40**

Marks for Attendance is as follows:

Below 75%	0
75% - 80%	1
81% - 85%	2
86% - 90%	3
91% - 95%	4
96% - 100%	5

The Principal of the College/Institute schedules the Internal Assessment tests for all courses. All faculty members are expected to conduct this Internal Assessment tests for 1.30 hours duration and evaluate and required to upload the marks to the Controller of Examinations of University. Colleges are also requested to preserve the answer sheets of Internal Assessment tests until declaration of results by the University.

8.3. Internal Assessment (Practicals)

Faculty in-charge of Lab courses shall evaluate the practical course for 60 marks. The break up is as follows:

Criteria	**Maximum Marks**
a) Laboratory exercises and Record	30
c) Mid Semester exam (Average of 2 exams)	15
c) Internal Viva voce	5
d) Percentage of Attendance	10
Total	**60**

Marks for Attendance is as follows:

Below 75%	0
75% - 80%	2

81% - 85%	4
86% - 90%	6
91% - 95%	8
96% - 100%	10

8.4. Internal Assessment (Project)

The Project work carried out in the eighth semester shall be assessed as follows:

Criteria	Marks
a) Continuous assessment (Guide)	25
b) Project Evaluation Committee	35
Total	**60**

8.5 Requirement for appearing for University Examination

The Controller of Examinations (COE) of Pondicherry University schedules the End-Semester exams for all theory and practical courses based on the University academic calendar.

A detailed Exam Time Table shall be circulated to all Colleges at least 15 days before the start of exams. Question Papers shall be set externally based on BOS approved syllabus.

A candidate shall be permitted to appear for university examinations at the end of any semester only if:

i) He / She secures not less than 75% overall attendance arrived at by taking into account the total number of periods in all subjects put together offered by the institution for the semester under consideration.

(*Candidates who secure overall attendance greater than 60% and less than 75% have to pay acondonation fee as prescribed by University along with a medical certificate obtained from a medical officer not below therankofAssistantDirector*)

ii) He / She earns a progress certificate from the Head of the institution for having satisfactorily completed the course of study in all the subjects pertaining to that semester

iii) His / Her conduct is found to be satisfactory as certified by the Head of the institution.

A candidate who has satisfied the requirement (i) to (iii) shall be deemed to have satisfied the course requirements for the semester.

8.6 End Semester Exam Evaluation Pattern

Course	**Maximum marks**
a) Theory course (Sec A, Sec B and Sec C) Questions from all units of syllabus	60 marks
b) Practical course (Based on Lab exercises/Record/ Practicals /Viva)	40 marks
c) Internship /Project Work (Based on Seminar/Project Work/Project report/Presentation and viva voce)	40 marks

8.7 Consolidation of Marks and PassingMinimum

The Controller of Examinations of the University consolidates the Internal Assessment marks uploaded by the Colleges and marks secured by students in the end-semester examination.

A student shall be declared to have passed the examination in a subject of study only if he/she secures not less than **40% marks individually both in internal assessment and end-semester examination or an aggregate of 40%.**

A candidate who has been declared "Fail" in a particular subject may reappear for that subject during the subsequent semesters and secure pass marks. However, there is a provision for revaluation of failed or passed subjects provided he/she fulfills the following norms for revaluation.

a) Applications for revaluation should be filed within 15 days from the date of declaration of resultsor 7days from the date of receipt of grade sheet whichever is earlier.

b) The candidate should have attended all the internal assessments conducted by the college as well as all the end semester examinations conducted by the University.

c) If a candidate has failed in more than two papers in the end semester examinations, his/her representation for revaluation will not be considered.

d) The request for revaluation must be made in the prescribed format duly recommended by the Head of the Institution along with there valuation fee prescribed by the University.

"A student shall be declared to have passed the examination in a subject of study only if he/she secures not less than **40% marks individually both in internal assessment and end-semester examination, or an aggregate of 40%.**

8.8. Arrear Exams

A student who failed to secure 40% marks in aggregate is declared as "Fail" and he is eligible to take up a supplementary examination by registering to the said course in the following semester. All other candidates who failed due to shortage of attendance and those seeking to improve the grade shall repeat the course.

8.9. Letter Grades and Calculation of CGPA

Total Marks Secured by a student in each course shall be converted into a letter grade. The following Table shows the seven letter grades and corresponding meaning and the grade points for the calculation of Cumulative Grade Point Average (CGPA).

Each course (Theory/Practical) is to be assigned 100 marks,irrespective of the number of credits,and the mapping of marks to grades may be done as per the following table:

Range of Marks	**Assigned Grade**	Grade Points
91-100	A^+	10
81-90	A	9
71-80	B^+	8
61-70	B	7
51-60	C^+	6
46-50	C	5
40-45	D	4
<40	F	0
Not Applicable	F^R (Fail due to shortage of attendance and therefore,to repeat the course)	0

Note: -F- denotes failure in the course; - F^R - denotes absent / detainedas per AICTE norms.

After the resultsaredeclared, grade sheets will be issued to the students. The grade sheets will contain the following details:

a) The college in which the candidate has studied.

b) The list of courses enrolled during the semester and the grades scored.

c) The Grade Point Average(GPA)for the semester and the Cumulative Grade Point Average(CGPA)of all enrolled subjects from first semester onwards.

d) GPA is the ratio of sum of the products of the number of credits(C)of courses registered and the corresponding Grades Points(GP) scored in those courses,taken for all the courses and sum of the number of credits of all the courses.

$$\mathbf{GPA = \sum(C \times GP)/ \sum C}$$

CGPA will be calculated in a similar manner, considering all the courses enrolled from first semester. F^R grades are to be excluded for calculating GPA and CGPA.

e) The conversion of CGPA into percentage marks is as follows

$$\% \text{ Mark} = (\text{CGPA} - 0.5) \times 10$$

9. Procedure for completing the B.Tech. course:

A candidate can join/rejoin the course of study of any semester only at the time of its normal commencement and only if he/she has satisfied the course requirements for the previous semester and further has registered for the university examinations of the previous semester in all the subjects as well as all arrear subjects if any.

However, the entire B.Tech. course should be completed within 7 years (14 semesters) and six years (12 semesters) for students admitted under lateral entry.

10. Award of Class and Rank in B.Tech. degree:

i) A candidate who satisfies the course requirements for all semesters and who passes all the examinations prescribed for all the eight semesters (six semesters for lateral entry candidates) within a maximum period of 7 years (6 years for lateral entry candidates) reckoned from the commencement of the first semester to which the candidate was admitted shall be declared to have qualified for the award of B.Tech. degree.

ii) A candidate who qualifies for the award of the B.Tech. degree passing in all subjects pertaining to the semesters 3 to 8 in his/her first appearance within 6 consecutive semesters (3 academic years) and in addition secures a CGPA of 8.50 and above for the semesters 3 to 8 shall be declared to have passed the examination in **FIRST CLASS** with **DISTINCTION**.

iii) A candidate who qualifies for the award of the B.Tech. degree by passing in all subjects relating to semesters 3 to 8 within a maximum period of eight semesters after his/her commencement of study in the third semester and in addition secures CGPA not less than 6.5 shall declared to have passed the examination in **FIRST CLASS**.

iv) All other candidates who qualify for the award of B.Tech. degree shall be declared to have passed the examination in **SECOND CLASS**.

v) For the Award of University ranks and Gold Medal for each branch of study, the CGPA secured from the 1st to 8th semester alone should be considered and it is mandatory that the candidate should have passed all the subjects from the1st to 8th semester in the first attempt. Rank certificates would be issued to the first ten candidates in each branch of study.

11. Provisions for Honors/Minor degree along with B.Tech. degree:

1. <u>B.Tech. with Honors Degree in the same Engineering discipline</u>

a. The student shall be given an option to earn a Honors degree in the same discipline of engineering at the end of first year based on his academic performance in the first year.

b. A student is eligible to exercise this option if he has passed all the subjects offered in the first year in the first attempt itself and has earned a CGPA of not less than 7.5.

c. Honors degree in a particular discipline of engineering shall be offered for a batch of students if and only if a minimum of 5 eligible students opt for it.

d. The student is required to earn an additional 20 credits (over and above the prescribed maximum credits in the curriculum) starting from the third semester onwards to become eligible for the award of Honors degree. 20 credits shall be earned by the student by completing 5 additional courses of 4 credits each, one in each of the 5 semesters starting from the third to seventh semester. The syllabus of these 5 courses are framed so as to cover advanced topics in that discipline of engineering.

e. The students admitted in the second year through Lateral Entry Scheme will also be given a chance to opt for Honors degree. Eligibility to avail this option is CGPA of 7.5 and above with no arrears in the third Semester. The student will join the existing batch of students in the fourth semester and earn 16 credits by registering the prescribed courses offered up to the seventh semester. The respective BoS will decide on a suitable course in lieu of the course offered in the third semester to facilitate the student to earn the remaining 4 credits.

f. A student is eligible to get the Honors degree only on completing the programme in 'First Class with Distinction' class.

g. A student can exercise the option to withdraw from the Honors degree at any time after entry.

h. Details about the courses completed and credits earned for Honors degree will appear only in the 'Eighth Semester Grade Sheet' and 'Consolidated Grade Sheet'. These details will be listed under the heading 'Credits Earned for Honors degree'. In the case of students who have either withdrawn from Honors degree or become ineligible for Honors degree by not securing 'First Class with Distinction', the credits earned for the courses registered and successfully completed for Honors degree will be listed under the heading 'Additional Credits Earned'.

i. The CGPA will be calculated for all the courses credited by the students inclusive of major and honors courses

j. Nomenclature of Honors Degree is 'B.Tech.(Honors) in XXX ', where XXX is Discipline in which the student has enrolled.

2. <u>B.Tech. with Minor degree in another Engineering discipline</u>

a) The student shall be given an option to earn a minor degree in another discipline of engineering of his choice at the end of first year based on his academic performance in the first year.

b) A student is eligible to exercise this option if he has passed all the subjects offered in the first year in the first attempt itself and has earned a CGPA of not less than 7.5.

c) Minor degree in a particular discipline of engineering shall be offered for a batch of students if and only if a minimum of 5 eligible students opt for it.

d) The student is required to earn an additional 20 credits (over and above the prescribed maximum credits in the curriculum) starting from the third semester onwards to become eligible for the award of minor degree. 20 credits shall be earned by the student by completing 5 additional courses of 4 credits each, one in each of the 5 semesters starting from the third to seventh semester. The curricular content of these 5 courses are framed in such a way that that these courses will essentially cover the core minimum knowledge required to be fulfilled for award of degree in the discipline of engineering in which the student chooses to earn the minor degree.

e) The students admitted in the second year through Lateral Entry Scheme will also be given a chance to opt for Minor degree. Students with a CGPA of 7.5 and with no arrears in the third semester are eligible to avail this option. The student will join the existing batch of students in the fourth semester and earn 16 credits by registering for prescribed courses offered up to seventh semester. The respective BoS will decide on a suitable course in lieu of the course offered in the third semester to facilitate the student to earn the remaining 4 credits.

f) A student can exercise the option to withdraw from the Minor degree at any time after entry.

g) Details about the courses completed and credits earned for Minor degree will appear only in the 'Eighth Semester Grade Sheet' and 'Consolidated Grade Sheet'. These details will be listed under the heading 'Credits Earned for Minor degree'. In the case of students who have withdrawn from Minor degree, the credits earned for the courses registered and successfully completed for Minor degree will be listed under the heading 'Additional Credits Earned'.

h) Nomenclature of Minor Degree is 'B.Tech. in XXX with Minor in YYY', where XXX is Discipline in which the student is enrolled and YYY is Discipline which the student has opted as Minor.

i)The CGPA will be calculated for all the courses credited by the students inclusive of major and minor courses.

12. Provision for withdrawal:

Based on the recommendation of the Head of the Institution, a candidate with valid reasons may be granted permission by the University to withdraw from writing the entire semester examination as one Unit. The withdrawal application shall be valid only if it is made earlier than the commencement of the last theory examination pertaining to that semester. Withdrawal shall be permitted only once during the entire course. A candidate who has withdrawn is also eligible to be awarded DISTINCTION provided he/she satisfies the other necessary conditions. But, they are not eligible to be awarded a rank.

13. Provisions for exit in B.Tech. course:

(For courses where AICTE specifies exit in the model curriculum)

The curriculum and the syllabus for all B.Tech programmes have been planned in compliance with the NEP guidelines proposed by AICTE. Accordingly, students joining B.Tech programmes shall have all benefits NEP offers in terms of exercising exit option during the course of study. Every B.Tech programme governed under this school board shall adopt the NEP guidelines, as and when proposed/amended by AICTE, and the following scheme will be applied for all such B.Tech programmes specified by AICTE.

NEP 2020 suggests that a student can exercise exits at multiple stages of the course of study. As per AICTE norms, a student can have two possible exits before the completion of the Full Engineering degree and may get a UG Diploma /Certificate or B.Sc. degree in the relevant discipline if he/she fulfils the following conditions: (Subject to change as per AICTE guidelines)

1. UG Diploma/Certificate in the relevant branch of study

A student should be able to get a UG Diploma if he/she completes:

a. 50% of the credits for B.Tech. (80-85 credits)

b. 50% of the program core courses

c. Students exiting the program after earning 50% credit requirements will be awarded a UG Diploma provided they secure an additional 6 credits through summer internships/apprenticeship of 2 months duration.

d. Students admitted through lateral entry cannot exercise the exit option as he will not be able to meet out the 50% Credits for B.Tech. degree.

2 B.Sc. in the relevant branch of study

A student should be able to get a B.Sc. degree if he/she completes:

(i) 75% of the credits for B.Tech. (minimum 120 credits) andatleast3yearsinthe program.

(ii) 100% of the core program courses.

(iii) Students exiting the program after earning 75% credit requirements will be awarded a B.Sc. provided they secure an additional 6 credits through 2 summer internships/apprenticeship for 2 months each.

(iv) With B.Sc. degree, the student is eligible for entry into programs which take B.Sc. degree as eligibility criteria.

2.1 Award of Class in B.Sc. degree

A candidate who satisfies the course requirements for all semesters and who passes all the examinations within a maximum period of 6 years (5 years for lateral entry candidates) reckoned from the commencement of the first semester to which the candidate was admitted shall be declared to have qualified for the award of B.Sc. degree in the relevant discipline.

i) A candidate who qualifies for the award of the B.Sc. degree passing in all subjects pertaining to semesters the 3 to 6 in his/her first appearance within 4 consecutive semesters (2 academic years) and in addition secures a CGPA of 8.50 and above for the semesters 3 to 6 shall be declared to have passed the examination in **FIRST CLASS** with **DISTINCTION**.

ii) A candidate who qualifies for the award of the B.Sc. degree by passing in all subjects relating to semesters 3 to 6 within a maximum period of six semesters after his/her commencement of study in the third semester and in addition secures CGPA not less than 6.5 shall declared to have passed the examination in **FIRST CLASS.**

iii) All other candidates who qualify for the award of B.Sc. degree shall be declared to have passed the examination in **SECOND CLASS**.

2.2 Re-entry to complete the program

A student exiting with B.Sc. should be entitled to re-enrol in the programme of the same Engineering discipline. Only students admitted to the B.Tech. programme and exercised an exit option are eligible for readmission to the B.Tech. programme under the same discipline. It is suggested that all credits will be transferred, if the student enrols back within a limited period (3 years) of exiting. In case a student enrols after that, then the decision on the transfer of credits should be based on the changes in the curriculum the student studied. A candidate after exit may rejoin the course only at the commencement of the semester at which he/she discontinued, provided he/she pays the prescribed fees to the University. The total period of completion of the B.Tech. course reckoned from the commencement of the first semester to which the candidate was admitted shall not in any case exceed 7 years, including of the period of discontinuance.

2.3 Completion Possibility in other Institutions

A student can earn B.Sc. in one institution (Engineering) and complete the degree program in another institution (same Engineering discipline only).

(Note: If these exit options are accepted for multipleB.Tech. programs, it is suggested that AICTE actively communicate these to the industry and other bodies, so they recognize these and accept them as bona-fide credentials for the purposes of recruitment and/or eligibility for admission to programs, appearing in competitive examinations, etc.)

14. Revision of Regulations and Curriculum:

The University may from time-to-time revise, amend or change the regulations of curriculum and syllabus as and when found necessary.

GENERAL COURSE STRUCTURE

&

CREDIT DISTRIBUTION

GENERAL COURSE STRUCTURE & CREDIT DISTRIBUTION

A. Definition of Credit:

1 Hr. Lecture (L)	1 Credit
1 Hr. Tutorial (T)	1 Credit
1 Hr. Practical (P)	0.5 Credit

B. Required Credits: In the light of the fact that a typical Model Four-year Under Graduate degree program in Engineering has about 160 credits, the total number of credits proposed for the four-year B. Tech in Robotics and Automation is kept as 160.

C. Structure of UG Program in RA: The structure of UG program in Robotics and Automation shall have essentially the following categories of courses with the breakup of credits as given:

S. No	Category	Credit Breakup for RA students	Percentage of Credit Breakup for RA students
1	Humanities and Social Sciences including Management courses	15	9%
2	Basic Science courses	26	16%
3	Engineering Science courses including workshop, drawing, basicsof electronics/electrical/mechanical/computer etc.	14	9%
4	Professional core courses	61	38%
5	Professional Elective courses relevant to chosen specialization/branch	12	8%
6	Open subjects – Electives from other technical and /or emergingsubjects	12	8%
7	Project work, seminar and internship in industry or elsewhere	20	12%
8	Mandatory Courses [Environmental Sciences, Induction Program, Indian Constitution,Essence of Indian Knowledge Tradition]	(non-credit)	-
	Total	**160**	**100%**

D. Course code and definition:

Course code	Definitions
BSC	Basic Science Courses
ESC	Engineering Science Courses
HSMC	Humanities and Social Sciences including Management courses
PCC	Professional core courses
PEC	Professional Elective courses
OEC	Open Elective courses
MC	Mandatory courses

- **Course level coding scheme:** Three-digit number (odd numbers are for the odd semester courses and even numbers are for even semester courses) used as suffix with the Course Code for identifying the level of the course. Digit at hundred's place signifies the year in which course is offered. e.g.

  101, 102 … etc., for first year.

  201, 202 …etc., for second year.

  301, 302 … etc., for third year.

  401, 402 … etc., for fourth year.

- Category-wise Courses

HUMANITIES & SOCIAL SCIENCES COURSES [HS]

(i) Number of Humanities & Social Science Courses: 6

(ii) Credits: 15

S. No	Code No.	Course Title	Semester	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1.	HSMC-101	English for Technical Writing	II	2	0	2	3
2.	HSMC-102	Universal Human Values	II	2	1	0	3
3.	HSMC-201	Life Skills	III	2	0	0	0
4.	HSMC-202	Management (Organizational Behaviour/ Finance & Accounting)	IV	3	0	0	3
5.	HSMC-301	Humanities – I	V	3	0	0	3
6.	HSMC-401	Humanities – II	VII	3	0	0	3
Total Credits							**15**

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BASIC SCIENCE COURSE [BSC]

(i) Number of Basic Science Courses:9

(ii) Credits: 26

S. No	Code No.	Course Title	Semester	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1.	BSCT-101	Chemistry	I	3	0	0	3
2.	BSCP-101	Chemistry Lab	I	0	0	2	1
3.	BSCT-102	Mathematics-I	I	3	1	0	4
4.	BSCT-103	Biology for Engineers	I	3	0	0	3
5.	BSCT-104	Physics	II	3	1	0	4
6.	BSCP-104	Physics Lab	II	0	0	2	1
7.	BSCT-105	Mathematics-II	II	3	1	0	4
8.	BSCT-201	Mathematics-III	III	2	1	0	3
9.	BSCT-202	Mathematics-IV	IV	2	1	0	3
Total Credits							**26**

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ENGINEERING SCIENCE COURSE [ESC]

(i) Number of Engineering Science Courses:7

(ii) Credits: 14

S. No	Code No.	Course Title	Semester	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1.	ESCP-101	Engineering Graphics & Design	I	1	0	4	3
2.	ESCT-102	Programming for Problem Solving	I	3	0	3	3
3.	ESCP-102	Programming for Problem Solving Lab	I	0	0	2	1
4.	ESCP-103	Design Thinking	I	0	0	2	1
5.	ESCT-104	Basic Electrical Engineering	II	2	1	0	3
6.	ESCP-104	Basic Electrical Engineering Lab	II	0	0	2	1
7.	ESCP-105	Digital Fabrication	II	0	0	4	2
Total Credits							**14**

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PROFESSIONAL CORE COURSES [PCC]

(i) Number of Professional Core Courses: 26

(ii) Credits: 61

S No	Code No.	Course Title	Semester	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1.	RAT-201	Power Electronics and Drives	III	3	0	0	3
2.	RAT -202	Analog Electronics and Circuits	III	3	0	0	3
3.	RAT-203	Strength of Materials	III	3	0	0	3
4.	RAT -204	Electronic Devices	III	3	0	0	3
5.	RAP -205	Electronic Devices Lab	III	0	0	2	1
6.	RAT -206	Sensors and Instrumentation	III	3	0	0	3
7.	RAP -207	Sensors and Instrumentation Lab	III	0	0	2	1
8.	RAT-208	Control Systems	IV	3	0	0	3
9.	RAP-209	Control Systems Lab	IV	0	0	2	1
10.	RAT-210	Robotics	IV	3	0	0	3
11.	RAP-211	Robotics Lab	IV	0	0	2	1
12.	RAT-212	Hydraulics and Pneumatics	IV	3	0	0	3
13.	RAP-213	Hydraulics and Pneumatics Lab	IV	0	0	2	1
14.	RAT-301	Signals & Systems	V	3	1	0	4
15.	RAT-302	Kinematics and Dynamics of Machines	V	3	1	0	4
16.	RAT- 303	Digital Electronics	V	3	0	0	3
17.	RAP-304	Digital Electronics Lab	V	0	0	2	1
18.	RAT -305	Microcontroller and Embedded Systems	V	3	0	0	3
19.	RAP-306	Microcontroller and Embedded Systems Lab	V	0	0	2	1
20.	RAT-307	Programmable Logic Controller	V	3	0	0	3
21.	RAP-308	Programmable Logic Controller Lab	V	0	0	2	1
22.	RAT-309	Mechatronics	VI	3	1	0	4

23.	RAT-310	Robotic Control Systems	VI	3	0	0	3
24.	RAP - 311	Robotic Control Systems Lab	VI	0	0	2	1
25.	RAT - 312	Programming for Robotics	VI	3	0	0	3
26.	RAP - 313	Programming for Robotics Lab	VI	0	0	2	1
Total Credits							61

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PROFESSIONAL ELECTIVE COURSES [PEC]

(i) Number of Professional Elective Courses: 4

(ii)Credits: 12

S.No	Code No.	Course Title	Semester	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1	PECT-1	Professional Elective-I	VI	3	0	0	3
2	PECT-2	Professional Elective-II	VII	3	0	0	3
3	PECT-3	Professional Elective-III	VII	3	0	0	3
4	PECT-4	Professional Elective- IV	VIII	3	0	0	3
						Total Credits	**12**

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OPEN ELECTIVE COURSES [OEC]

(i) Number of Open Elective Courses: 4

(ii)Credits: 12

S.No	Code No.	Course Title	Semester	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1	OECT-1	Open Elective-I	VI	3	0	0	3
2	OECT-2	Open Elective-II	VII	3	0	0	3
3	OECT-3	Open Elective-III	VII	3	0	0	3
4	OECT-4	Open Elective-IV	VIII	3	0	0	3
						Total Credits	**12**

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PROJECT

(i) Number of PROJECT: 5

(ii)Credits: 20

S. No	Course Code	Course Title	Semester	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1	PROJ RA-201	Micro Project	IV	0	0	4	2
2	PROJ RA-301	Mini Project	VI	0	0	6	3
3	PROJ RA-401	Seminar	VII	0	0	2	1
4	PROJ RA-402	Internship	VII	0	0	4	2
5	PROJ RA-403	Project and Viva-Voce	VIII	0	0	24	12
Total Credits							**20**

INDUCTION PROGRAM

The Essence and Details of Induction program can also be understood from the 'Detailed Guide on Student Induction program', as available on AICTE Portal, (Link:https://www.aicteindia.org/sites/default/files/Detailed%20Guide%20on%20Student%20Induction%20program.pdf). For more, Refer **Appendix II.**

Induction program (mandatory)	**Three-week duration**

Induction program (mandatory)	**Three-week duration**
Induction program for students to be offered right at the start of the first year.	• Physical activity • Creative Arts • Universal Human Values • Literary • Proficiency Modules • Lectures by Eminent People • Visits to local Areas • Familiarization to Dept./Branch & Innovations

A. Mandatory Visits/ Workshop/Expert Lectures:

a. It is mandatory to arrange one industrial visit every semester for the students of eachbranch.

b. It is mandatory to conduct a One-week workshop during the winter break after fifthsemester on professional/ industry/ entrepreneurial orientation.

c. It is mandatory to organize at least one expert lecture per semester for each branchby inviting resource persons from domain specific industry.

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SEMESTER WISE STRUCTURE

Semester I									
3-Weeks Induction Programme (UHV-I)									
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credit**	**Marks**		
							IA	**UE**	**TM**
1.	BSCT-101	Chemistry	3	0	0	3	40	60	100
2.	BSCP-101	Chemistry Laboratory	0	0	2	1	60	40	100
3.	BSCT-102	Mathematics-I	3	1	0	4	40	60	100
4.	ESCP-101	Engineering Graphics & Design	1	0	4	3	60	40	100
5.	ESCT-102	Programming for Problem Solving	3	0	0	3	40	60	100
6.	ESCP-102	Programming for Problem Solving Laboratory	0	0	2	1	60	40	100
7.	BSCT-103	Biology for Engineers	3	0	0	3	40	60	100
8.	ESCP-103	Design Thinking	0	0	2	1	60	40	100
9.	AU-101^	IDEA Lab Workshop	2	0	4	0	-	-	-
Total						**19**	400	400	800
Note: ^ represents "Audit Course".									

Semester II									
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credit**	**Marks**		
							IA	**UE**	**TM**
1.	BSCT-104	Physics	3	1	0	4	40	60	100
2.	BSCP-104	Physics Laboratory	0	0	2	1	60	40	100
3.	BSCT-105	Mathematics-II	3	1	0	4	40	60	100
4.	ESCT-104	Basic Electrical Engineering	2	1	0	3	40	60	100
5.	ESCP-104	Basic Electrical Engineering Laboratory	0	0	2	1	60	40	100
6.	ESCP-105	Digital Fabrication	0	0	4	2	60	40	100
7.	HSMC-101	English for Technical Writing	2	0	2	3	60	40	100
8.	HSMC-102	Universal Human Values -II	2	1	0	3	60	40	100
9.	AU-102^	Sports and Yoga	1	0	1	0	-	-	-
Total						**21**	420	380	800
Note: ^ represents "Audit Course".									

Semester III									
S.No	**Course Code**	**Course Title**	**Periods**				**Marks**		
			L	**T**	**P**	**Credits**	**IA**	**UE**	**TM**
1.	BSCT-201	Mathematics-III	2	1	0	3	40	60	100
2.	RAT-201	Power Electronics and Drives	3	0	0	3	40	60	100
3.	RAT-202	Analog Electronics and Circuits	3	0	0	3	40	60	100
4.	RAT-203	Strength of Materials	3	0	0	3	40	60	100
5.	RAT-204	Electronic Devices	3	0	0	3	40	60	100
6.	RAP-205	Electronic Devices Lab	0	0	2	1	60	40	100
7.	RAT-206	Sensors and Instrumentation	3	0	0	3	40	60	100
8.	RAP-207	Sensors and Instrumentation Lab	0	0	2	1	60	40	100
9.	HSMC-201	Life Skills	2	0	0	0	100	-	100
					Total	**20**	**460**	**440**	**900**

Semester IV									
			Periods				**Marks**		
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credits**	**IA**	**UE**	**TM**
1.	BSCT- 202	Mathematics-IV	2	1	0	3	40	60	100
2.	RAT-208	Control Systems	3	0	0	3	40	60	100
3.	RAP-209	Control Systems Lab	0	0	2	1	60	40	100
4.	RAT-210	Robotics	3	0	0	3	40	60	100
5.	RAP-211	Robotics Lab	0	0	2	1	60	40	100
6.	RAT -212	Hydraulics and Pneumatics	3	0	0	3	40	60	100
7.	RAP-213	Hydraulics and Pneumatics Lab	0	0	2	1	60	40	100
8.	PROJ RA - 201	Micro project	0	0	4	2	60	40	100
9.	HSMC-202	Management (Organizational Behaviour/ Finance & Accounting)	3	0	0	3	40	60	100
10.	AU-201	Environmental Sciences	2	0	0	0	100	-	100
					Total	**20**	**540**	**460**	**1000**

Note: Student should pass following two additional courses in either design stream or manufacturing stream to qualify for certification with 3 credits for each course.

a) Robotic Operating System
b) Solidworks

OR

Two months Internship for 6 credits

Semester V									
			Periods				Marks		
S.No	Course Code	Course Title	L	T	P	Credits	IA	UE	TM
1.	RAT-301	Signals and Systems	3	1	0	4	40	60	100
2.	RAT -302	Kinematics and Dynamics of Machines	3	1	0	4	40	60	100
3.	RAT -303	Digital Electronics	3	0	0	3	40	60	100
4.	RAP -304	Digital Electronics Lab	0	0	2	1	60	40	100
5.	RAT -305	Microcontroller and Embedded Systems	3	0	0	3	40	60	100
6.	RAP -306	Microcontroller and Embedded Systems Lab	0	0	2	1	60	40	100
7.	RAT -307	Programmable Logic Controller	3	0	0	3	40	60	100
8.	RAP -308	Programmable Logic Controller Lab	0	0	2	1	60	40	100
9.	HSMC-301	Humanities - I	3	0	0	3	40	60	100
10	AU-301	Professional Ethics	2	0	0	0	100	-	100
Total						**23**	**520**	**480**	**1000**

Semester VI									
			Periods				Marks		
S.No	Course Code	Course Title	L	T	P	Credits	IA	UE	TM
1.	RAT -309	Mechatronics	3	1	0	4	40	60	100
2.	RAT -310	Robotic Control Systems	3	0	0	3	40	60	100
3.	RAP -311	Robotic Control Systems Lab	0	0	2	1	60	40	100
4.	RAT -312	Programming for Robotics	3	0	0	3	40	60	100
5.	RAP -313	Programming for Robotics Lab	0	0	2	1	60	40	100
6.	PECT-1	Professional Elective-I	3	0	0	3	40	60	100
7.	OECT-1	Open Elective-I	3	0	0	3	40	60	100
8.	PROJ RA -301	Mini project	0	0	6	3	60	40	100
9.	AU-302	Indian Constitution	2	0	0	0	100	-	100
Total						**21**	**480**	**420**	**900**

Note: Student should pass following two additional courses in either design stream or manufacturing stream to qualify for certification with 3 credits for each course.

a) Robotic Process Automation
b) Interfacing Sensors with Robot controller

OR

Two months Internship for 6 credits

Semester VII									
			Periods				Marks		
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credits**	**IA**	**UE**	**TM**
1.	PECT-2	Professional Elective-II	3	0	0	3	40	60	100
2.	PECT-3	Professional Elective-III	3	0	0	3	40	60	100
3.	OECT-2	Open Elective-II	3	0	0	3	40	60	100
4.	OECT-3	Open Elective-III	3	0	0	3	40	60	100
5.	HSMC-401	Humanities - II	3	0	0	3	40	60	100
6.	PROJ RA -401	Seminar	0	0	2	1	100	-	100
7.	PROJ RA -402	Internship	0	0	4	2	100	-	100
8.	AU-401	Indian Knowledge System	2	0	0	0	100	-	100
Total			**17**	**-**	**6**	**18**	**500**	**300**	**800**
Note - Minimum 6 weeks Internship after the sixth semester									

Semester VIII									
			Periods				Marks		
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credits**	**IA**	**UE**	**TM**
1.	PECT-4	Professional Elective- IV	3	0	0	3	40	60	100
2.	OECT-4	Open Elective-IV	3	0	0	3	40	60	100
3.	PROJ RA -403	Project and Viva -Voce	0	0	24	12	60	40	100
Total			**6**	**-**	**24**	**18**	**140**	**160**	**300**

NOTE - In case of semester-long project work done in industry the PEC-04 and OEC-04 may be offered in online mode.

PROFESSIONAL ELECTIVE COURSES

S.No	Course Code	Course Title	Periods				Marks		
			L	T	P	Credits	IA	UE	TM
1.	RAEL- 1	Industrial Networking	3	0	0	3	40	60	100
2.	RAEL-2	Field and Service Robotics	3	0	0	3	40	60	100
3.	RAEL-3	Drone Technologies	3	0	0	3	40	60	100
4.	RAEL-4	Design of Mechanical Transmission Systems	3	0	0	3	40	60	100
5.	RAEL-5	Design of Robot Elements	3	0	0	3	40	60	100
6.	RAEL-6	Automation System Design	3	0	0	3	40	60	100
7.	RAEL-7	Vision Guided Robotics	3	0	0	3	40	60	100
8.	RAEL-8	Medical Robotics	3	0	0	3	40	60	100
9.	RAEL-9	Agricultural Robotics and Automation	3	0	0	3	40	60	100
10.	RAEL-10	COBOT (Collaborative Robotics)	3	0	0	3	40	60	100
11.	RAEL-11	CNC and Metrology	3	0	0	3	40	60	100
12.	RAEL-12	Totally Integrated Automation	3	0	0	3	40	60	100

OPEN ELECTIVE COURSES

S.No	Course Code	Course Title	Periods				Marks		
			L	T	P	Credits	IA	UE	TM
1.	RAOE - 1	Robot Operating Systems	3	0	0	3	40	60	100
2.	RAOE - 2	UAV and Underwater Robotics	3	0	0	3	40	60	100
3.	RAOE - 3	Industrial IoT and Automation	3	0	0	3	40	60	100
4.	RAOE - 4	Cognitive Robotics	3	0	0	3	40	60	100
5.	RAOE - 5	Industrial Drives for Automation	3	0	0	3	40	60	100
6.	RAOE - 6	Applied Robotics	3	0	0	3	40	60	100
7.	RAOE -7	Robotic Process Automation and Development	3	0	0	3	40	60	100
8.	RAOE -8	Industrial Robotics and Material Handling Systems	3	0	0	3	40	60	100
9.	RAOE -9	Micro Robotics	3	0	0	3	40	60	100
10.	RAOE -10	Robot Vision and Intelligence	3	0	0	3	40	60	100
11.	RAOE -11	Artificial Intelligence for Robotics	3	0	0	3	40	60	100
12.	RAOE -12	Humanoid Robotics	3	0	0	3	40	60	100

S.No	Course Category	I	II	III	IV	V	VI	VII	VIII	Total Credits
1	**HSMC**	-	6	-	3	3	-	3	-	15
2	**BSC**	11	9	3	3	-	-	-	-	26
3	**ESC**	8	6	-	-	-	-	-	-	14
4	**PCC**	-	-	17	12	20	12	-	-	61
5	**PEC**	-	-	-	-	-	3	6	3	12
6	**OEC**	-	-	-	-	-	3	6	3	12
7	**PROJ**	-	-	-	2	-	3	3	12	20
									Total Credits	**160**

HONOUR DEGREE COURSES									
S.No	**Course Code**	**Course Title**	**Periods**				**Marks**		
			L	**T**	**P**	**Credits**	**IA**	**UE**	**TM**
1.	RAHO- 1	Intelligent control of Robotic System	3	0	0	3	40	60	100
2.	RAHO-2	Automation for Robotics	3	0	0	3	40	60	100
3.	RAHO-3	Non-Linear Control of Robotics	3	0	0	3	40	60	100
4.	RAHO-4	Robotics and Automation in the Food Industry	3	0	0	3	40	60	100
5.	RAHO-5	Adaptive control of Robot Manipulator	3	0	0	3	40	60	100
6.	RAHO-6	Sliding Mode Control in Robotics	3	0	0	3	40	60	100

MINOR DEGREE COURSES FOR OTHER DEPARTMENT STUDENTS									
DRONE TECHNOLOGY									
S.No	**Course Code**	**Course Title**	**Periods**				**Marks**		
			L	**T**	**P**	**Credits**	**IA**	**UE**	**TM**
1.	RAMD- 1	Introduction to Drone Technology	3	0	0	3	40	60	100
2.	RAMD- 2	Theory of Drones	3	0	0	3	40	60	100
3.	RAMD- 3	Engineering Materials for Unmanned Aerial Vehicles	3	0	0	3	40	60	100
4.	RAMD- 4	Introduction to UAV Electronics	3	0	0	3	40	60	100
5.	RAMD-5	Drone Metrology, Assembly and Maintenance	3	0	0	3	40	60	100
6.	RAMD-6	Computer aided 3D Modeling for Drone	3	0	0	3	40	60	100

SEMESTER – I

SEMESTER I

INDUCTION PROGRAM (UHV-I)	THREE-WEEK DURATION(MANDATORY)

Objective:

The induction program for students offered at the start of the first year aims to provide a holistic and enriching experience to new students, fostering their personalgrowth, academic preparedness, and a strong sense of belonging to the institution.

The program is designed to achieve the following objectives:

1. To help students smoothly transition from school to college life.
2. To facilitate opportunities for students to interact with their peers, faculty, and staff.
3. To enhance Physical Well-being: and encouraging Creative Expression.
4. To instill Universal Human Values.
5. To develop Communication and Literary Skills, Visit Local areas and get inspiration from Eminent Personalities and thus gain Confidence to nurture a Positive Learning Environment.

The Induction program contains.

- Physical activity
- Creative Arts
- Universal Human Values
- Literary
- Proficiency Modules
- Lectures by Eminent People
- Visits to local Areas
- Familiarization to Dept./Branch & Innovations

The Essence and Details of Induction program can also be understood from the "Detailed Guide on Student Induction program", as available on AICTE Portal,

(Link:https://www.aicteindia.org/sites/default/files/Detailed%20Guide%20on%20Student%20I nduction%20program.pdf).

BSCT-101	CHEMISTRY	3L:0T:0P	3 Credits

Course Objectives:

- To acquaint the students with basic concepts of chemistry in understanding the atomic & molecular structure and its nanoscale applications.
- To understand the fundamental concepts of various spectroscopic techniques and applications.
- To understand the basic electrochemical properties such as thermodynamic functions, cell potentials, lead storage batteries, corrosion and phase rule.
- To describe and explain the observed trends in atomic size, ionization energy, and electron affinity of the elements.
- To identify the various types, preparation and applications of polymer used in the industrial processes.

Course Contents:

MODULE I - ATOMIC AND MOLECULAR STRUCTURE: 9 Hours

Atomic and Molecular Structure: Molecular orbital‟s of diatomic molecules. Band theory of solids. Liquid crystal and its applications. Point defects in solids. Structure and applications of Graphite and Fullerenes. Concepts of Nanomaterials and its application

MODULE II - SPECTROSCOPIC TECHNIQUES AND APPLICATIONS: 9 Hours

Principles of spectroscopy and selection rules. Electronic spectroscopy. Fluorescence and its applications in medicine. Elementary idea and simple applications of Rotational, Vibrational, Ultravoilet & Visible and Raman spectroscopy.

MODULE III – ELECTRO CHEMISTRY: 9 Hours

Thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies. Free energy and EMF. Cell potentials, Nernst Equation and application, Lead storage battery. Corrosion; causes, effects and its prevention. Phase Rule and its application to water system.

MODULE IV - PERIODIC PROPERTIES 9 Hours

Effective nuclear charge, penetration of orbital‟s, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electro-negativity, polarizability, oxidation states, coordination numbers and geometries, hard soft acids and bases, molecular geometries.

MODULE V – POLYMER: 9 Hours

Basic concepts of polymer-Blend and composites, Conducting and biodegradable polymers. Preparation and application of some industrially important polymers (BunaS, Buna-N, Neoprene, Nylon-6, nylon-6,6 and Terylene). General methods of synthesis of organometallic compounds (Grignard reagent) and their applications.

Total No. of Hours: 45

Text Books:

1. B. H. Mahan, "University chemistry" Pearson Education, 2009.
2. C.N.R. Rao, "University Chemistry" World Scientific Publishing Company, 2009
3. M. J. Sienko and R. A. Plane, "Chemistry: Principles and Applications" McGraw-Hill, 3rd edition 1980.

Reference Books:

1. C. N. Banwell, "Fundamentals of Molecular Spectroscopy" McGraw-Hill Book Company, 1983.
2. B. L. Tembe, Kamaluddin and M. S. Krishnan, "Engineering Chemistry (NPTELWeb-book).
3. P. W. Atkins, Julio de Paula, "Physical Chemistry" Oxford University Press, 2018

Course Outcomes:

On successful completion of this course, the students will be able to,

- Get an understanding of the theoretical principles understanding molecular structure, bonding and properties
- Distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques
- Understand and explain the thermodynamic functions and cell potentials for different applications.
- Rationalize specific models and processes for better understanding of material properties and applications.
- Learn the synthesis of various industrially important polymer and its applications.

BSCP-101	CHEMISTRY LABORATORY	0L:0T:2P	1 Credits

Course Objectives:

The Chemistry laboratory course will enable students to get a hands-on experience of determining various analysis parameters learnt in the theory course using different methods/techniques prevalent in analytical chemistry.

List of Experiments:

1. Determination of surface tension and viscosity.
2. Determination of chloride content of water.
3. Determination of cell constant and conductance of solutions.
4. Potentiometry - determination of redox potentials and emfs
5. Synthesis of a polymer/drug.
6. Determination of the partition coefficient of a substance between two immiscible liquids.
7. Saponification/acid value of oil.
8. Chemical analysis of a salt.
9. Lattice structures and packing of spheres.
10. Spectrophotometry: Beer-Lambert‟s law verification and determination of strength of unknown solution.
11. Thin layer chromatography.
12. Ion exchange column for removal of hardness of water.
13. The pH of minimum viscosity for gelatin sols and/or coagulation of the whitepart of egg

REFERENCES:

Virtual Labs

SL. No.	Experiment Name	Experiment Link(s)
1	Determination of surface tension and viscosity.	http://pcv-au.vlabs.ac.in/physical-chemistry/Determination_of_Viscosity_of_Organic_Solvents/
2	Ion exchange column for removal of hardness of water.	http://icv-au.vlabs.ac.in/inorganic-chemistry/Water_Analysis_Determination_of_Chemical_Parameters/
3	Determination of chloride content of water.	http://vlabs.iitb.ac.in/vlabs-dev/labs/nitk_labs/Environmental_Engineering_1/experiments/determination-of-chloride-nitk/simulation.html
4	Colligative properties using freezing point depression.	http://pcv-au.vlabs.ac.in/physical-chemistry/Cryoscopy/
5	Determination of the rate constant of are action.	http://pcv-au.vlabs.ac.in/physical-chemistry/EMF_Measurement/

6	Determination of cell constant	http://icv-au.vlabs.ac.in/inorganic-chemistry/Water_Analysis_Determination_of_Physical_Parameters/
7	Potentiometry - determination of redoxpotentials and EMFs.	http://pcv-au.vlabs.ac.in/physical-chemistry/EMF_Measurement/
8	Saponification/acid value of an oil.	http://biotech01.vlabs.ac.in/bio-chemistry/Estimation_of_Saponification_Value_of_Fats_or_Oils/
9	Lattice structures and packing ofspheres.	https://vlab.amrita.edu/?sub=1&brch=282&sim=370&cnt=1

Text Books:

1. B. H.Mahan, & Rollie J Meyers , "University chemistry" Pearson Education India; 4th edition (1 January 2009).
2. M.J.Sienkoand R.A.Plane,Ann Arbor, "Principles and Applications" Mich: Edwards Bros., 1955.

Reference Books:

1. B. L. Tembe, Kamaluddin and M. S. Krishnan, "Engineering Chemistry (NPTEL Web-book).
2. P. W. Atkins, Julio de Paula, "Physical Chemistry" Oxford University Press, International Eleventh edition, 2018.
3. K. Peter C. Vollhardt & Neil E. Schore, "Organic Chemistry: Structure and Function" 5th Edition December 28, 2005

Course Outcome:

The Chemistry laboratory course aims at developing abilities in combining chemical principles alongside handling instruments/techniques and synthesis methodologies to facilitate good understanding of the subject.

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BSCT-102	MATHEMATICS-I	3L:1T:0P	4 Credits

Course Objective:

- To comprehend the mathematical concepts of matrices, ordinary differential equations, multivariable calculusand problem-solving.

Course Contents:

MODULE I LINEAR ALGEBRA(MATRICES) (12 Hrs)

Rank of a matrix - Consistency of a system of linear equations - Characteristic equation of a matrix - Eigen values and Eigen vectors - Properties of Eigen values and Eigen vectors - Cayley-Hamiltontheorem (excluding proof)- Verification- Application (Finding Inverse and Power of a matrix)- Diagonalization of a matrix by orthogonal and similarity transformation- Quadratic form – Nature of Quadratic Form- Orthogonal reduction of quadratic form to canonical form.

MODULE II ORDINARY DIFFERENTIAL EQUATIONS (12 Hrs)

Differential Equations of First Order- Exact equations- Leibnitz's linear equations- Bernoulli's equation- Equations solvable for p- Clairaut's equation- Differential equations of Higher order- Linear differential equations of higher order with constant coefficients- Euler's linear equation of higher order with variable coefficients- Method of variation of parameters.

MODULE III MULTIVARIABLE CALCULUS (DIFFERENTIATION) (12 Hrs)

Partial differentiation- Partial derivatives of first order and higher order- Partial differentiation of implicit functions- Euler's theorem on homogeneous functions - Total derivative - Jacobian Properties - Taylor's series for functions of two variables- Maxima and minima of functions of two variables.

MODULE IV MULTIVARIABLE CALCULUS (MULTIPLE INTEGRALS) (12 Hrs)

Double integration (Cartesian form and Polar form)-constant limits- variable limits- over the region R- Change of variables in double integrals (Cartesian to polar)- Appli- cation of double integral- Area by double integration- Change of Order of Integration- Triple Integration (Cartesian- Spherical and Cylindrical)-constant limits- variable limits- over the region R- Application of triple integral- Volume by triple integration.

MODULE V MULTIVARIABLE CALCULUS (VECTOR CALCULUS) (12 Hrs)

Vector Differential Operator- Gradient - Properties -Directional derivative - Divergence and curl Properties and relations- Solenoidal and Irrotational vector fields - Line integral and Surface integrals - Integral Theorems (excluding Proof) - Green's theorem - Stoke's theorem - Gauss divergence theorem.

Text Books:

1. Veerarajan T., "Engineering Mathematics - I & II ", Tata McGraw-Hill, New Delhi, 2014 &; 2015.
2. Dr. M.K. Venkataraman, "Engineering Mathematics – Volume I and Volume II", The National PublishingCompany, Chennai 2008.

References:

1. Grewal B.S., “Higher Engineering Mathematics”, Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. Bali N.P and Manish Goyal., “A Text Book of Engineering Mathematics”, Laxmi Publications(P) Ltd, 2011.
3. Erwin Kreyszig, “Advanced Engineering Mathematics”, John Wiley & Sons, New Delhi, 9th Edition, 2011
4. Ramana B.V., “Higher Engineering Mathematics”, Tata McGraw-Hill, New Delhi, 2010.

ONLINE / NPTEL Courses:

1. Differential equations for engineers: https://nptel.ac.in/courses/111106100
2. Calculus of Several Real Variables: https://nptel.ac.in/courses/111104125
3. Engineering Mathematics - I: https://nptel.ac.in/courses/111105121
4. Matrix Analysis with Applications: https://nptel.ac.in/courses/111107112

Course Outcomes:

- To solve practical problems using Matrix algebra.
- To solve various types of ordinary differential equations, including higher-order linear equation.
- To compute partial derivatives, determine total derivatives, Jacobians, employ Taylor series, and find extremesof functions of two variables.
- To demonstrate proficiency in evaluating double integration and triple integration and using them to computearea and volume.
- To apply Green’s theorem, Stoke’s theorem and Gauss divergence theorem.

ESCP-101	ENGINEERING GRAPHICS & DESIGN	1L:0T:4P	3 Credits

Course Objectives:

- To provide the basic knowledge about Engineering Drawing.
- To learn the concepts of projections, technical drawing, dimensioning and specifications
- To understand the engineering graphics standards and solid modeling.
- To learn the analysis of Isometric views
- To understand the basic concepts of computer aided drafting hardware and its importance in the field of engineering and design.

Course Contents:

MODULE I- INTRODUCTION:

Introduction, Conics and Special Curves

MODULE II- PROJECTIONS:

Projection of points, lines and planes

MODULE III- SOLIDS:

Projection of solids, section of solids, development of surface

MODULE IV- ISOMETRIC PROJECTIONS:

Isometric and Orthographic projections

MODULE V- AUTOCAD:

Introduction to computer Aided Drafting hardware overview of application software – 2D drafting commands (Auto CAD) for simple shapes – Dimensioning

Text Books:

1. Bhatt N.D., Panchal V.M. & Ingle P.R., "Engineering Drawing" Charotar Publishing House (2014).
2. Shah, M.B. & Rana B.C., "Engineering Drawing and Computer Graphics" Pearson Education (2008).
3. Agrawal B. & Agrawal C. M., "Engineering Graphics" TMH Publication, 2012.
4. K. Venugopal, "Engineering Drawing and Graphics + Auto CAD" 4th edition, New Age International Publication Ltd., 2004

Reference Books:

1. Narayana, K.L. & P Kannaiah, "Text book on Engineering Drawing" Scitech Publishers, 2008.
2. CAD Software Theory and User Manuals.

Course Outcomes:

On successful completion of this course, the students will be able to

- Describe engineering design and its place in society.
- Discuss the visual aspects of engineering design.
- Use engineering graphics standards.
- Illustrate solid modelling.
- Use computer-aided geometric design.
- Design creating working drawings.

ESCT-102	PROGRAMMING FOR PROBLEM SOLVING	3L:0T:0P	3 Credits

Course Objectives:

- To learn the fundamentals of computers.
- To understand the various steps in program development.
- To learn the syntax and semantics of any programming language.
- To learn the usage of structured programming approach in solving problems.
- To understated and formulate algorithm for programming script
- To analyze the output based on the given input variables

Course Contents:

MODULE I - INTRODUCTION TO PROGRAMMING: 6 Hours

Introduction to components of a computer system: - disks, memory, processor, where a program is stored and executed, operating system, compilers etc. Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithms Flowchart/Pseudocode with examples.

MODULE II- ALGORITHMS TO PROGRAMS: 6 Hours

Source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code. Arithmetic expressions and precedence. Conditional Branching and Loops. Writing and evaluation of conditionals and consequent branching. Iteration and loops.

MODULE III - INTRODUCTION TO ARRAYS AND APPLICATIONS: 6 Hours

Arrays, Arrays (1-D, 2-D), Character arrays and Strings, Basic Algorithms, Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexity through example programs (no formal definition required)

MODULE IV – FUNCTIONS: 6 Hours

Functions (including using built in libraries), Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference. Recursion as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc.Quick sort or Merge sort.

MODULE V – STRUCTURES AND POINTERS: 6 Hours

Defining structures and Array of Structures. Pointers, Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation), File handling.

Total No. of Hours: 30

Text Books:

1. Byron Gottfried, Schaum's, “Outline of Programming with C”, McGraw-Hill. 1996
2. E. Balaguruswamy, “Programming in ANSI C” Tata McGraw-Hill. 2019

Reference Books:

1. Brian W. Kernighan and Dennis M. Ritchie, “ The C Programming Language” Prentice Hall of India. Second Edition 2015.

Course Outcomes:

Upon successful completion of the course, students should be able to:

- Formulate simple algorithms for arithmetic and logical problems and translate the algorithms to programs and execute the programs and correct syntax and logical errors.
- Discuss the use of arrays for to work with arrays, strings, and basic data structures like linked lists, queues, and stacks.
- Understand the use of functions in the programming language.
- Discuss the arrays and its significance in the programming language with involving arrayconcepts.
- Implement the use of pointers and implementation of memory and handling of files in any programming.

ESCP-102	PROGRAMMING FOR PROBLEM SOLVING LABORATORY	0L:0T:2P	1 Credit

Course Objectives:

- Introduce students to the fundamental concepts of the any programming language,including variables, data types, operators, and control structures.
- Introduce problem-solving techniques and algorithms to approach and solveprogramming challenges efficiently.
- Develop proficiency in writing any programs to implement algorithms and solvecomputational problems.
- Introduce students to basic data structures in any, such as arrays, strings, and pointers,and guide them in applying these structures to solve problems effectively.

List of Experiments:

1. Familiarization with programming environment
2. Simple computational problems using arithmetic expressions
3. Problems involving if-then-else structures
4. Iterative problems e.g., sum of series
5. 1D Array manipulation
6. Matrix problems, String operations
7. Simple functions
8. Programming for solving Numerical methods problems
9. Recursive functions
10. Pointers and structures
11. File operations

Course Outcomes:

Upon successful completion of the course, students should be able to:

- Demonstrate the problem solving skills through programming simple logics.
- Demonstrate the array concepts and memory management through programming.
- Illustrate the pointers and file operations through programming.

References:

Virtual Labs

S. No	Experiment Name	Experiment Link(s)
1	Simple computational problems using arithmetic expressions.	http://ps-iiith.vlabs.ac.in/exp7/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab
2	Iterative problems e.g., sum of series.	http://ps-iiith.vlabs.ac.in/exp4/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab
3	1D Array manipulation.	http://cse02- iiith.vlabs.ac.in/exp4/index.html
4	Matrix problems, String operations.	http://ps-iiith.vlabs.ac.in/exp5/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab
5	Simple functions.	http://cse02- iiith.vlabs.ac.in/exp2/index.html
6	Programming for solving Numerical methods problems.	http://ps-iiith.vlabs.ac.in/exp1/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab
7	Recursive functions.	http://ps-iiith.vlabs.ac.in/exp6/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab

BSCT-103	BIOLOGY FOR ENGINEERS	3L:0T:0P	3 Credits

Course Objectives:

- To familiarize the students with the basic biological concepts and their engineering applications.
- To develop the interdisciplinary vision of biological engineering.
- Familiarize engineering students with the principles of microbiology, including the structure and function of microorganisms, their significance in various engineering applications, and techniques for microbial analysis and identification.

Course Contents:

MODULE I - INTRODUCTION AND CLASSIFICATION OF BIOLOGICAL SCIENCE: 9 Hours

Bring out the fundamental differences between science and engineering by drawing a comparison between eye and camera, Bird flying and aircraft. Biological observations of 18th Century that lead to major discoveries. Examples from Brownian motion and the origin of thermodynamics by referring to the original observation of Robert Brown and Julius Mayor. Classification based on (a) energy and carbon utilization-Autotrophs, heterotrophs, lithotropes (b) Ammonia excretion – aminotelic, uricoteliec, ureotelic (c) Habitata- acquatic or terrestrial (d) Molecular taxonomy-three major kingdoms of life.

MODULE II – GENETICS: 9 Hours

Mendel"s laws, Concept of segregation and independent assortment. Concepts of excessiveness and dominance. Concept of mapping of phenotype to genes. Discuss about the single gene disorders in humans. Discuss the concept of complementation using human genetics.

MODULE III - BIOMOLECULES AND ENZYMES: 9 Hours

Discuss - monomeric units, polymeric structures, sugars, starch and cellulose, amino acids and proteins. Enzyme classification. Mechanism of enzyme action. Enzyme kinetics and kinetic parameters.

MODULE IV - INFORMATION TRANSFER: 9 Hours

DNA as a genetic material. Hierarchy of DNA structure- from single stranded to double helix to nucleosomes. Concept of genetic code. Universality and degeneracy of genetic code. Define gene in terms of complementation and recombination. DICOM Image formats, The DNA Technology (Use and Application)Regulation Bill, 2019

MODULE V - MICROBIOLOGY ANALYSIS: 9 Hours

Proteins- structure and function. Hierarch in protein structure. Primary secondary, tertiary and quaternary structure. Proteins as enzymes, transporters, receptors and structural elements. Exothermic and endothermic versus endergonic and xergonic reactions. Synthesis of glucose from CO_2 and H_2O (Photosynthesis). Energy yielding and energy consuming reactions. Identification and classification of single celled organisms.

Total No. of Hours: 45

Text Books:

1. Conn,E.E; Stumpf,P.K; Bruening,G; Doi,R.H., "Outlines of Biochemistry" John Wiley and Sons, 2009.
2. Prescott, L.M J.P. Harley and C.A. Klein, "Microbiology" Wm C. Brown Publishers , 2nd edition 1995.

Reference Books:

1. Uma Devi Koduru, "General Biology" Khanna Book Publishing Company. 2022
2. Campbell, N. A.; Reece, J. B.; Urry, Lisa; Cain, M, L.; Wasserman, S. A.; Minorsky, P. V.; Jackson, R. B. "Biology: A global approach" Pearson Education Ltd. 12th Edition, 2020.
3. E.E; Stumpf, P.K; Bruening, G; Doi, R.H., "Outlines of Biochemistry" John Wiley and Sons. 2006.

Course Outcomes:

Upon successful completion of the course, students should be able to:

- Describe how biological observations of 18th Century that lead to major discoveries.
- Highlight the concepts of recessiveness and dominance during the passage of genetic material from parent to offspring
- Classifyenzymes and distinguish between different mechanisms of enzyme action.
- Identify DNA as a genetic material in the molecular basis of information transfer.
- Identifyand classify single celled microorganisms

ESCP-103	DESIGN THINKING	0L:0T:2P	1 Credit

Course Objectives:

- To provide the new ways of creative thinking
- To learn the innovation cycle of Design Thinking process
- To develop innovative products

Course Contents:

MODULE I - LEARNING, MEMORY AND EMOTIONS: 9 Hours

Understanding the learning process, kolb‟s learning styles, assessing and interpreting, understanding the memory process, problems in retention, memory enhancement techniques, understanding emotions: experience & expression, assessing empathy, application with peers

MODULE II - DESIGN THINKING, BEING INGENIOUS & FIXING PROBLEM: 9 Hours

Definition of design thinking, need for design thinking, objectives of design thinking, concepts& brainstorming, stages of design thinking process (explain with examples) – empathize, define, ideate, prototype, test, understanding creative thinking process, understanding problem solving, testing creative problem solving.

MODULE III: PRODUCT DESIGN, PROTOTYPING & TESTING: 9 Hours

Process of engineering product design, design thinking approach, stages of product design, examples of best product designs and functions, assignment – engineering product design, What is Prototype? Why Prototype? Rapid Prototype Development process, Testing, Sample Example, Test Group Marketing

MODULE IV: CELEBRATING THE DIFFERENCE AND CUSTOMER CENTRICITY: 9 Hours

Understanding of individual differences & uniqueness, group discussion and activities to encourage the understanding, acceptance and appreciation of individual difference. Practical examples of customer challenges, use of design thinking to enhance customer experience, parameters of product experience, alignment of customer expectations with product design.

MODULE V: FEEDBACK, RE-DESIGN & RE-CREATE: 9 Hours

Feedback loop, Focus on User Experience, Address “ergonomic challenges, User focused design, rapid prototyping & testing, final product, Final Presentation – “Solving Practical Engineering Problem through Innovative Product Design & Creative Solution”.

Total no. of Hours: 45

Course Outcomes:

On successful completion of the module students will be able to:

- Compare and classify the various learning styles and memory techniques and Apply them in their engineering education
- Analyze emotional experience and Inspect emotional expressions to better understand users while designing innovative products
- Develop new ways of creative thinking and Learn the innovation cycle of Design Thinking process for developing innovative products
- Propose real-time innovative engineering product designs and Choose appropriate frame works, strategies, techniques during prototype development
- Perceive individual differences and its impact on everyday decisions and further Create a better customer experience

AU-101	IDEA LAB WORKSHOP	2L:0T:4P	0 CREDIT

Course Objectives:

- To learn all the skills associated with the tools and inventory associated with theIDEA Lab.
- Learn useful mechanical and electronic fabrication processes.
- Learn necessary skills to build useful and standalone system/ project with enclosures.
- Learn necessary skills to create print and electronic documentation for the system /project.

MODULE	Topics
1.	Electronic component familiarization, Understanding electronic system design flow. Schematic design and PCB layout and Gerber creation using Eagle CAD. Documentation using Doxygen, Google Docs, Overleaf. Version control tools - GIT and Git Hub. Basic 2D and 3D designing using CAD tools such as Free CAD, Sketchup, Prusa Slicer, Flat CAM, Ink space, Open BSP and Veri CUT.
2.	Familiarization and use of basic measurement instruments - DSO including various triggering modes, DSO probes, DMM, LCR bridge, Signal and function generator. Logic analyzer and MSO. Bench power supply (with 4-wire output) Circuit prototyping using (a) breadboard, (b) Zero PCB (c) „Manhattan" style and (d) custom PCB. Single, double and multilayer PCBs. Single and double-sided PCB prototype fabrication in the lab. Soldering using soldering iron/station. Soldering using a temperature controlled reflow oven. Automated circuit assembly and soldering using pick and place machines.
3.	Electronic circuit building blocks including common sensors. Arduino and Raspberry Pi-programming and use. Digital Input and output. Measuring time and events. PWM. Serial communication. Analog input. Interrupts programming. Power Supply design (Linear and Switching types),Wireless power supply, USB PD, Solar panels, Battery types and charging.
4.	Discussion and implementation of a mini project.
5.	Documentation of the mini project (Report and video).

LABORATORY ACTIVITIES:

S. No.	List of Lab activities and experiments
1.	Schematic and PCB layout design of a suitable circuit, fabrication and testing of the circuit.
2.	Machining of 3D geometry on soft material such as soft wood or modeling wax.
3.	3D scanning of computer mouse geometry surface. 3D printing of scanned geometry using FDM or SLA printer.
4.	2D profile cutting of press fit box/casing in acrylic (3 or 6 mm thickness)/cardboard, MDF(2 mm) board using laser cutter & engraver.
5.	2D profile cutting on plywood /MDF (6-12 mm) for press fit designs.
6.	Familiarity and use of welding equipment.
7.	Familiarity and use of normal and wood lathe.
8.	Embedded programming using Arduino and/or Raspberry Pi.
9.	Design and implementation of a capstone project involving embedded hardware, software and machined or 3D printed enclosure.

Reference Books:

1. Chris Hackett. Weldon Owen, "The Big Book of Maker Skills: Tools & Techniques for BuildingGreat Tech Projects". 2018.
2. Sean Michael Ragan, Weldon Owen; "The Total Inventors Manual (Popular Science): TransformYour Idea into a Top-Selling Product", 2017.
3. Paul Horowitz and Winfield Hill, "The Art of Electronics". Cambridge University Press. 3rdedition. 1995.
4. Simon Monk, "Programming Arduino: Getting Started with Sketches" McGraw Hill. 2ndedition.2012.
5. Ian Gibson, David W Rosen, Brent Stucker., "Additive Manufacturing Technologies: RapidPrototyping to Direct Digital Manufacturing", Springer, 2010.
6. Chapman W.A.J, "Workshop Technology", Volume I, II, III, CBS Publishers and distributors,5th Edition,2002.

SEMESTER – II

SEMESTER – II

BSCT104	**PHYSICS**	**3L:1T:0P**	**4 Credits**

Course Objectives:

- To understand the physics of simple harmonic motion (SHM) and its applications in various fields.
- To understand the characteristics and behavior of non-dispersive transverse and longitudinal waves in one dimension and to introduce the concept of dispersion in waves and its implications.
- To understand the behavior and propagation of light and to study the principles of geometric optics and their applications.
- To understand the wave nature of light and its interactions with matter and study the principles of wave optics and their applications.
- To understand the principles and applications of lasers and study the properties and behavior of laser light.

Course Contents:

MODULE I - SIMPLE HARMONIC MOTION AND OSCILLATOR: 12 Hours

Mechanical and electrical simple harmonic oscillators, complex number notation and phasor representation of simple harmonic motion, damped harmonic oscillator – heavy, critical and light damping, energy decay in a damped harmonic oscillator, quality factor, forced mechanical and electrical oscillators, electrical and mechanical impedance, steady state motion of forced damped harmonic oscillator, power absorbed by oscillator.

MODULE II -WAVES AND INTRODUCTION TO DISPERSION: 12 Hours

Transverse wave on a string, the wave equation on a string, Harmonic waves, reflection and transmission of waves at a boundary, impedance matching, standing waves and their Eigen frequencies, longitudinal waves and the wave equation for them, acoustics waves and speed of sound, standing sound waves. Waves with dispersion, water waves, superposition of waves and Fourier method, wave groups and group velocity.

MODULE III - PROPAGATION AND GEOMETRIC OPTICS: 12 Hours

Fermat‟s principle of stationary time and its applications e.g. in explaining mirage effect, laws of reflection and refraction, Light as an electromagnetic wave and Fresnel equations, reflectance and transmittance, Brewster‟s angle, total internal reflection, and evanescent wave. Mirrors and lenses and optical instruments based on them, transfer formula and the matrix method.

MODULE IV - WAVE OPTICS: 12 Hours

Huygens‟ principle, superposition of waves and interference of light by wave front splitting

and amplitude splitting; Young‟s double slit experiment, Newton‟s rings, Michelson interferometer, Mach- Zehnder interferometer. Farunhofer diffraction from a single slit and a circular aperture, the Rayleigh criterion for limit of resolution and its application to vision; Diffraction gratings and their resolving power.

MODULE V – LASERS: 12 Hours

Einstein‟s theory of matter radiation interaction and A and B coefficients; amplification of light by population inversion, different types of lasers: gas lasers (He-Ne, CO2), solid-state lasers (ruby, Neodymium), dye lasers; Properties of laser beams: mono-chromaticity, coherence, directionality and brightness, laser speckles, applications of lasers in science, engineering and medicine.

Total No. of Hours: 60

Course Outcomes:

On successful completion of the module students will be able to:

- Solve engineering problems dealing with simple, damped, or forced harmonic oscillation and perform Fourier analysis of wave phenomena.
- Differentiate between transverse and longitudinal waves and explain their properties.
- Understand the generation and propagation of light and explain the principles of geometric optics, including reflection and refraction.
- Understand the wave nature of light and its properties, such as interference and diffraction.
- Understand the basic principles of laser operation, including population inversion and stimulated emission

Text Books:

1. Ian G. Main, “Vibrations and Waves” Physics Cambridge University Press; 3rd edition (1993).
2. H.J. Pain, “The physics of vibrations and waves” John Wiley & Sons, Ltd. Sixth Edition 2005.

Reference Books:

1. E. Hecht, “Optics” addison wesley (2001)
2. O. Svelto, “Principles of Lasers” Springer books, 2010.
3. R.N.Chaudhuri, “Waves and Oscillations” New Age International (P) Limited, 2010.

BSCP-104	PHYSICS LABORATORY	0L:0T:2P	1 Credit

Course Objectives:

- To observe and study the diffraction pattern produced by a single slit.
- To observe and study the interference pattern produced by double slits.
- To verify the wave nature of light and measure the wavelength of light.
- To measure the speed of light using a Michelson interferometer setup.
- To measure the speed of light on a tabletop using the modulation technique.

List of Experiments

1. **Single-Slit Diffraction Experiment:** A laser pointer or a beam of ordinary light is passed through a single narrow slit, and the resulting diffraction pattern is observed on a screen or a wall. The pattern will show a central maximum and alternating dark and bright fringes on both sides of the central maximum.
2. **Double-Slit Interference Experiment:** A laser or a light source is directed through two closely spaced slits. The resulting pattern on a screen or wall will show a series of alternating bright and dark fringes. This is known as an interference pattern, demonstrating the wave nature of light.
3. **Young's Double-Slit Experiment:** This is an extension of the double-slit interference experiment. By measuring the interference pattern and knowing the distance between the slits and the screen, one can determine the wavelength of light used.
4. **Michelson Interferometer (Measurement of Speed of Light):** In this experiment, a Michelson interferometer is set up, and the speed of light is measured by observing the fringe shift produced when one of the arms of the interferometer is moved.
5. **Measurement of Speed of Light using Modulation:** This experiment involves using a laser, a rotating mirror, and a photosensitive detector to measure the time taken for light to travel a known distance, allowing the speed of light to be calculated.
6. **Minimum Deviation from a Prism:** A prism is placed in a beam of light, and the angle of minimum deviation (where the emergent ray is parallel to the incident ray) is measured. Using this angle, along with the known refractive index of the surrounding medium, the refractive index of the prism material can be calculated.
7. **Lloyd's Mirror Interferometer:** In this experiment, a light source is directed towards a half-silvered mirror (Lloyd's mirror configuration), creating interference fringes by the combination of direct and reflected light.
8. Experiments to study Lasers.

Course Outcomes:

i. Comprehend the concept of interference and how waves combine constructively anddestructively to produce varying amplitudes.

ii. Understand the single-slit diffraction pattern and calculate the angles of diffraction fordifferent wavelengths and slit sizes.

iii. Understand the double-slit interference pattern and calculate fringe spacing and anglesof interference for various setups.

iv. Develop skills to analyze and interpret interference patterns resulting from differentlight sources and experimental configurations.

v. Develop a comprehensive understanding of the fundamental principles of laseroperation, including stimulated emission, population inversion, and optical gain.

References:

Virtual Labs

S. No.	Experiment Name	Experiment Link(s)
1	Diffraction and interference experiments (from ordinary light or laser pointers).	http://ov-au.vlabs.ac.in/optics/Diffraction_Grating/
2	Minimum deviation from a prism.	http://ov-au.vlabs.ac.in/optics/Spectrometer_i_d_Curve/

BSCT-105	MATHEMATICS- II	3L:1T:0P	4 Credits

Course Objective:

- To formulate and solve partial differential equations, Laplace, Fourier transforms within the engineering domain.

Course Contents:

MODULE I PARTIAL DIFFERENTIAL EQUATIONS (12 Hrs)

Formation of partial differential equations, Solutions of standard types of first order partial differential equations, Lagrange s linear equation, Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

MODULE II LAPLACE TRANSFORM (12 Hrs)

Existence conditions, Transforms of elementary functions , Properties, Transform of unit step function and unit impulse function , Transforms of derivatives and integrals , Transforms of Periodic Functions , Initial and final value theorems.

MODULE III INVERSE LAPLACE TRANSFORM (12 Hrs)

Inverse Laplace Transforms Properties, Convolution theorem, Application - Solution of ordinary differential equations with constant coefficients - Solution of simultaneous ordinary differentialequations.

MODULE IV FOURIER TRANSFORM (12 Hrs)

Fourier Integral theorem (statement only) , Fourier transform and its inverse, Properties: Fourier sine and cosine transforms, Properties, Convolution and Parseval s identity.

MODULE V FOURIER SERIES (12 Hrs)

Dirichlet s conditions , Expansion of periodic functions into Fourier series- Change of interval, Half-range Fourier series, Root mean square value - Parseval s theorem on Fourier coefficients, Harmonic analysis.

Text Books:

1. Grewal B.S, “Higher Engineering Mathematics”, Khanna Publishers, New Delhi, 43rd Edition, 2015.
2. Veerarajan T, “Transforms and Partial Differential Equations”, Tata McGraw-Hill, New Delhi, 2012.

References:

1. Bali N.P and Manish Goyal., “A Text Book of Engineering Mathematics”, Laxmi Publications(P) Ltd, 2011.
2. Erwin Kreyszig, “Advanced Engineering Mathematics”, John Wiley & Sons, New Delhi, 9th Edition, 2011.
3. Ramana B.V., “Higher Engineering Mathematics”, Tata McGraw-Hill, New Delhi, 2010.

ONLINE / NPTEL Courses:

1. Laplace Transform: https://nptel.ac.in/courses/111106139
2. Partial Differential Equations: https://nptel.ac.in/courses/111101153
3. Advanced Engineering Mathematics: https://nptel.ac.in/courses/111107119

Course Outcomes:

- To formulate and solve various types of partial differential equations.
- To understand the Laplace transform and its properties.
- To apply Laplace transforms to solve ordinary differential equations with constant coefficients and simultaneousordinary differential equations.
- To understand and apply Fourier transform techniques, including Fourier integral theorem, properties of Fouriertransforms, convolution, and Parseval's identity.
- To apply Fourier series and harmonic analysis, enabling them to analyze and synthesize periodic signals andfunctions in various engineering and mathematical applications.

ESCT- 104	BASIC ELECTRICAL ENGINEERING	2L: 1T:0 P	3 Credits

Course Objectives:

- To understand and gain basic knowledge about DC and AC circuits.
- To learn the concept of single phase and three phase circuit with power measurement.
- To study the operating principles of Transformers.
- To explore the working of the DC Machines and motors.
- To study the three phase induction motors.

Course Contents:

MODULE I - D. C. CIRCUITS: 9 Hours

Ohm's Law and Kirchhoff‟s Laws; Analysis of series, parallel and series-parallel circuits excited by independent voltage sources; Power and energy; Electromagnetism covering, Faradays Laws, Lenz's Law, Fleming's Rules, Statically and dynamically induced EMF; Concepts of self-inductance, mutual inductance and coefficient of coupling; Energy stored in magnetic fields;

MODULE II - A.C. CIRCUITS: 9 Hours

Generation of sinusoidal voltage- definition of average value, root mean square value, form factor and peak factor of sinusoidal voltage and current and phasor representation of alternating quantities; Analysis with phasor diagrams of R, L, C, RL, RC and RLC circuits; Real power, reactive power, apparent power and power factor, series, parallel and series-parallel circuits; Three Phase A.C. Circuits - Necessity and Advantages of three phase systems, Generation of three phase power, definition of Phase sequence, balanced supply and balanced load; Relationship between line and phase values of balanced star and delta connections; Power in balanced three phase circuits, measurement of power by two wattmeter method;

MODULE III – TRANSFORMERS: 9 Hours

Principle of operation and construction of single-phase transformers (core and shell types). EMF equation, losses, efficiency and voltage regulation

MODULE IV - DC MACHINES: 9 Hours

Working principle of DC machine as a generator and a motor; Types and constructional features; EMF equation of generator, relation between EMF induced and terminal voltage enumerating the brush drop and drop due to armature reaction; DC motor working principle; Back EMF and its significance, torque equation; Types of D.C. motors, characteristics and applications; Necessity of a starter for DC motor;

MODULEV- THREE PHASE INDUCTION MOTORS: 9 Hours

Concept of rotating magnetic field; Principle of operation, types and constructional features; Slip and its significance; Applications of squirrel cage and slip ring motors; Necessity of a starter, star-delta starter.

Total No. of Hours: 45

Text Books:

1. Nagrath I.J. and D. P. Kothari, " Basic Electrical Engineering" Tata McGraw Hill (2001).
2. Hayt and Kimberly, "Engineering Circuit Analysis" Tata McGraw Hill, 8th Edition, 2013.

References Books:

1. Kulshreshtha D.C., "Basic Electrical Engineering" Tata McGraw Hill (2009).
2. Rajendra Prasad, "Fundamentals of Electrical Engineering" Prentice Hall, India Hughes, 2009.

Course Outcomes:

On successful completion of the module students will be able to:

1. Understand the concept of DC circuits and Electromagnetic principles over inductors,
2. Explain the concepts of AC circuits over RLC circuits and with knowledge of power andload performance and Obtain the power measurement using single phase and three phase circuit
3. Discuss the principles of operation and construction of single-phase transformers
4. Explain the operation and characterizes of DC machines and motors.
5. Illustrate the principle of the three phase induction motors.

ESCP-104	BASIC ELECTRICAL ENGINEERING LABORATORY	0L:0T:2 P	1 Credit

Course Objectives:

- Understand the importance of electrical safety in handling electrical equipment and wiring.
- Understand the techniques for making secure and reliable electrical joints.
- Understand the principles of series and parallel circuits and their applications in lamp circuits.
- Learn the concept and purpose of staircase, wiring in residential andcommercial settings.
- Learn the concept of load tests in motors and transformers.

List of Experiments

1. Electrical Safety, Precautions, study of tools and accessories.
2. Practices of different joints. Wiring and testing of series and parallel lamp circuits.
3. Staircase wiring, Doctor‟s room wiring.
4. Bed room and godown wiring
5. Wiring and testing a ceiling fan and fluorescent lamp circuit.
6. Study of different types of fuses, circuit breakers and A.C and D.C meters.
7. OC and SC test on single phase transformer.
8. Load test on single phase transformer.
9. Load test on DC shunt motor.
10. Two wattmeter method of power measurement.
11. Load test on single phase induction . and 3 phase induction motor.
12. Speed control methods of DC motor

Course Outcomes:

On successful completion of the experiment students will be able to:

1. Demonstrate a thorough understanding of electrical safety practices, including the use of personal protective equipment (PPE) and safety guidelines.
2. Design and execute wiring layouts for series and parallel lamp circuits,understanding their applications and advantages.
3. Plan and execute a staircase/ n wiring system, incorporating appropriate switching mechanisms for efficient and convenient lighting control.
4. Evaluate the performance of Transformers and motors for different loads.
5. Discuss the power measurements in DC machines.

ESCP-105	DIGITAL FABRICATION	0L:0T:4P	2 Credits

Course Objectives:

The course is designed to impart knowledge and skills related to 3D printing technologies, selection of material and equipment and develop a product using this technique in Industry environment.

Course Contents:

1. **3D Printing (Additive Manufacturing)**
   Introduction, Process, Classification, Advantages, Additive V/s Conventional Manufacturing processes, Applications.

2. **CAD for Additive Manufacturing**
   CAD Data formats, Data translation, Data loss, STL format.

3. **Additive Manufacturing Techniques**

   Stereo- Lithography, LOM, FDM, SLS, SLM, Binder Jet technology.
   Process, Process parameter, Process Selection for various applications.
   Additive Manufacturing Application Domains: Aerospace, Electronics, Health Care, Defence, Automotive, Construction, Food Processing, Machine Tools

4. **Materials**
   Polymers, Metals, Non-Metals, Ceramics.
   Various forms of raw material- Liquid, Solid, Wire, Powder; Powder Preparation and their desired properties, Polymers and their properties.
   Support Materials.

5. **Additive Manufacturing Equipment**
   Process Equipment- Design and process parameters
   Governing Bonding Mechanism
   Common faults and troubleshooting
   Process Design

6. **Post Processing: Requirement and Techniques**

7. **Product Quality**
   Inspection and testing
   Defects and their causes

List of Experiments

1. 3D Modelling of a single component.
2. Assemblyof CAD modelled Components.
3. Exercise on CAD Data Exchange.
4. Generation of .stl files.
5. Identification of a product for Additive Manufacturing and its AM process plan.
6. Printing of identified product on an available AM machine.
7. Post processing of additivelymanufactured product.
8. Inspection and defect analysis of the additivelymanufactured product.
9. Comparison of Additively manufactured product with conventional manufactured counterpart.

Text Books:

1. AICTE"s Prescribed Textbook: Workshop / Manufacturing Practices (with Lab Manual), Khanna Book Publishing Co.

2. Lan Gibson, David W. Rosen and Brent Stucker, "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.

3. Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing", Hanser Publisher, 2011.

4. Sabrie Soloman, "3D Printing and Design", Khanna Publishing House, Delhi.

Reference Books:

1. CK Chua, Kah Fai Leong, "3D Printing and Rapid Prototyping- Principles and Applications", World Scientific, 2017.
2. J.D. Majumdar and I. Manna, "Laser-Assisted Fabrication of Materials", Springer Series in Material Science, 2013.
3. L. Lu, J. Fuh and Y.S. Wong, "Laser-Induced Materials and Processes for Rapid Prototyping", Kulwer Academic Press, 2001.
4. Zhiqiang Fan And Frank Liou, "Numerical Modelling of the Additive Manufacturing (AM) Processes of Titanium Alloy", InTech, 2012.

Course Outcomes:

After completion of this course, the students will be able to:

1. Develop CAD models for 3D printing.
2. Import and Export CAD data and generate. stl file.
3. Select a specific material for the given application.
4. Select a 3D printing process for an application.
5. Produce a product using 3D Printing or Additive Manufacturing (AM).

HSMC-101	ENGLISH FOR TECHNICAL WRITING	2L:0T:2P	3 Credit

Course Objectives:

- To provide learning environment to practice listening, speaking, reading and writing skills and assist the students to carry on the tasks and activities through guided instructions and materials.
- To effectively integrate English language learning with employability skills and training, by providing hands-on experience through case-studies, mini-projects, group and individual presentations.

Course Contents:

MODULE I - VOCABULARY BUILDING: 9 Hours

The concept of Word Formation, Root words from foreign languages and their use in English. Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives. Synonyms, antonyms, and standard abbreviations.

MODULEII - BASIC WRITING SKILLS: 9 Hours

Sentence Structures, Use of phrases and clauses in sentences, Importance of proper punctuation, Creating coherence, Organizing principles of paragraphs in documents, Techniques for writing precisely.

MODULE III - IDENTIFYING COMMON ERRORS IN WRITING: 9 Hours

Subject-verb agreement, Noun-pronoun agreement, Misplaced modifiers, Articles, Prepositions, Redundancies and Clichés.

MODULE IV - NATURE, STYLE OF SENSIBLE WRITING: 9 Hours

Describing, Defining, Classifying, Providing examples or evidence, Writing introduction and conclusion

MODULE V - WRITING PRACTICES AND ORAL COMMUNICATION: 9 Hours

Comprehension, Précis Writing, Essay Writing, Listening Comprehension, Pronunciation, Intonation, Stress and Rhythm, Common Everyday Situations: Conversations and Dialogues, Communication at Workplace, Interviews, Formal Presentations.

Total No. of Hours: 45

Text Books:

1. Effective Communication Skills. Kul Bhushan Kumar, Khanna Book Publishing, 2022.
2. Practical English Usage. Michael Swan. OUP. 1995.
3. Remedial English Grammar. F.T. Wood. Macmillan,2007.

Reference Books:

1. On Writing Well. William Zinsser. Harper Resource Book. 2001.
2. Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.

Course Outcomes

Upon successful completion of the course, students should be able to:

1. Aware of correct usage of English grammar in writing and speaking
2. Increase their reading speed and comprehension of academic articles
3. Improve their reading fluency skills through extensive reading
4. Speaking ability in English both in terms of fluency and comprehensibility
5. Oral presentations and receive feedback on their performance

HSMC-102	UNIVERSAL HUMAN VALUES - II	2L:1T:0P	3 Credits

PRE-REQUISITES: None. Universal Human Values 1 (Desirable)

Course Objectives:

During the Induction Program, students would get an initial exposure to human valuesthrough Universal Human Values-I. This exposure is to be augmented by this compulsory full semester foundation course. This introductory course input is intended:

- To help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
- To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
- To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature.
- Thus, this course is intended to provide a much-needed orientational input in value education to the young enquiring minds.

Course Contents:

MODULE I – INTRODUCTION TO VALUE EDUCATION: 9 Hours

Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education) ; Understanding Value Education; Self-exploration as the Process for Value Education; Continuous Happiness and Prosperity – the Basic Human Aspirations; Happiness and Prosperity – Current Scenario; Method to Fulfill the Basic Human Aspirations: Exploring Natural Acceptance.

MODULE II – HARMONY IN THE HUMAN BEING: 9 Hours

Understanding Human being as the Co-existence of the Self and the Body; Distinguishing between the Needs of the Self and the Body; Exploring the difference of Needs of Self and Body; The Body as an Instrument of the Self; Understanding Harmony in the Self ; Harmony of the Self with the Body ; Programme to ensure self-regulation and Health; Exploring Harmony of Self with the Body.

MODULE III – HARMONY IN THE FAMILY AND SOCIETY: 9 Hours

Harmony in the Family – the Basic Unit of Human Interaction; „Trust' – the Foundational Value in Relationship; 'Respect' – as the Right Evaluation; Other Feelings, Justice in Human-to-Human Relationship; Understanding Harmony in the Society; Vision for the Universal Human Order.

MODULE4 – HARMONY IN THE NATURE/EXISTENCE: 9 Hours

Understanding Harmony in the Nature; Interconnectedness, self-regulation and Mutual Fulfillment among the Four Orders of Nature: - Exploring the Four Orders of Nature; Realizing Existence as Co-existence at All Levels; The Holistic Perception of Harmony in Existence: - Exploring Co-existence in Existence.

MODULE5 – IMPLICATIONS OF THE HOLISTIC UNDERSTANDING – A LOOK AT PROFESSIONAL ETHICS: 9 Hours

Natural Acceptance of Human Values; Definitiveness of (Ethical) Human Conduct: - Exploring Ethical Human Conduct; A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order; Competence in Professional Ethics:- Exploring Humanistic Models in Education; Holistic Technologies, Production Systems and Management Models-Typical Case Studies; Strategies for Transition towards Value-based Life and Profession.

Total No. of Lectures: 45

Text Book and Teachers Manual

1. R R Gaur, R Asthana, G P Bagaria, "A Foundation Course in Human Values and Professional Ethic",Excel Books, 2nd Revised Edition, New Delhi, 2019.
2. RR Gaur, R Asthana, G P Bagaria, "Teachers‟ Manual for A Foundation Course in Human Values and Professional Ethics", Excel Books, 2nd Revised Edition New Delhi, 2019.ISBN 978-93-87034-53.

Reference Books:

1. Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak," Jeevan Vidya" 1999.
2. A.N. Tripathi, "Human Values" New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. Mohandas Karamchand Gandhi "The Story of My Experiments with Truth".

Course Outcomes

1. Discuss the Right understanding about the human aspirations.
2. Explore the harmony in the human being with the right understanding about the body and self.
3. Develop effective communication skills for promoting understanding and resolving conflicts within the family and society with Trust and Respect.
4. Develop a comprehensive understanding of the concept of harmony and its significance in nature and human life.
5. Recognize the Natural Acceptance of Human Values and Strategies for Transition towards Value-based Life and Profession.

AU-102	SPORTS AND YOGA	1L:0T:1P	0 Credit

Course Objectives:

- To make the students understand the importance of sound health and fitness principles as they relate to better health.
- To expose the students to a variety of physical and yogic activities aimed at stimulating their continued inquiry about Yoga, physical education, health and fitness.
- To create a safe, progressive, methodical and efficient activity based plan to enhance improvement and minimize risk of injury.
- To develop among students an appreciation of physical activity as a lifetime pursuit and a means to better health.

Course Contents:

MODULE I - INTRODUCTION TO PHYSICAL EDUCATION: 9 Hours

Meaning & definition of Physical Education; Aims & OBJECTIVESs of Physical Education; Changing trends in Physical Education; Ancient & Modern Olympics (Summer & Winter); Olympic Symbols, Ideals, OBJECTIVESs & Values; Awards and Honours in the field of Sports in India (Dronacharya Award, Arjuna Award, Dhayanch and Award, Rajiv Gandhi Khel Ratna Award etc.)

MODULE II - PHYSICAL FITNESS, WELLNESS AND LIFE STYLE: 9 Hours

Meaning & Importance of Physical Fitness & Wellness. Components of Physical fitness Components of Health related fitness. -Components of wellness. - Preventing Health Threats through Lifestyle Change; Concept of Positive Lifestyle; Nutritional practices for good Health.

MODULE III - FUNDAMENTALS OF ANATOMY AND PHYSIOLOGY IN PHYSICALEDUCATION, SPORTS AND YOGA: 9 Hours

Define Anatomy, Physiology & Its Importance; Effect of exercise on the functioning of Various Body Systems. (Circulatory System, Respiratory System, Neuro-Muscular System etc.)

MODULE IV - YOGA AND LIFESTYLE: 9 Hours

Meaning & Importance of Yoga, Elements of Yoga; Introduction - Asanas, Pranayama, Meditation & Yogic Kriyas; Yoga for concentration & related Asanas (Sukhasana; Tadasana; Padmasana &Shashakasana); Relaxation Techniques for improving concentration
- Yog-nidra

Asanas as preventive measures.

Hypertension: Tadasana, Vajrasana, Pavan Muktasana, Ardha Chakrasana Bhujangasana,Sharasana.

Obesity: Procedure, Benefits & contraindications for Vajrasana, Hastasana, Trikonasana, Ardh Matsyendrasana.

Back Pain: Tadasana, Ardh Matsyendrasana, Vakrasana, Shalabhasana, Bhujangasana. Diabetes: Bhujangasana, Paschimottasana,Pavan Muktasana, Ardh Matsyendrasana. Asthema: Sukhasana, Chakrasana, Gomukhasana, Parvatasana, Bhujangasana,Paschimottasana, Matsyasana.

MODULE V - PSYCHOLOGY & SPORTS: 9 Hours

Definition & Importance of Psychology in Physical Edu. & Sports; Define & Differentiate Between Growth & Development; Adolescent Problems & Their Management; Emotion: Concept, Type & Controlling of emotions; Meaning, Concept & Types of Aggressions in Sports. Psychological benefits of exercise. Anxiety & Fear and its effects on Sports Performance. Motivation, its type & techniques. Understanding Stress & Coping Strategies. Meaning and Concept of Doping ; Prohibited Substances & Methods :- Side Effects of Prohibited Substances.

Total No. of Lectures: 45

Text Books:

1. Ajmer Singh, Jagdish Bains , Jagtar Singh Gill and Rachpar Singh Brar, "Essentialsof Physical Education" by Kalyani publications, 2022.
2. B.K.S. Iyengar, "Light On Yoga: The Classic Guide to Yoga by the World's Foremost Authority"2006.
3. Health and Physical Education – NCERT (11th and 12th Classes).

Course Outcomes:

On successful completion of the course the students will be able to:

1. Discuss the physical education needs and history with reference to awards given in promotion of the sports in India.
2. Practice Physical activities and Hatha Yoga and Breathing techniques focusing on yoga for strength, flexibility, and relaxation, including strength and flexibility, balance and coordination.
3. Learn techniques for increasing concentration and decreasing anxiety which leads to stronger academic performance.
4. Develop understanding of health-related fitness components: cardio respiratory endurance, flexibility and body composition etc.
5. Develop understanding of psychological problems associated with the age and lifestyle.
6. Demonstrate an understanding of sound nutritional practices as related to health and physical performance.

SEMESTER – III

SEMESTER III

BSCT-201	**MATHEMATICS-III**	**2L:1T:0P**	**3 credits**

COURSE OBJECTIVES

- To understand analytic functions, properties, harmonic conjugates, analytic function construction, standard conformal mapping, and bilinear transformations.
- To apply Cauchy's theorem, integral formulas, Taylor & Laurent series
- To solve one dimensional wave equations and one dimensional heat flow equations using Fourier series solutions.
- To solve two dimensional steady-state heat flow equations using Fourier series solutions.
- To develop Z- transform techniques which will perform the analysis for discrete time systems.

COURSE CONTENTS:

MODULE I:ANALYTIC FUNCTIONS **9 PERIODS**

Analytic Functions – Necessary and sufficient conditions for analyticity in Cartesian and polar coordinates – Properties of Analytic Functions– Harmonic conjugates – Construction of analytic function – Standard Conformal mapping –Bilinear transformation.

MODULE II:COMPLEX INTEGRATION **9 PERIODS**

Line integral – Cauchy's integral theorem – Cauchy's integral formula – Taylor's and Laurent's series – Singularities – Residues – Residue theorem – Application of residue theorem for evaluation of real integrals – Use of circular contour and semicircular contour.

MODULE III : **Applications of PDEs (Wave Equation)** **9 PERIODS**

Solution of PDE by Method of separation of variables – Classification of PDE – Fourier Series Solutions of one dimensional wave equation.

MODULE IV:Applications of PDEs – II (Heat Equation) **9 PERIODS**

Fourier Series Solutions of one dimensional equation of heat flow equation – Steady state solution of two dimensional equation of heat flow equation. (Cartesian and Polar)

MODULE V: Z – TRANSFORM **9 PERIODS**

Z-transforms; Elementary properties; Convolution theorem; Inverse Z - transform (using partial fraction, convolution theorem and residues); Discrete time systems and Difference equations; Solution of difference equations using Z – transform.

TOTAL PERIODS:45

Course Outcomes

On successful completion of this course, the students will be able to

- Analyze and construct analytic functions, understand conformal mapping, and apply bilinear transformations.
- Apply complex integration techniques, including Cauchy's integral theorem and formula, Taylor's and Laurent's series, and residue theorem for real integral evaluation.
- Proficient in solving wave equation using Fourier series solutions.
- Proficient in heat flow equations using Fourier series solutions.
- Use Z-transform techniques to analyze and solve discrete-time systems.

TEXT BOOKS:

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. Veerarajan T., "Engineering Mathematics", Tata McGraw-Hill, New Delhi, 2008.
3. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw-Hill, New Delhi, 2010.

REFERENCE BOOKS:

1. Bali N.P and Manish Goyal., "A Text Book of Engineering Mathematics", Laxmi Publications(P) LTD-2011.
2. Dr. M.K. Venkataraman, "Engineering Mathematics – Volume I and Volume II", The National Publishing Company, Madras 2001.

RAT-201	POWER ELECTRONICS AND DRIVES	3L:0T:0P	3 Credits

COURSE OBJECTIVES:

- To understand the operations of power semiconductor devices.
- To analyze the performance of the single phase and three phase converters.
- To study the basics of the inverters and choppers.
- To understand the operation of electric drives.
- To analyze the performance drives used for automation.

COURSE CONTENTS:

MODULE – I: POWER SEMICONDUCTOR DEVICES 9 PERIODS

Power diodes - Power transistors - Characteristics of SCR - TRIAC – Power MOSFET - IGBT - Thyristor protection circuits - Thyristor triggering circuits- Selection of device.

MODULE – II: CONVERTERS 9 PERIODS

Single phase - Three phase - Fully controlled rectifiers - Effect of source and load inductance -single phase- Three phase AC voltage controller -Control Circuits for AC to DC and AC toAC converters.

MODULE – III: INVERTERS AND CHOPPERS 9 PERIODS

Voltage Source inverters - bridge inverters- 120° and 180° conduction - Pulse Width Modulation - Single and Multiple PWM - SPWM - Generation of pulses for SPWM - DC choppers : Buck- Boost - Buck Boost -Generation of timing pulses for DC choppers - Applications (Block diagram approach) Uninterrupted power supplies - SMPS - Basics of Magnetic design for power electronics.

MODULE IV: INTRODUCTION TO DRIVES 9 PERIODS

Basic elements-types of electric drives-factors influencing electric drives-heating and cooling curves -loading conditions and classes of duty-Selection of power rating for drive motors with regard to thermal overloading and load variation factors.

MODULE V: DRIVES FOR AUTOMATION 9 PERIODS

Operating modes - quadrant operation of chopper - Closed loop control of DC drives. Stator and rotor voltage control - frequency and voltage control - Current Control - Basics of vector control- Block diagram - Stepper Motor Drive - BLDC Motor Drive - PMSM Drive-protection devices for drives.

TOTAL PERIODS:45

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

- Acquire knowledge on power semiconductor devices..
- Acquire the knowledge on single phase and three phase converters.
- Study the basics of electric drive.
- Acquire knowledge on drives for automation.

TEXT BOOKS:

1. Rashid M H , "Power Electronics –Circuits, Devices and Applications", 4th edition Pearson Education India, 2017.
2. Ramu Krishnan, "Electric Motor Drives: Modeling, Analysis, and Control", Prentice Hall, 2002.
3. Bimal K Bose, “Modern Power Electronics and AC Drives", Pearson Education, 2002.

REFERENCE BOOKS:

1. Roger C Dugan, Surya Santoso, Mark F McGranaghan , "Electrical Power Systems Quality", 3rd edition McGraw Hill, 2012.
2. Mohan, Undel, "Power Electronics", John Wiley and sons, 2003.
3. Vedam Subramaniam , "Thyristor control of Electrical Drives", Tata McGraw-Hill, 1998.

RAT - 202	ANALOG ELECTRONICS AND CIRCUITS	3L:0T:0P	3 Credits

COURSE OBJECTIVES:

- To introduce the basic building blocks of linear integrated circuits and the linear and non-linear applications of operational amplifiers.
- To introduce the concepts of waveform generation and introduce some special function ICs 555and 565.
- To learn the theory of active filter, ADC and DAC.
- To study the differential, multi-stage and operational amplifiers
- To learn the linear and non-linear applications of op-amp

COURSE CONTENTS:

MODULE I: AMPLIFIERS AND OSCILLATORS USING BJT 9 PERIODS

BJT–Configurations, Small signal analysis using hybrid model – Analysis of CE amplifiers, Frequency response; Operation and analysis of RC phase shift, Wienbridge, Hartely, Colpitts and crystal oscillators; Non-sinusoidal oscillators: Astable, Monostable & bistable Multivibrators.

MODULE II: OPERATIONAL AMPLIFIER 9 PERIODS

Ideal and Practical Op-Amp, Op-Amp Characteristics, DC and AC Characteristics, Features of 741 Op-Amp, Pin details -Linear applications - Inverting, Non-Inverting, summing, subtracting, averaging, Differential, Instrumentation Amplifier, AC Amplifier, Differentiators and Integrators, I-V converter, V-I converters, Non linear applications -Comparators, Schmitt Trigger, Precision rectifier.

MODULE III : DIFFERENTIAL, MULTI-STAGE AND OPERATIONAL AMPLIFIERS 9 PERIODS

Differential amplifier; power amplifier; direct coupled multi-stage amplifier; internal structure of an operational amplifier, ideal op-amp, non-idealities in an op-amp (Output offset voltage, input bias current, input offset current, slew rate, gain bandwidth product)

MODULE IV: ACTIVE FILTERS AND DATA CONVERTERS 9 PERIODS

Introduction to Active Filters, LPF, HPF, Band pass, Band reject and All Pass Filters, Basic DAC, Different types of DACs-Weighted resistor DAC, R-2R ladder DAC, Different Types of ADCs - Parallel Comparator Type ADC, Counter Type ADC, Successive Approximation ADC, Single and Dual Slope ADC. Features and Pin details of DAC and ADC ICs -DAC0800 and ADC0808.

MODULE V: OP-AMP, IC-555 & IC 565 APPLICATIONS **9 PERIODS**

Oscillators - RC Phase shift and Wein-bridge. Waveform generators - Square, triangular and saw tooth, IC555 Timer - Functional Diagram, Monostable and Astable Operations, IC565 PLL - Block Schematic, Description of Individual Blocks and IC pins, Applications.

TOTAL PERIODS:45

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

- Summarize the basic building blocks of linear integrated circuits and the linear and non-linear applications of operational amplifiers.
- Interpret the concepts of waveform generation and introduce some special function ICs 555and 565.
- Define the theory of active filter, ADC and DAC.
- Understand the differential, multi-stage and operational amplifiers
- Analyse the linear and non-linear applications of op-amp

TEXT BOOKS

1. Morris Mano M, Digital Logic and Computer Design, Prentice Hall 1994.
2. Roy Choudhry D, Shail Jain, -Linear Integrated Circuits, New Age International Pvt. Ltd., 2018, Fifth Edition.
3. Ramakant A. Gayakwad , Op-AMP and Linear ICs, Prince Hall, 1994.

REFERENCE BOOKS

1. Robert B.Northrop, Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation, CRC Press, 2004.
2. Sergio Franco, Design with Operational Amplifiers and analog Integrated circuits, McGraw- Hills, 2003.
3. S Salivahanan and V S Kanchana Bhaaskaran, Linear Integrated Circuits, McGraw Hill Education, 3rd Edition, 2018.

RAT-203	STRENGTH OF MATERIALS	3L:0T:0P	3 Credits

COURSE OBJECTIVES:

- To understand the concepts of stress, strain, principal stresses and principal planes.
- To study the concept of shearing force and bending moment due to external loads in
- To determinate beams and their effect on stresses.
- To determine stresses and deformation in circular shafts and helical spring due to torsion.
- To compute slopes and deflections in determinate beams by various methods.
- To study the stresses and deformations induced in thin and thick shells.

COURSE CONTENTS:

MODULE I - STRESS, STRAIN AND DEFORMATION OF SOLIDS 9 PERIODS

Rigid bodies and deformable solids – Tension, Compression and Shear Stresses – Deformation of simple and compound bars – Thermal stresses – Elastic constants – Volumetric strains – Stresses on inclined planes – principal stresses and principal planes – Mohr's circle of stress.

MODULE II - TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM 9 PERIODS

Beams – types transverse loading on beams – Shear force and bending moment in beams – Cantilevers – Simply supported beams and over – hanging beams. Theory of simple bending– bending stress distribution – Load carrying capacity – Proportioning of sections – Flitched beams – Shear stress distribution.

MODULE III - TORSION 9 PERIODS

Torsion formulation stresses and deformation in circular and hollows shafts – Stepped shafts– Deflection in shafts fixed at the both ends – Stresses in helical springs – Deflection of helical springs, carriage springs.

MODULE IV - DEFLECTION OF BEAMS 9 PERIODS

Double Integration method – Macaulay's method – Area moment method for computation of slopes and deflections in beams - Conjugate beam and strain energy – Maxwell's reciprocal theorems.

MODULE V - THIN CYLINDERS, SPHERES AND THICK CYLINDERS 9 PERIODS

Stresses in thin cylindrical shell due to internal pressure circumferential and longitudinal stresses and deformation in thin and thick cylinders – spherical shells subjected to internal pressure – Deformation in spherical shells – Lame's theorem.

TOTAL PERIODS:45

COURSE OUTCOMES:

On successful completion of this course, the students will be able to

- Understand the concepts of stress and strain in simple and compound bars, the importance
- of principal stresses and principal planes.
- Understand the load transferring mechanism in beams and stress distribution due to
- shearing force and bending moment.
- Apply basic equation of simple torsion in designing of shafts and helical spring
- Calculate the slope and deflection in beams using different methods.
- Analyze and design thin and thick shells for the applied internal and external pressures

TEXT BOOKS

1. Bansal, R.K., , "Strength of Materials",Laxmi Publications (P) Ltd., 2016
2. Subramanian R., "Strength of Materials", Oxford University Press, Oxford Higher Education Series, 2010.
3. Jindal U.C., "Strength of Materials", Asian Books Pvt. Ltd., New Delhi, 2009.

REFERENCE BOOKS

1. Egor. P.Popov , “Engineering Mechanics of Solids”, Prentice Hall of India, New Delhi, 2002
2. Ferdinand P. Been, Russell Johnson, J.r. and John J. Dewole,"Mechanics of Materials", Tata McGraw Hill Publishing ‘co. Ltd., New Delhi, 2005.
3. Hibbeler, R.C., "Mechanics of Materials", Pearson Education, Low Price Edition, 2013

RAT-204	ELECTRONIC DEVICES	3L:0T:0P	3 Credits

COURSE OBJECTIVES:

- To understand the operation and characteristics of PN Junction Diode
- To study BJT Transistor Characteristics, Operations, and Models
- To explore the characteristics and operations of JFETs and MOSFETs.
- To explore the characteristics and operations of special semiconductor devices
- To study the characteristics and operations of power and display devices

COURSE CONTENTS:

MODULE I: SEMICONDUCTOR DIODES **9 PERIODS**

PN junction diode, Current equations, Energy Band diagram, Diffusion and drift current densities, forward and reverse bias characteristics, Transition and Diffusion Capacitances, Switching Characteristics, Breakdown in PN Junction Diodes. Characteristics of Schottky barrier diode-Zener diode-Varactor diode – Tunnel diode- Gallium Arsenide device.

MODULE II: BIPOLAR JUNCTION TRANSISTOR **9 PERIODS**

NPN -PNP -Operations-Early effect-Current equations — Input and Output characteristics of CE, CB, CC – Hybrid -p model – h-parameter model, Ebers Moll Model- Gummel Poon-model, Multi Emitter Transistor.

MODULE III: FIELD EFFECT TRANSISTORS **9 PERIODS**

JFETs — Drain and Transfer characteristics -Current equations-Pinch off voltage and its significance-MOSFET- Characteristics- Threshold voltage -Channel length modulation, D-MOSFET, E-MOSFET-Characteristics — Comparison of MOSFET with JFET.

MODULE IV: SPECIAL SEMICONDUCTOR DEVICES **9 PERIODS**

Metal-Semiconductor Junction- MESFET, FINFET, PINFET, CNTFET, DUAL GATE MOSFET, LASER diode, LDR.

MODULE V: POWER AND DISPLAY DEVICES **9 PERIODS**

Operation and Characteristics: UJT, SCR, Diac, Triac, Power BJT- Power MOSFET- DMOS-VMOS. LED, LCD, Photo transistor, Opto Coupler, Solar cell, CCD.

TOTAL PERIODS:45

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

- Apply knowledge science and engineering to understand semiconductor diodes, Diode equation and characteristics.
- Analyze functional aspects of BJT, JFET, MOSFET and it's biasing.
- Study the characteristics and operations of power and display devices

TEXT BOOKS:

1. Jacob Millman and Christos C. Halkias, Integrated Electronics‖ Tata McGraw-Hill, Second Edition, 2010.
2. R.L. Boylestad and L. Nashelsky, Electronic Devices and Circuit Theory‖, Pearson Education, Tenth Edition, 2013.
3. David A. Bell ,Electronic devices and circuits, Oxford University higher education, 5th edition 2008.

REFERENCE BOOKS:

1. Donald A Neaman, Semiconductor Physics and Devices‖, Tata McGraw-Hill, Fourth Edition, 2017.
2. S. Salivahanan, N. Suresh Kumar and A. Vallavaraj, Electronic Devices and Circuits, 3rd Editio, TMH, 2012.
3. Robert L.Boylestad, Electronic devices and circuit theory, 2002.

RAP-205	ELECTRONIC DEVICES LAB	0L:0T:2P	1 Credit

LIST OF EXPERIMENTS:

1. V-I characteristics of semiconductor diodes a) PN Junction diode b) Point contact diode c) Zener diode
2. Characteristics of BJT in CE configuration a) Determination of input and output characteristics b) Determination of voltage gain, current gain, input and output resistances from the characteristics
3. Characteristics of JFET a) Determination of output and transfer characteristics
   Determination of pinch off voltage, rd, gm and μ from the characteristics
4. Characteristics of MOSFET a) Determination of output and transfer characteristics
   b) Determination of pinch off voltage, rd, gm and μ from the characteristics
5. Characteristics of UJT, SCR and TRIAC
6. To study the application of Op-amp IC741 as
   a. Inverting amplifier
   b. Non-inverting amplifier
   c. Voltage follower
   d. Summer
   e. Subtractor
7. To study the op-amp performance as differentiator and integrator for various time constants

RAT-206	SENSORS AND INSTRUMENTATION	3L:0T:0P	3 Credits

COURSE OBJECTIVES:

- To understand the purpose of measurement, the methods of measurements, errors associatedwith measurements.
- To know the principle of transduction and classifications of sensors used in health careapplications.
- To describe the characteristics of different of sensors used in health care applications.
- To summarize the different types of chemical and biosensors.
- To know the different display and recording devices.

COURSE CONTENTS:

MODULE I: SCIENCE OF MEASUREMENT 9 PERIODS

Measurement System – Instrumentation - Classification and Characteristics of Transducers - Static and Dynamic - Errors in Measurements and their statistical analysis – Calibration - Primary and secondary standards.

MODULE II: DISPLACEMENT, PRESSURE, TEMPERATURE SENSORS 9 PERIODS

Strain Gauge: Gauge factor, sensing elements, configuration, and unbounded strain gage. Capacitive transducer - various arrangements, Inductive transducer, LVDT, Passive types: RTD materials & range, relative resistance vs. temperature characteristics, thermistor characteristics,Thermocouple - characteristics.

MODULE III: PHOTOELECTRIC AND PIEZO ELECTRIC SENSORS 9 PERIODS

Phototube, scintillation counter, photo multiplier tube (PMT), photovoltaic, photo conductive cells, photo diodes, phototransistor, comparison of photoelectric transducers. Spectrophotometric applications of photo electric transducers. Piezoelectric active transducer - Equivalent circuit and its characteristics, pressure & ultrasound transducer.

MODULE IV: MEASUREMENTS AND RECORDING DEVICES 9 PERIODS

AC and DC Bridges -Wheat stone bridge, Kelvin's double bridge, Maxwell's bridge, Hay's bridge, Schering's bridge. PMMC writing systems, servo recorders, photographic recorder, magnetic tape recorder, Inkjet recorder, thermal recorder.

MODULE V: SIGNAL CONDITIONING AND DAQ SYSTEMS 9 PERIODS

Amplification – Filtering – Sample and Hold circuits – Data Acquisition: Single channel and multi channel data acquisition – Data logging - applications - Automobile, Aerospace, Home appliances, Manufacturing, Environmental monitoring.

TOTAL PERIODS:45

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

- Illustrate the various characteristics of sensors and measurement system.
- Select appropriate passive or active transducers for measurement of displacement,temperature and pressure.
- Evaluate the use of photoelectric and piezoelectric sensors for biomedical applications.
- Use the chemical and biosensors for measuring glucose and urea.
- Assess AC and DC bridges and recorders for appropriate measurement.

TEXT BOOKS

1. John G. Webster, Medical Instrumentation Application and Design, Wiley India Pvt. Ltd,New Delhi, 5th edition, 2020
2. A.K.Sawhney, Electrical & Electronics Measurement and Instrumentation, Dhanpat Rai & Co, New Delhi, 19th Revised edition, Reprint 2015.
3. Ernest O. Doebelin and Dhanesh N. Manik, Measurement systems, Application and design, McGraw Hill, 6th edition, 2012.

REFERENCE BOOKS

1. L.A Geddes and L.E.Baker, Principles of Applied Biomedical Instrumentation, Wiley IndiaPvt. Ltd, 3rd Edition, 2008.
2. Khandpur R.S, Handbook of Biomedical Instrumentation, Tata McGraw Hill, New Delhi,3rd edition, 2014.
3. Leslie Cromwell, Biomedical Instrumentation and measurement, Prentice hall of India, New Delhi, 2nd edition, 2015.
4. Albert D.Helfrick and William D. Cooper, Modern Electronic Instrumentation and Measurement Techniques, Prentice Hall of India, 1st edition, 2016.

RAP-207	**SENSORS AND INSTRUMENTATION LAB**	**0L:0T:2P**	**1 Credit**

LIST OF EXPERIMENTS:

1. Characterize the temperature sensor (RTD)
2. Simulate the performance of a bio-sensor
3. Measurement of level in a tank using capacitive type level probe
4. Characterize the LVDT
5. Design an orifice plate for a typical application
6. Simulate the performance of a chemical sensor
7. Characterize the strain gauge sensor
8. Characterize the temperature sensor (Thermocouple)
9. Determine the Characteristics of Various Light Detectors (Optical Sensors).
10. Data acquisition through Virtual Instrumentation.

HSMC-201	LIFE SKILLS	2 L: 0T: 0P	0 credits

COURSE OBJECTIVES:

- To develop communication competence in prospective engineers.
- To enable them to convey thoughts and ideas with clarity and focus.
- To develop report writing skills.
- To equip them to face interview & Group Discussion.
- To inculcate critical thinking process.
- To prepare them on problem solving skills.
- To provide symbolic, verbal, and graphical interpretations of statements in a problem description.
- To understand team dynamics & effectiveness.
- To create an awareness on Engineering Ethics and Human Values.
- To instill Moral and Social Values, Loyalty and also to learn to appreciate the rights of others.
- To learn leadership qualities and practice them.

COURSE CONTENTS:

MODULE I : COMMUNICATION SKILL

Introduction to Communication, The Process of Communication, Barriers to Communication, Listening Skills, Writing Skills, Technical Writing, Letter Writing, Job Application, Report Writing, Non-verbal Communication and Body Language, Interview Skills, Group Discussion, Presentation Skills, Technology-based Communication.

MODULE II: CRITICAL THINKING & PROBLEM SOLVING

Creativity, Lateral thinking, Critical thinking, Multiple Intelligence, Problem Solving, Six thinking hats, Mind Mapping & Analytical Thinking.

MODULE III: TEAMWORK

Groups, Teams, Group Vs Teams, Team formation process, Stages of Group, Group Dynamics, Managing Team Performance & Team Conflicts.

MODULE IV: ETHICS, MORAL & PROFESSIONAL VALUES

Human Values, Civic Rights, Engineering Ethics, Engineering as Social Experimentation, Environmental Ethics, Global Issues, Code of Ethics like ASME, ASCE, IEEE.

MODULE V: LEADERSHIP SKILLS

Leadership, Levels of Leadership, Making of a leader, Types of leadership, Transactions Vs Transformational Leadership, VUCA Leaders, DART Leadership, Leadership Grid & leadership Formulation

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

- Communicate effectively.
- Make effective presentations.
- Write different types of reports.
- Face interview& group discussion.
- Critically think on a particular problem.
- Solve problems.
- Work in Group & Teams Handle Engineering Ethics and Human Values.
- Become an effective leader.

TEXT BOOK:

1. Life Skills for Engineers, Complied by ICT Academy of Kerala, McGraw Hill Education (India) Private Ltd., 2016First Edition; Oxford Publishers
2. Barun K. Mitra; (2011), "Personality Development & Soft Skills", First Edition; Oxford Publishers.
3. Kalyana; (2015) "Soft Skill for Managers"; First Edition; Wiley Publishing Ltd

REFERENCE BOOKS:

1. Larry James (2016); "The First Book of Life Skills"; First Edition; Embassy Books.
2. Shalini Verma (2014); "Development of Life Skills and Professional Practice"; First Edition; Sultan Chand (G/L) & Company
3. John C. Maxwell (2014); "The 5 Levels of Leadership", Centre Street, A division of Hachette Book Group Inc.

SEMESTER – IV

SEMESTER IV

BSCT-202	MATHEMATICS -IV	2 L: 1T: 0P	3 credits

Course Objectives

- To analyze data using central tendency, dispersion, correlation, and regression.
- To apply large sample tests, conduct chi-square tests for goodness of fit and independence of attributes.
- To understand the fundamental concepts of experimental design, including one-way and two-way classifications.
- To solve linear systems using iterative and direct methods, and apply the power method to find dominant eigen values and eigen vectors.
- To utilize numerical methods for solving ordinary differential equations.
- To apply numerical techniques for solving partial differential equations.

MODULE I: Basic Statistics **9 PERIODS**

Measures of Central tendency – Mean – Median – Mode; Measure of Dispersion – Range – Variance – Standard Deviation; Correlation and regression; Curve fitting by the method of least squares.

MODULE II: Testing of Hypothesis **9 PERIODS**

Sampling distributions - Estimation of parameters - Statistical hypothesis - Large sample tests based on Normal distribution for single mean and difference of means -Tests based on Chi-square and F distributions for mean, variance and proportion - Contingency table (test for independent) - Goodness of fit.

MODULE III: Design of Experiments **9 PERIODS**

One way and two way classifications - Completely randomized design – Randomized block design – Latin square design - factorial design.

MODULE IV: Solution of Linear System and Numerical Integration **9 PERIODS**

Solutions to Linear System of Equations - Direct methods - Gauss elimination - LU decomposition - Iterative methods - Jacobi method, Gauss-Seidel method; Power method to find the dominant eigen value and eigen vector; Numerical Integration - Trapezoidal and Simpson’s Rules.

MODULE V:Numerical Solution of ODEs and PDEs **9 PERIODS**

Euler's method – Euler's modified method – Taylor's method and Runge – Kutta method for simultaneous equations and 2nd order equations – Stability analysis of single step methods – Multistep methods – Milne's and Adams' methods; Finite Difference Method for PDEs

TOTAL PERIODS:45

Course Outcomes

On successful completion of this course, the students will be able to

- Analyze data, infer relationships, and model distributions in statistics.
- Perform large sample tests, test for ratio of variances, chi-square test.
- Apply the fundamental concepts of experimental design, including one-way and two-way classifications..
- Compute the numerical solution of a given system AX=B using both direct and iterative methods and the largest eigen value and its corresponding eigenvector of a given matrix.
- Solve ordinary and partial differential equations numerically using the finite difference method.

TEXT BOOKS:

1. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.
2. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8th Edition, 2014.
3. Spiegel. M.R., Schiller. J. and Srinivasan. R.A., "Schaum's Outlines on Probability and Statistics ", Tata McGraw Hill Edition, 2004.

REFERENCE BOOKS:

1. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", 8th Edition, Pearson Education, Asia, 2007.
2. David Kincaid and Ward Cheney, "Numerical Analysis", 3rd edition, American Mathematics Society, (Indian Edition) – 2010.
3. Gerald C.F., and Wheatley P.O., "Applied Numerical Analysis", Addison-Wesley Publishing Company, 1994.
4. Jain, M.K., Iyengar, S.R. and Jain, R.K., "Numerical Methods for Scientific and Engineering Computation", New Age international, 2003.
5. Grewal. B.S. and Grewal. J.S., "Numerical Methods in Engineering and Science ", 10th Edition, Khanna Publishers, New Delhi, 2015.
6. Burden, R.L and Faires, J.D, "Numerical Analysis", 9th Edition, Cengage Learning, 2016.

RAT -208	CONTROL SYSTEMS	3 L: 0T:0P	3 credits

COURSE OBJECTIVES:

- To understand the use of transfer function models for analysis physical systems and introduce the control system components.
- To provide adequate knowledge in the time response of systems and steady state error analysis.
- To accord basic knowledge in obtaining the open loop and closed–loop frequencyresponses of systems.
- To introduce stability analysis and design of compensators.
- To introduce state variable representation of physical systems.

COURSE CONTENTS:

MODULE I: SYSTEMS AND THEIR REPRESENTATION 9 PERIODS

Basic elements in control systems – Open and closed loop systems – Electrical analogy of mechanical and thermal systems – Transfer function – Synchros – AC and DC servomotors – Block diagram reduction techniques – Signal flow graphs.

MODULE II: TIME RESPONSE 9 PERIODS

Time response – Time domain specifications – Types of test input – I and II order system response – Error coefficients – Generalized error series – Steady state error – Root locus construction- Effects of P, PI, PID modes of feedback control.

MODULE III: FREQUENCY RESPONSE 9 PERIODS

Frequency response – Bode plot – Polar plot – Nyquist plot- Constant M - N circles - Nichols Chart- Determination of closed loop response from open loop response - Correlation between frequency domain and time domain specifications.

MODULE IV: STABILITY AND COMPENSATOR DESIGN 9 PERIODS

Characteristics equation – Routh Hurwitz criterion – Performance criteria – Lag, lead and lag- lead networks – Effect of Lag, lead and lag-lead compensation on frequency response analysis - Design of compensator network using Bode plot.

MODULE V: STATE VARIABLE ANALYSIS 9 PERIODS

Concept of state variables – State models for linear and time invariant Systems – Solution of state and output equation in controllable canonical form – Concepts of controllability and observability.

TOTAL PERIODS:45

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

- Understand the importance of transfer function
- Analyse the system with respect to time domain
- Analyse the system with respect to frequency domain
- Analyse the stability of the system
- Design a compensator system to meet the desired specifications
- Implement a PID controller to improve the stability of the system

TEXT BOOKS:

1. S.Salivahanan, R.Rengaraj, and G.R.Venkatakrishnan, "Control systems Engineering", Pearson India Education, 2016.
2. Nagarath, I.J. and Gopal, M., "Control Systems Engineering", 7^{th} edition New Age International Publishers, 2021.
3. Katsuhiko Ogata, "Modern Control Engineering", Pearson India Education, 2015.

REFERENCE BOOKS:

1. Benjamin C. Kuo, "Automatic Control Systems", Wiley, 2018.
2. Richard C.Dorf and Bishop, R.H., "Modern Control Systems", Pearson IndiaEducation,2016.
3. John J.D., Azzo Constantine, H. and HoupisSttuart, N Sheldon, "Linear Control SystemAnalysis and Design with SIMULATION", CRC Taylor& Francis Reprint 2014.
4. M.Gopal, "Control System: Principle and design", McGraw Hill Education, 2012.
5. NPTEL Video Lecture Notes on "Control Engineering "by Prof. S. D. Agashe, IITBombay.

RAP -209	CONTROL SYSTEMS LAB	0 L: 0T:2P	1 Credit

LIST OF EXPERIMENTS:

1. Simulating and Analyzing Mechanical Systems with Differential Equations
2. Simulating and Analyzing Responses of Simple Electrical Systems with Differential Equations.
3. Analyzing Step Responses and Time Domain Specifications of First and Second-Order Systems
4. Comparative Analysis and Simulation of P, PI, PD, and PID Controllers for First and Second-Order Systems.
5. Simulating and Analyzing Frequency Response and Stability of a Robot Manipulator
6. Analyzing Routh-Hurwitz Stability Criterion for a given System
7. Analyzing Root Locus Plots and System Response Characteristics of Control Systems using Software Tools.
8. Exploring Nyquist Stability Criterion and System Response Characteristics with Software Tools for a Given System
9. Analyzing Response of Linear Discrete-Time Systems to Various Input Signals.
10. Modeling a Robot Manipulator in State Space and Analyzing System Matrices with Software Tools

RAT-210	ROBOTICS	3L:0T:0P	3 credits

COURSE OBJECTIVESS

- To introduce the functional elements of Robotics
- To impart knowledge on the direct and inverse kinematics
- To introduce the manipulator differential motion and control
- To educate on various path planning techniques
- To introduce the dynamics and control of manipulators

COURSE CONTENTS:

MODULE I: BASIC CONCEPTS **9 PERIODS**

Brief history-Types of Robot–Technology-Robot classifications and specifications-Design and control issues- Various manipulators – Sensors - work cell - Programming languages.

MODULE II: DIRECT AND INVERSE KINEMATICS **9 PERIODS**

Mathematical representation of Robots - Position and orientation – Homogeneous transformation-Various joints- Representation using the Denavit Hattenberg parameters -Degrees of freedom-Direct kinematics-Inverse kinematics- SCARA robots- Solvability – Solution methods-Closed form solution.

MODULE III: MANIPULATOR DIFFERENTIAL MOTION AND STATICS **9 PERIODS**

Linear and angular velocities-Manipulator Jacobian-Prismatic and rotary joints–Inverse -Wrist and arm singularity - Static analysis - Force and moment Balance.

MODULE IV: PATH PLANNING **9 PERIODS**

Definition-Joint space technique-Use of p-degree polynomial-Cubic polynomial-Cartesian space technique - Parametric descriptions - Straight line and circular paths - Position and orientation planning.

MODULE V: DYNAMICS AND CONTROL **9 PERIODS**

Lagrangian mechanics-2DOF Manipulator-Lagrange Euler Formulation-Dynamic model – Manipulator control problem-Linear control schemes-PID control scheme-Force control of robotic manipulator.

TOTAL PERIODS:45

COURSE OUTCOMES

On successful completion of the module students will be able to:

- Ability to understand basic concept of robotics.
- Analyze Instrumentation systems and their various applications.
- Know about the differential motion add statics in robotics
- Know about the various path planning techniques.
- Know about the dynamics and control in robotics industries

TEXT BOOKS:

1. R.K.Mittal and I.J.Nagrath, Robotics and Control, Tata McGraw Hill, New Delhi,4th Reprint, 2017.
2. JohnJ.Craig ,Introduction to Robotics Mechanics and Control, Third edition, Pearson Education, 2009.
3. Mikell P Groover, Mitchell Weiss, Roger N Nagel, Nicholas Odrey, Ashish Dutta "Industrial Robotics (SIE): Technology, Programming and Applications, McGraw Hill Education India, 2012

REFERENCE BOOKS:

1. Ashitava Ghoshal, Robotics-Fundamental Concepts and Analysis', Oxford University Press, Sixth impression, 2010.
2. K. K.Appu Kuttan, Robotics, I K International, 2007.
3. Edwin Wise, Applied Robotics, Cengage Learning, 2003.
4. R.D.Klafter, T.A.Chimielewski and M.Negin, Robotic Engineering–An Integrated Approach, Prentice Hall of India, New Delhi, 1994.
5. B.K.Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers,Chennai, 1998.
6. S.Ghoshal, " Embedded Systems & Robotics" – Projects using the 8051 Microcontroller", Cengage Learning, 2009.

RAP-211	ROBOTICS LAB	0L:0T:2P	1 Credit

List of experiments

1. Simulation of Mathematical Model of Robot.
2. Forward and Inverse Dynamic Analysis of a 2-DOF Robotic Manipulator using Software Tools.
3. Building and Programming a Simple Arduino-Based Robot for basic movement.
4. Build a robot that can navigate through a maze or an environment by using sensors to detect obstacles and avoid them.
5. Construct a robotic arm using servo motors or stepper motors and program the arm to perform various tasks, such as picking up objects, sorting the colour, or drawing shapes.
6. Build a robot that follows a black line on a contrasting surface using line-following sensors.
7. Designing a 3D Model of a Robotic Arm and Grippers Using Software
8. Implement a PID controller for a robotic arm or mobile robot and simulate its performance in tracking a desired trajectory.

RAT -212	HYDRAULICS AND PNEUMATICS	3 L:0T:0 P	3 Credits

COURSE OBJECTIVES:

- To provide student 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 CONTENTS:

MODULE I: FLUID POWER PRINICIPLES AND HYDRAULIC PUMPS 9 PERIODS

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.

MODULE II: HYDRAULIC ACTUATORS AND CONTROL COMPONENTS 9 PERIODS

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.

MODULE III: HYDRAULIC CIRCUITS AND SYSTEMS 9 PERIODS

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.

MODULE IV: PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS 9 PERIODS

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.

MODULE V: TROUBLE SHOOTING AND APPLICATIONS 9 PERIODS

Installation, Selection, Maintenance, Trouble Shooting 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.

TOTAL PERIODS:45

COURSE OUTCOMES

On successful completion of the module students will be able to:

- Understand the Fluid power and operation of different types of pumps.
- Summarize the features and functions of Hydraulic motors, actuators and Flow control valves.
- Understand the Different types of Hydraulic circuits and systems.
- Understand the working of different pneumatic circuits and systems.
- Summarize the various trouble shooting methods and applications of hydraulic and pneumatic systems.

TEXT BOOKS:

1. Anthony Esposito, -Fluid Power with Application|, Pearson Education (Singapore) Pvt. Ltd, Delhi, India, 2013.
2. Majumdar S.R., "Oil Hydraulics Systems- Principles and Maintenance", Tata McGraw-Hill, 2001.
3. Majumdar S.R., "Pneumatic systems – Principles and maintenance", Tata McGraw Hill, 2002

REFERENCE BOOKS:

1. Anthony Lal, "Oil hydraulics in the service of industry", Allied publishers, 1982.
2. Dudelyt, A. Pease and John T. Pippenger, "Basic Fluid Power", Prentice Hall, 1987.
3. Michael J, Prinches and Ashby J. G, "Power Hydraulics", Prentice Hall, 1989.
4. Shanmugasundaram.K, "Hydraulic and Pneumatic controls", Chand & Co, 2006.

RAP -213	HYDRAULICS AND PNEUMATICS LAB	0 L: 0T:2P	1 Credit

LIST OF EXPERIMENTS

1. Simulation of basic hydraulic, pneumatic and electrical circuits.
2. Study of Electro pneumatic circuits.
3. Simulation of electro- pneumatic circuits using microprocessor.
4. Modeling and analysis of basic hydraulic, pneumatic and electrical circuits using Simulation Software.
5. Study of various types of transducers.
6. Study of various signal conditioning circuits.
7. Open and closed loop control of AC and DC drives.
8. Study of PLC and its applications.
9. Study of hydraulics circuit using PLC.

PROJ RA -201	MICRO PROJECT	0L:0T:4P	2 Credits

COURSE OBJECTIVES:

The main objectives of Micro Project is to let the students apply the knowledge of theoretical concepts which they have learnt as a part of the curriculum of the minor degree using real time problems or situations.

COURSE CONTENTS:

This course is a project type. The plan of conducting this course is given below:

1. Participants will be divided into teams of two members within first week of the starting of the course by the course coordinators/managers depending on the number of participants registered in the course. The benefits of such team-based projects are listed in the Course Outcomes below.
2. The teams will have a team coordinator or leader, which will be identified by the coordinators/managers of the course (may be the first name in the list of a student team).
3. The projects could be of the following types: a) Literature search (LS) type: Studying about an aspect of robotics, say, vision, robot kinematics, dynamic, controls, etc. b) Algorithm development (AD) type: Analyse, say, a robot kinematics using Robo Analyzer or Simulation/Octave/Freemat/Scilab or similar software or write an algorithm using any programming language (Python, etc.). For example, writing forward kinematics of a robot or image processing in Vision. c) Design/synthesis (DS) type: Proposing a new type of system/device for performing certain task. For example, a mobile robot for Covid-19 isolation wards.
4. The teams will be asked to contact their team members within a week and decide their topic with two weeks, i.e., within first 3 weeks of the starting of the course.
5. Students MUST spend about 4 hours in a week to discuss their progress together, study together or individually, write programs, fabricate circuits, etc.
6. During the project session the coordinators will explain how to do literature survey, how to find the sources of hardware, which software to use for a particular purpose, how to select an electric motor, etc., present case studies, etc.
7. At the end of the course duration, each team will submit no more than 10 slides in .pdf file and/or not more than a video of one min to showcase their project hardware/software/plots, etc. generated during the project to a cloud (say, Google Drive).

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

- To describe and discuss the elements of effective management,
- discuss and apply the planning, organizing and control processes,
- describe various theories related to the development of leadership skills, motivationtechniques, team work and effective communication,
- communicate effectively through both oral and written presentation,
- Learners will have a better understanding of human behaviour in organization.
- They will know the framework for managing individual and group performance.

SUPPLEMENTARY LEARNING MATERIAL:

1. http://www.ddrobocon.in/
2. http://courses.csail.mit.edu/iap
3. https://fabacademy.org/students

HSMC-202	MANAGEMENT (ORGANIZATIONAL BEHAVIOUR/ FINANCE & ACCOUNTING)	3L:0T:0P	3 Credits

COURSE OBJECTIVES:

- To understand and appreciate the fact that why & how of human behaviour in organizations is critical for its success and to orient the managers-to-be to develop people skills to make and run the work-place effective, innovative and stake-holder centric.
- To acquaint the students with the fundamentals principles of financial, cost and management accounting and to enable the students to prepare, analyse and interpret financial statements.

COURSE CONTENTS:

MODULE I: ORGANISATIONAL BEHAVIOUR 9 PERIODS

Introduction, Definition, Nature & Scope; Basic Concepts of OB. including, Behaviour – Individual & organizational, and Self Image [includes discussion on self-esteem & self-efficacy]; Introduction to the theoretical constructs and models of Organisational Behaviour.

MODULE II: PERCEPTION AND LEARNING 9 PERIODS

Personality and Individual Differences; Motivation – Content & Process Theories of Work Motivation - and Job Performance; Personal Values, Attitudes and Beliefs; Conflicts & Stress – Concept, why and how & Management.

MODULE III: ORGANISATIONAL STRUCTURE 9 PERIODS

& its influence on personnel behaviour in organizations; Organisational Climate and Culture; Creating a culture for Innovation & Creativity; Organisational Change and Development.

MODULE IV: BOOK-KEEPING AND ACCOUNTING 9 PERIODS

– Meaning – Definition – Objectives of Financial Accounting – Branches of Accounting: Financial, Cost and Management Accounting – Accounting Concepts and conventions – journal – Ledger – Trial Balance – Preparation of Final Accounts: Trading, Profit and Loss Account and Balance Sheet (problems) – Accounting Standards – Groups interested in Accounting Information.

MODULE V: DEPRECIATION 9 PERIODS

– Definition – Causes – Necessity of providing for depreciation – Methods of Calculating Depreciation: Straight Line Method and Written Down Value Method -Financial Statements – Meaning – Types of financial Analysis – Techniques of Financial Analysis – Ratio Analysis – Profitability Ratios – Coverage Ratios – Turnover Ratios – Financial Ratios – Ratios to Financial Statement (problems) – uses and limitations of Ratio Analysis

COURSE OUTCOMES:

On successful completion of this course, the students will be able to

- Demonstrate the conceptual frame work of Orgnaisational Behaviour
- Understand and interpret the individual differences and analyze various theories and models of OB
- Anlayze the various structure of the organization for acheviing organizational goals efficiently and effectively
- Analyze and interpret financial statements using accounting information
- Outcome: Apply various methods of Depreciation and Ratio Analysis tools to solve the related problems

TEXT BOOKS:

1. Fred Luthans, ORGANISATIONAL BEHAVIOUR, 11th Edition, Tata McGraw Hill, New Delhi.
2. Christopher Grey, A Very Short Fairly Interesting and Reasonably Cheap Book About Studying Organizations, 2nd Edition, University of Warwick
3. N. Vinayakam & B. Charumathi: Financial Accounting, S. Chand 2. S.N.

REFERENCE BOOKS:

1. Robbins: Organizational Behaviour: [International Edition 11], Prentice Hall
2. Michael Drafke, Human Side of Organizations [International Edition 10], Pearson Education, New Delhi.
3. R.S. Dwivedi: HUMAN RELATIONS AND ORGANISATIONAL BEHAVIOUR, 5 th Edition, Macmillan India Limited, New Delhi.
4. Hellriegel, Slocum & Woodman: ORGANISATIONAL BEHAVIOUR, Thomson South-Western, New Delhi.
5. Hingorani, Ramanathan & Grewal: Management Accounting, Sultan Chand
6. R.N. Anthony: Management Accounting – Text and cases, Irwin
7. B.K. Bhar: Cost Accounting, Academic Publishers
8. H.G. Guthman: Analysis of Financial Statements, Prentice Hall

AU-201	ENVIRONMENTAL SCIENCES	2 L:0T:0 P	0 CREDITS

COURSE OBJECTIVES:

- To know about the environment
- To understand about environmental pollution
- To apply the knowledge in understanding various environmental issues and problems

COURSE CONTENTS:

MODULE I: ENVIRONMENT AND ENERGY RESOURCES

Environmental segments – atmosphere, hydrosphere, lithosphere and biosphere. Atmospheric layers. Pollution definition and classification. Pollutants classification. Forest resources – use and over exploitation, deforestation, forest management. Water resources – use and conflicts over water, dams - benefits and problems. Mineral resources – mineral wealth of India, environmental effects of extracting and using mineral resources. Food resources – world food problems, environmental impact of modern Agriculture – fertilizer and pesticides. Energy resources – growing needs, renewable and non-renewable energy resources and use of alternate energy sources. From unsustainable to sustainable development.

MODULE II: ECOSYSTEM & BIODIVERSITY

Concept of an ecosystem - structure and function of an ecosystem. Producers, consumers, and decomposers. Energy flow in the ecosystem. Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of forest, grassland, desert and aquatic (fresh water, esturine and marine) ecosystems. Biodiversity – definition, genetic species and ecosystem diversity. Value of biodiversity - consumptive use, productive use, social, ethical, aesthetic and option values. Hot spots of biodiversity. Threats to biodiversity, habitat loss, poaching of wildlife, human wildlife conflicts. Endangered and endemic species. Conservation of biodiversity – in-situ and ex-situ conservation of biodiversity.

MODULE III: AIR POLLUTION

Definition and classification. Chemical and photochemical reaction in different layers of atmosphere. Causes, sources, effects and control measures of air pollutants - oxides of Nitrogen, oxides of Carbon, oxides of Sulfur, hydrocarbons, chloro-fluoro carbons and particulates. Mechanism and effects of air pollution phenomenon – Global Warming, Ozone Depletion, Acid Rain, Sulfurous Smog and Photochemical Smog.

MODULE IV: WATER AND LAND POLLUTION

Water pollution – causes and effects of organic water pollutants – pesticides, insecticides, detergents and surfactants. Causes and effects of inorganic water pollutants – heavy metal pollution due to Hg, Pb, Cr & Cu.

Water pollution control and monitoring – DO, COD, BOD & TOC. Land Pollution – Solid waste management – causes, effect and control measures of urban and industrial wastes. Thermal and radioactive pollution.

MODULE V: POLLUTION CONTROL AND MONITORING

Basic concepts and instrumentation of IR, UV-VIS, atomic absorption spectrometry, Gas Chromatography and Conductometry. Analysis of air pollutants – NOx, COx, SOx, H2S, Hydrocarbons and particulates.

COURSE OUTCOMES

On successful completion of the module students will be able to:

- Apply fundamental knowledge to understand about the environment
- Identify environmental pollution through science
- Apply basic knowledge to solve various environmental issues and problems

TEXT BOOKS:

1. Raghavan Nambiar K., ‑Text Book of Environmental Studies‖ 2nd edition, Scitech Publications, India, Pvt. Ltd, Chennai, 2010.
2. A.K. De, ‑Environmental chemistry‖ 6rd edition; New age international (P) Ltd, New Delhi, 2006
3. G. S. Sodhi, Fundamental concepts of environmental chemistry, I Ed, Alpha Science International Ltd, India, 2009.

REFERENCE BOOKS:

1. B.K. Sharma, ‑Environmental chemistry‖ 11th Ed, KRISHNA Prakashan Media (P) Ltd, Meerut, 2014.
2. S.S.Dara, and D.D. Mishra ‑A text book of environmental chemistry and pollution control, 5th Ed, S.Chand and Company Ltd, New Delhi, 2018.
3. Richard T. Wright, Environmental Science: Toward a Sustainable Future, 10thedition, Prentice Hall, 2011

SEMESTER – V

RAT-301	SIGNALS AND SYSTEMS	3 L:1T:0 P	4 Credits

COURSE OBJECTIVES:

- To impart knowledge about Signals and systems & their mathematical representation.
- To understand about analysis of Discrete time signals and systems
- To know about Transformation techniques & their use.
- To understand about filters and realisation of DT systems.

COURSE CONTENTS:

MODULE I: CLASSIFICATION OF SIGNALS AND SYSTEMS 12 PERIODS

Standard signals-Step, Ramp, Pulse, Impulse, Real and complex exponentials and Sinusoids-Classification of signals – Continuous time (CT) and Discrete Time (DT) signals, Periodic & Aperiodic signals, Deterministic & Random signals, Energy & Power signals - Classification of systems- CT systems and DT systems- – Linear & Nonlinear, Time-variant & Time-invariant, Causal & Non-causal, Stable & Unstable.

MODULE II: ANALYSIS OF DISCRETE TIME SIGNALS 12 PERIODS

Baseband signal Sampling – Discrete Fourier series - Fourier Transform of discrete time signals (DTFT) & its properties - Z Transform & its properties – Evaluation of the inverse z-transform.

MODULE III: ANALYSIS OF DISCRETE TIME SYSTEMS 12 PERIODS

Impulse response – MODULE Step response - Difference equations – Convolution sum – Discrete Time Fourier Transform and Z transform Analysis of recursive & non-recursive systems – Realization of DT systems connected in parallel and series.

MODULE IV: DISCRETE AND FAST FOURIER TRANSFORM 12 PERIODS

Discrete Fourier transform – properties of DFT – Convolution using DFT – Magnitude and phase representation, Computation of DFT using FFT algorithm – DIT &DIF using radix 2 FFT Linear Filtering using FFT.

MODULE V: DESIGN OF DIGITAL FILTERS 12 PERIODS

Characteristics of Butterworth and Chebyshev filters – Design of IIR filters using impulse invariance method and bilinear transformation, Design of FIR filter using Rectangular and Hamming windows.

TOTAL PERIODS:60

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

- Acquire knowledge on Signals and systems & their mathematical representation
- Understand and analyze the discrete time systems
- Understand the importance of transforms & their computation
- Understand the types of digital filters and design for digital implementation

TEXT BOOKS

1. Allan V.Oppenheim, S.Wilsky and S.H.Nawab, - Signals and Systems, Pearson, 2015.
2. John G. Proakis & Dimitris G. Manolakis, - Digital Signal Processing – Principles,Algorithms & Applications, Fourth Edition, Pearson Education / Prentice Hall, 2007.
3. S.Salivahanan-Digital Signal Processing,McGraw Hill Eductaion,New Delhi, ThirdEdition,2015.

REFERENCE BOOKS

1. R.E.Zeimer, W.H.Tranter and R.D.Fannin, ―Signals & Systems - Continuous and Discrete‖, Pearson, 2007.
2. A.V.Oppenheim,R.W.Schafer and J.R.Buck-Discrete-Time Signal Processing,8th Indian Reprint,Pearson ,2004.
3. Sanjit K.Mitra-Digital Signal Processing-A Computer Based Approach-McGraw Hill Education,New Delhi,2013.

RAT-302	KINEMATICS AND DYNAMICS OF MACHINES	3L:1T:0P	4 Credits

COURSE OBJECTIVES

- To understand the basic knowledge about kinematics of machines.
- To understand the basic components and layout of linkages in the assembly of a system/ machine.
- To understand the principles in analyzing the assembly with respect to the displacement, velocity, and acceleration at any point in a link of a mechanism.
- To understand the motion resulting from a specified set of linkages, design few linkage mechanisms and cam mechanisms for specified output motions.
- To understand the basic concepts of toothed gearing and kinematics of gear trains and the effects of friction in motion transmission and in machine components.

COURSE CONTENTS:

MODULE I: KINEMATIC OF MACHINES 12 PERIODS

Mechanisms – Terminology and definitions – kinematics inversions of 4 bar and slide crank chain – kinematics analysis in simple mechanisms – velocity and acceleration polygons – Analytical methods – computer approach – cams – classifications – displacement diagrams - layout of plate cam profiles – derivatives of followers motion – circular arc and tangent cams.

MODULE II: GEARS and GEAR TRAINS 12 PERIODS

Spur gear – law of toothed gearing – involute gearing – Interchangeable gears – Gear tooth action interference and undercutting – nonstandard teeth – gear trains – parallel axis gears trains – epicyclic gear trains – automotive transmission gear trains.

MODULE III: FRICTION 12 PERIODS

Sliding and Rolling Friction angle – friction in threads – Friction Drives –Belt and rope drives.

MODULE IV: KINEMATICS OF CAM MECHANISMS 12 PERIODS

Classification of cams and followers – Terminology and Definitions – Displacement Diagrams- Uniform velocity , Parabolic , Simple Harmonic and cycloid motions – Derivatives of follower motions – Layout of plate cam profiles – Specified Contour cams – Circular arc and tangent cams – Pressure angle and undercutting – Sizing of cams.

MODULE V: BALANCING AND VIBRATION 12 PERIODS

Static and Dynamic balancing – Balancing of revolving and reciprocating masses – Balancing machines – free vibrations – Equations of motion – natural Frequency – Damped Vibration bending critical speed of simple shaft.

TOTAL PERIODS:60

COURSE OUTCOMES

On successful completion of the module students will be able to:

- Understand the basic knowledge of kinematics of machines
- Students can able to apply fundamentals of mechanism for the design of new mechanisms
- Able to know about the linkages, design few linkage mechanisms and cam mechanisms for specified output motions.
- Impart knowledge about the gears and gear trains.
- Ability to analyze them for optimum design

TEXT BOOKS:

1. Ambekar A.G., "Mechanism and Machine Theory" Prentice Hall of India, New Delhi, 2007
2. Shigley J.E., Pennock G.R and Uicker J.J., "Theory of Machines and Mechanisms", Oxford University Press, 2003

REFERENCE BOOKS:

1. Thomas Bevan, "Theory of Machines", CBS Publishers and Distributors, 1984.
2. Ghosh. A, and A.K. Mallick, "Theory and Machine", Affiliated East-West Pvt. Ltd., New Delhi, 1988.
3. Rao.J.S. and Dukkipatti R.V. "Mechanisms and Machines", Wiley-Eastern Ltd., New Delhi, 1992.
4. John Hannah and Stephens R.C., "Mechanics of Machines", Viva Low Prices Student Edition, 1999.
5. V.Ramamurthi, Mechanisms of Machine, Narosa Publishing House, 2002.
6. Robert L.Norton, Design of Machinery, McGraw-Hill, 2004.

RAT-303	DIGITAL ELECTRONICS	3 L:0T:0 P	3 Credits

COURSE OBJECTIVES:

- To present the Digital fundamentals, Boolean algebra and its applications in digital systems
- To familiarize with the design of various combinational digital circuits using logic gates
- To introduce the analysis and design procedures for synchronous and asynchronous sequential circuits
- To explain the various semiconductor memories and related technology
- To introduce the electronic circuits involved in the making of logic gates

COURSE CONTENTS:

MODULE I: DIGITAL FUNDAMENTALS 9 PERIODS

Number Systems – Decimal, Binary, Octal, Hexadecimal, 1‘s and 2‘s complements, Codes – Binary, BCD, Excess 3, Gray, Alphanumeric codes, Boolean theorems, Logic gates, Universal gates, Sum of products and product of sums, Minterms and Maxterms, Karnaugh map Minimization and Quine-McCluskey method of minimization.

MODULE II: COMBINATIONAL CIRCUIT DESIGN 9 PERIODS

Design of Half and Full Adders, Half and Full Subtractors, Binary Parallel Adder – Carry look ahead Adder, BCD Adder, Multiplexer, Demultiplexer, Magnitude Comparator, Decoder, Encoder, Priority Encoder.

MODULE III: SYNCHRONOUS SEQUENTIAL CIRCUITS 9 PERIODS

Flip flops – SR, JK, T, D, Master/Slave FF – operation and excitation tables, Triggering of FF, Analysis and design of clocked sequential circuits – Design - Moore/Mealy models, state minimization, state assignment, circuit implementation – Design of Counters- Ripple Counters, Ring Counters, Shift registers, Universal Shift Register.

MODULE IV: ASYNCHRONOUS SEQUENTIAL CIRCUITS 9 PERIODS

Stable and Unstable states, output specifications, cycles and races, state reduction, race free assignments, Hazards, Essential Hazards, Pulse mode sequential circuits, Design of Hazard free circuits.

MODULE V: MEMORY DEVICES AND DIGITAL INTEGRATED CIRCUITS 9 PERIODS

Basic memory structure – ROM -PROM – EPROM – EEPROM –EAPROM, RAM – Static and dynamic RAM - Programmable Logic Devices – Programmable Logic Array (PLA) - Programmable Array Logic (PAL) – Field Programmable Gate Arrays (FPGA) - Implementationof combinational logic circuits using PLA, PAL.Digital integrated circuits: Logic levels, propagation delay, power dissipation, fan-out and fan- in, noise margin, logic families and their characteristics-RTL, TTL, ECL, CMOS

TOTAL PERIODS:45

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

- Use digital electronics in the present contemporary world
- Design various combinational digital circuits using logic gates
- Do the analysis and design procedures for synchronous and asynchronous sequential Circuits
- Use the semiconductor memories and related technology
- Use electronic circuits involved in the design of logic gates

TEXT BOOKS:

1. M. Morris Mano and Michael D. Ciletti, “Digital Design”, 5th Edition, Pearson, 2014.
2. A.Anand Kumar “Fundamentals of Digital Circuits”, 4th Edition, PHI Learning Private Limited, 2016.
3. Soumitra Kumar Mandal “Digital Electronics”, McGraw Hill Education Private Limited,2016.

REFERENCE BOOKS:

1. Charles H.Roth. “Fundamentals of Logic Design”, 6th Edition, Thomson Learning, 2013.
2. Thomas L. Floyd, “Digital Fundamentals”, 10th Edition, Pearson Education Inc, 2011
3. S.Salivahanan and S.Arivazhagan“Digital Electronics”, Ist Edition, Vikas PublishingHouse pvt Ltd, 2012.
4. Anil K.Maini “Digital Electronics”, Wiley, 2014.

RAP-304	DIGITAL ELECTRONICS LAB	0 L:0T:2 P	1 Credit

LIST OF EXPERIMENTS:

1. Verification and interpretation of truth table for AND, OR, NOT, NAND, NOR, Ex-OR, Ex-NOR gates
2. Construction of half and full adder using XOR and NAND gates and verification of its operation
3. To Study and Verify Half and Full Subtractor
4. Realization of logic functions with the help of Universal Gates (NAND, NOR)
5. Construction of a NOR gate latch and verification of its operation
6. Verify the truth table of RS, JK, T and D flip-flops using NAND and NOR gates
7. Design and Verify the 4-Bit Serial In - Parallel Out Shift Registers
8. Implementation and verification of decoder or de-multiplexer and encoder using logic gates
9. Implementation of 4x1 multiplexer and 1x4 demultiplexer using logic gates
10. Design and verify the 4- Bit Synchronous or Asynchronous Counter using JK Flip Flop
11. Verify Binary to Gray and Gray to Binary conversion using NAND gates only
12. Verify the truth table of one bit and two bit comparator using logic gates
13. Data converters

    Construction and study performance of

    a. DAC circuits – R-2R and ladder type.

    b. Successive approximation type ADC.

RAT -305	MICROCONTROLLER AND EMBEDDED SYSTEMS	3L:0T:0P	3 Credits

COURSE OBJECTIVES:

- To understand the architectures and the instruction set of 8085, 8086, 8051
- To learn the assembly language program using 8085, 8086 and 8051 instructions set
- To learn interfacing of microprocessors and microcontrollers with various peripheral
- To introduce embedded systems, its hardware, software, devices and buses used for embedded networking.

COURSE CONTENTS:

MODULE I: INTEL 8085 MICROPROCESSOR 9 PERIODS

Intel 8085 Hardware - Architecture – Pin description and addressing modes; Intel 8086 Hardware – Pin description and addressing modes; Intel 8051 Microcontroller: Introduction – Architecture – Memory Organization – Special Function Registers – Pins and Signals – Timing and control – Port Operation – Memory and I/O interfacing – Interrupts – Instruction Set and Programming.

MODULE II: ON-CHIP PERIPHERALS & PERIPHERAL DEVICES 9 PERIODS

I/O Port Programming - Timer Registers -Timer Modes - Overflow Flags - Clocking Sources -Timer/ Counter Interrupts – Timer Programming - Baud Rate Generation - Serial Port Register -Modes of Operation - Serial Port Programming- Interrupt Organization- Processing Interrupts - Interrupt Programming- Programmable Peripheral Interface (8255) - Keyboard / Display Controller (8279) - Programmable Interrupt Controller (8259).

MODULE III: DESIGN OF MICROCONTROLLER BASED SYSTEM 9 PERIODS

Voltage, Current and Frequency Measurement - DC Motor Control - Stepper Motor control - Case Studies: Arduino Board Overview - Arduino IDE - Temperature Control.

MODULE IV: EMBEDDED SYSTEMS & ARCHITECTURE OF ARM PROCESSOR 9 PERIODS

Processor Embedded into a system - Embedded Hardware MODULEs and devices in a system - Embedded Software in a System -Classification of Embedded Systems - Embedded Design Life Cycle - Design Example: Model Train Controller. ARM Embedded System - CISC and RISC Processors - ARM Architecture - Programming Model - Operating Modes.

MODULE V: INTRODUCTION TO PIC MICROCONTROLLER AND ARM PROGRAMMING **9 PERIODS**

General Introduction, PIC 16F877 architecture, Registers, Memory Organization, Addressing Modes, Instruction Set of PIC Microcontroller, PIC16F877 Peripherals: Timers, CCP modules,ADC modules, External Memory Interface. ARM Instruction Set - ARM Instruction Types: Data Transfer, Data Processing and Control Flow Instructions - Interrupts – Exceptions types - NVIC Registers for interrupt control**.**

TOTAL PERIODS:45

COURSE OUTCOMES

On successful completion of this course students will be able to:

- Interpret the architecture & instruction set of 8085, 8086, 8051 microcontroller to develop assembly language programs
- Illustrate the application of 8051 microcontroller on chip peripherals to implement the functions of I/O port, timer/Counter, serial port & interrupts.
- Demonstrate the peripheral devices 8255 PPI and 8279 for integrating keyboard, 7 segment display, LCD display and traffic light controller & 8259 PIC for handling multiple interrupts I/O
- Design 8051 Microcontroller based systems for measuring electrical and physical quantities & Motor control. Interpret the hardware and software components of an embedded system for an application and infer the architecture and programming model of ARM processor.
- Infer the instruction set and exception types of ARM processor to develop Assembly language programs

TEXT BOOKS:

1. Krishna Kant, “Microprocessors and Microcontrollers – Architectures, Programming and System Design 8085, 8086, 8051, 8096”, PHI, 2014.

2. Muhammad Ali Mazidi, Janice Gillispie Mazidi and Rolin D. McKinley, "The 8051 Microcontroller and Embedded Systems Using Assembly and C ", 2nd Edition, Pearson Education 2013.

3. Kenneth J. Ayala, "The 8051 Microcontroller. Architecture, Programming and Applications", 3rd Edition, West publishing company 2014

4. Andrew N.Sloss, Dominic Symes and Chris Wright, "ARM System Developer's Guide: Designing and Optimizing System Software", Morgan Kaufmann Publishers, 1st Edition, 2004.

5. Raj Kamal, "Embedded Systems Architecture, Programming and Design", Tata McGraw Hill, 2nd Edition, 2009

REFERENCE BOOKS:

1. Soumitra Kumar Mandal "Microprocessors and Microcontrollers Architecture Programming and Interfacing using 8085, 8086 & 8051" Tata McGraw Hill Publishing Co Ltd, 1st Edition, 2011.
2. Myke Predko, "Programming and Customizing the 8051 Microcontroller", 1st Edition, 2012.
3. Chris Braith, "8051 Microcontroller Application based Introduction", Elsevier 2004.
4. Manish K Patel, "The 8051 Microcontroller Based Embedded Systems "Tata McGraw Hill Publishing Co Ltd, Ist Edition, 2014.
5. Jonathan W Valvano, "Embedded Systems: Introduction to Arm® Cortex TM-M Microcontrollers", 5th Edition, 2015.
6. Shibu K.V, "Introduction to Embedded Systems", Tata Mc Graw Hill, 1st Edition, 2009.
7. Jean J.Labrosse, "Embedded Systems Building Blocks", CMP Books, 2nd Edition, 2010.

RAP -306	MICROCONTROLLER AND EMBEDDED SYSTEMS LAB	0L:0T:2P	1 Credit

LIST OF EXPERIMENTS:

MICROCONTROLLER LAB:

1. Developing Assembly Language Programs using 8051 Microcontroller Kits
2. Interfacing Traffic light controller
3. Interfacing ADC
4. Interfacing DAC

EMBEDDED LABORATORY

1. Voltage Measurement with display
2. Designing a voltmeter to measure voltage from 0 to 5 volts and displaying the measured value using 7 segment displays
3. Design of Water Pump Controller to sense the water level in a tank
4. Digital Clock with LCD display
5. Temperature Measurement with 7 segment display
6. Establishing an FM link between two microcontrollers for data transfer.
7. Moisture sensor and sprinkler controller design
8. Designing a lamp controller having a light sensor and a time

RAT -307	PROGRAMMABLE LOGIC CONTROLLER	3L:0T:0P	3Credits

COURSE OBJECTIVES:

- To provide knowledge levels needed for PLC programming and operating.
- To make the students understand how devices are connected with PLC input and output modules.
- To train the students to create ladder diagrams from process control descriptions.
- To make the students understand various types of PLC registers
- Apply PLC Timers and Counters for the control of industrial processes
- To make the students understand PLC functions, Data Handling Futions
- To train the students to develop a ―coil and contact‖ control system to operate a basic robot and analog PLC operations.

COURSE CONTENTS:

MODULE I : INTRODUCTION TO FACTORY & PROCESS AUTOMATION 9 PERIODS

Industrial Versions - Control elements of Industrial Automation- IEC/ ISA Standards for Control Elements – Selection criteria for control elements- Construction of Relay Ladder logic with different control elements- Need for PLC - PLC evolution.

MODULE II: PROGRAMMABLE LOGIC CONTROLLERS 9 PERIODS

Architecture of PLC - Types of PLC – PLC modules, PLC Configuration -Scan cycle - Capabilities of PLC- Selection criteria for PLC – PLC Communication with PC and software- PLC Wiring- Installation of PLC and its Modules.

MODULE III: PROGRAMMING IN PLC 9 PERIODS

Types of Programming – Bit Instructions -Timers and counters– PLC arithmetic functions PTO / PWM generation- High Speed Counter – Analog Scaling – Encoder Interfacing- Servo drive control – Stepper Motor Control.

MODULE IV: HMI SYSTEMS 9 PERIODS

Need for HMI in Industrial Automation, Types of HMI – Configuration of HMI, Screen development and navigation, Configuration of HMI elements / objects and Interfacing with PLC.

MODULE V: NETWORKING 9 PERIODS

PLC Networking- Networking standards & IEEE Standard - Protocols - Field bus - Process bus and Ethernet -CAN Open**.** APPLICATIONS OF PLC: Case studies of manufacturing automation and Process automation.

TOTAL PERIODS:45

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

- Gain knowledge on Programmable Logic Controllers
- Learn about the design of systems using Programmable Logic Controllers
- Know about the different applications of Programmable Logic Controllers
- Understand different types of Devices to which PLC input and output modules are connected
- Provide the knowledge about understand various types of PLC registers
- Create ladder diagrams from process control descriptions.
- Apply PLC timers and counters for the control of industrial processes
- Use different types PLC functions, Data Handling Function.
- Develop a ―coil and contact‖ control system to operate a basic robot and analog PLC operations.

TEXT BOOKS:

1. W. Bolton, -Programmable logic controllers‖, Elsevier Ltd, 2015.
2. Frank D Petruzella, -Programmable logic controllers‖, McGraw-Hill, 5th Ed, 2016..

REFERENCE BOOKS:

1. John R Hackworth and Fredrick D Hackworth Jr., -Programmable Logic Controllers: Programming Methods and Applications‖, Pearson Education, 2015.
2. SIMATIC Programming with STEP 7, SIEMENS Manual, 2014.

RAP -308	PROGRAMMABLE LOGIC CONTROLLER LAB	0L:0T:2P	1 Credit

LIST OF EXPERIMENTS

Study of different PLCs and their specification

1. Development of ladder logic diagram using Bit Instructions.
2. PLC based Crane control.
3. PLC based parking station using Counter and Bit Instructions.
4. Analog Sensor interfacing with PLC.
5. Encoder interfacing with
6. Stepper motor / Servo motor control using PLC
7. Study of hydraulics circuit using PLC
8. Co-ordinated motion of multiple pneumatic actuators in a desired sequence using Cascade method
9. Integration of fringe condition modules in multiple actuator pneumatic systems
10. Co-ordinated motion of multiple actuator, electro – pneumatic systems in a desired sequence using hard – wire programmed control systems
11. Co-ordinated motion of multiple actuator, electro – pneumatic systems in a desired sequence using PLC.
12. Control of speed, direction and number of revolutions of a stepper motor using PC.

HSMC-301	HUMANITIES-I	3 L:0T:0P	3 credits

COURSE CONTENTS:

MODULE 1: COURSE INTRODUCTION-NEED, BASIC GUIDELINES, CONTENT AND PROCESS FOR VALUE EDUCATION 9 PERIODS

Self-Exploration–what is it? -Its content and process; 'Natural Acceptance' and Experiential Validation-as the process for self-exploration. Continuous Happiness and Prosperity- A look at basic Human Aspirations. Right understanding, Relationship and Physical Facility-the basic requirements for fulfillment of aspirations of every human being with the incorrect priority. Understanding Happiness and Prosperity correctly-A critical appraisal of the current scenario. Method to fulfill the above human aspirations: understanding and living in harmony at various levels. Practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking.

MODULE 2: UNDERSTANDING HARMONY IN THE HUMAN BEING – HARMONY IN MYSELF! 9 PERIODS

Understanding human being as a co-existence of the sentient 'I' and the material 'Body'. Understanding the needs of Self ('I') and 'Body' happiness and physical facility. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer). Understanding the characteristics and activities of 'I' and harmony in 'I'. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail. Programs to ensure Sanyam and Health. Practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Ensuring health vs dealing with disease discussion.

MODULE 3: UNDERSTANDING HARMONY IN THE FAMILY AND SOCIETY-HARMONY IN HUMAN -HUMAN RELATIONSHIP 9 PERIODS

Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship. Understanding the meaning of Trust; Difference between intention and competence. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals. Visualizing a universal harmonious order in society – Undivided Society, Universal Order-from family to world family. Practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Elicit examples from students' lives.

MODULE 4: UNDERSTANDING HARMONY IN THE NATURE AND EXISTENCE-WHOLE EXISTENCE AS COEXISTENCE 9 PERIODS

Understanding the harmony in the Nature. Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self- regulation in nature. Understanding Existence as Co-existence of mutually interacting MODULEs in all-pervasive space. Holistic perception of harmony at all levels of existence. Practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of Technology etc.

MODULE 5: IMPLICATIONS OF THE ABOVE HOLISTIC UNDERSTANDING OF HARMONY ON PROFESSIONAL ETHICS 9 PERIODS

Natural acceptance of human values. Definitiveness of Ethical Human Conduct. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order.

TOTAL PERIODS:45

COMPETENCE IN PROFESSIONAL ETHICS:

1. Ability to utilize the professional competence for augmenting universal human order
2. Ability to identify the scope and characteristics of people-friendly and ecofriendly production systems,
3. Ability to identify and develop appropriate technologies and management patterns for above production systems.
4. Case studies of typical holistic technologies, management models and production systems. Strategy for transition from the present state to Universal Human Order:
5. At the level of individual: as socially and ecologically responsible engineers, technologistsand managers
6. At the level of society: as mutually enriching institutions and organizations.
7. Practice Exercises and Case Studies in Practice (tutorial) Sessions to discuss the conduct asan engineer or scientist etc.

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

- Develop holistic perspective based on self-exploration about themselves (humanbeing), family, society and nature/existence.
- Cultivate the harmony in the human being, family, society and nature/ existence
- Strengthen self-reflection
- Build commitment and courage to act.

TEXT BOOKS:

1. Human Values and Professional Ethics by RRGaur, RSangal, GPBagaria, ExcelBooks, NewDelhi,2010

REFERENCE BOOKS

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, NewDelhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautifu l- E.F Schumacher.
6. Slow is Beautiful- Cecile Andrews
7. Economy of Permanence-JC Kumarappa
8. Bharat Mein Angreji Raj-Pandit Sunderlal
9. Rediscovering India-by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K.Gandhi
11. India Wins Freedom-Maulana Abdul KalamAzad
12. Vivekananda-Romain Rolland(English)
13. Gandhi-Romain Rolland(English)

AU-301	PROFESSIONAL ETHICS	2 L:0T:0P	0 credits

COURSE OBJECTIVES

- To enable the students to create an awareness on Engineering Ethics and Human Values to instill Moral and Social Values and Loyalty and to appreciate the rights of others.

CORSE OUTCOMES

- Upon completion of the course, the student should be able to apply ethics in society, discuss the ethical issues related to engineering and realize the responsibilities and rights in the society.

The course should covered the following topics by way of Seminars, Expert Lectures and Assignments in Engineering Ethics– Moral issues, Ethical theories and their uses Engineering as Experimentation–Code of Ethics Engineer's responsibility for safety Responsibilities and rights Global issues of engineering ethics.

REFERENCE BOOK:

1. MikeMartin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw-Hill, 2003

SEMESTER – VI

SEMESTER VI

RAT -309	MECHATRONICS	3L:1T:0P	4 Credits

COURSE OBJECTIVES:

- To Synergies the combination of mechanical, electronics, control engineering andcomputer.
- To provide a focused laboratory environment to the engineering students to apply and absorb Mechatronics concepts.
- To provide a common ground where students could perform experimental study regarding fundamental sequence control by utilizing various sensors and actuators.

COURSE CONTENTS:

MODULE I: INTRODUCTION **12 PERIODS**

Definition of Mechanical Systems, Philosophy and approach; Systems and Design: Mechatronic approach, Integrated Product Design, Modeling, Analysis and Simulation, Man-Machine Interface.

MODULE II: SENSORS AND TRANSDUCERS **12 PERIODS**

classification, Development in Transducer technology, Opto- Electronics-Shaft encoders, CD Sensors, Vision System, etc.

MODULE III: DRIVES AND ACTUATORS **12 PERIODS**

Hydraulic and Pneumatic drives, Electrical Actuators such as servo motor and Stepper motor, Drive circuits, open and closed loop control; Embedded Systems: Hardware Structure, Software Design and Communication, Programmable Logic Devices, Automatic Control and Real Time Control Systems

MODULE IV: SMART MATERIALS **12 PERIODS**

Shape Memory Alloy, Piezoelectric and Magnetostrictive Actuators: Materials, Static and dynamic characteristics, illustrative examples for positioning, vibration isolation, etc.

MODULE V: MICROMECHATRONIC SYSTEMS **12 PERIODS**

Microsensors, Micro actuators; Micro-fabrication techniques LIGA Process: Lithography, etching, Micro-joining etc. Application examples; Case studies Examples of Mechatronic Systems from Robotics Manufacturing, Machine Diagnostics, Road vehicles and Medical Technology.

TOTAL PERIODS:60

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

- Identify the key elements of mechatronics system, representation into blockdiagram.
- Apply knowledge of the concept of signal processing and signal conditioning for its industrial applications.
- Analyze the requirements for a given industrial process and select the most appropriate Actuators, sensors, design circuit according to applications.
- Understand the different logic gates, architecture of microprocessor and microcontroller for industrial applications.

TEXT BOOKS:

1. Mechatronics System Design, Devdas Shetty & Richard A. Kolk, PWS Publishing Company (Thomson Learning Inc.).
2. Mechatronics: A Multidisciplinary Approach, William Bolton, Pearson Education
3. A Textbook of Mechatronics, R.K. Rajput, S. Chand & Company Private Limited
4. Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, William Bolton, Prentice Hall.

REFERENCE BOOKS:

1. Bolton, “Mechatronics”, Pearson, Singapore.
2. Mahalik, “Principles, concepts and applications Mechatronics”, TMH.
3. Ramesh Gaonkar, “Introduction to 8085-PENRAM”, International Publishing.
4. Muzumdar, “Pneumatics” –Tata McGraw-Hill Education.

RAT -310	ROBOTIC CONTROL SYSTEMS	3L:0T:0P	3 Credits

COURSE OBJECTIVES:

- To introduce the overview of robotic systems and their dynamics
- To impart knowledge on system stability
- To acquire knowledge on joint space and task space control schemes
- To understand the concept of nonlinear control and observer schemes

COURSE CONTENTS:

MODULE I : INTRODUCTION AND OVERVIEW OF ROBOTIC SYSTEMS AND THEIR DYNAMICS 9 PERIODS

Forward and inverse dynamics. Properties of the dynamic model and case studies. Introduction to nonlinear systems and control schemes.

MODULE II: SYSTEM STABILITY AND TYPES OF STABILITY 9 PERIODS

Lyapunov stability analysis, both direct and indirect methods. Lemmas and theorems related to stability analysis.

MODULE III: JOINT SPACE AND TASK SPACE CONTROL SCHEMES 9 PERIODS

Position control, velocity control, trajectory control and force control.

MODULE IV: NONLINEAR CONTROL SCHEMES 9 PERIODS

Proportional and derivative control with gravity compensation, computed torque control, sliding mode control, adaptive control, observer based control, robust control and optimal control.

MODULE V: NONLINEAR OBSERVER SCHEMES: **9 PERIODS**

Design based on acceleration, velocity and position feedback. Numerical simulations using software.

TOTAL PERIODS:45

COURSE OUTCOMES

On successful completion of the module students will be able to:

- Understand basic concept of robotic systems and their dynamics.
- Analyze system stability and types of stability
- Know about joint space and task space control schemes
- Understand the concept of nonlinear control and observer schemes

TEXT BOOKS:

1. R Kelly, D. Santibanez, LP Victor and Julio Antonio, ―Control of Robot Manipulators in Joint Space‖, Springer, 2005.
2. A Sabanovic and K Ohnishi, ―Motion Control Systems‖, John Wiley & Sons (Asia), 2011
3. R M Murray, Z. Li and SS Sastry, ―A Mathematical Introduction to Robotic Manipulation, CRC Press, 1994.

REFERENCE BOOK:

1. J J Craig, ―Introduction to Robotics: Mechanics and Control, Prentice Hall, 4th Ed, 2018.

RAP -311	ROBOTIC CONTROL SYSTEMS LAB	0L:0T:2P	1 Credit

List of experiments

Mechanisms Simulation

1. Fourbar Mechanism
2. The Slider Crank Mechanism

Robotics Simulation

1. Forward Kinematics of a 5R Robot Manipulator
2. Forward Kinematics of a 6R Robot Manipulator
3. Inverse Kinematics of a 6R Robot Manipulator

Control Systems Simulation

1. Open loop characteristic of DC motor
2. Closed loop characteristic of DC motor with Proportional Control
3. Closed loop characteristic of DC motor with Proportional and Derivative Control
4. Closed loop characteristics of DC motor with Proportional and Integral Control
5. Closed loop characteristics of DC motor with Proportional Integral and Derivative Control(Continuous)
6. Closed loop characteristics of DC motor with Proportional Integral and Derivative Control(Discrete)
7. Control of one degree of freedom revolute type robot arm

RAT -312	PROGRAMMING FOR ROBOTICS	3L:0T:0P	3 Credits

COURSE OBJECTIVES

- To acquire the knowledge on advanced algebraic tools for the description of motion.
- To analyze and design the motion for articulated systems
- To develop an ability to use software tools for analysis and design of robotic systems.

MODULE I: BASICS OF ROBOTICS **9 PERIODS**

History – Definition – Components – Building a robot – The Robot drive mechanism. ROBOT SIMULATION: Mathematical modeling of the robot - Robot kinematics – Concepts of ROS and Gazebo.

MODULE II: DESIGNING CHEFBOT USING LAUNCHPAD **9 PERIODS**

Specifications - Block diagram - Working with Robotic Actuators and Wheel Encoders - Interfacing DC geared motor with Tiva C LaunchPad - Interfacing quadrature encoder with Tiva C Launchpad - Working with Dynamixel actuators.

MODULE III: WORKING WITH ROBOTIC SENSORS **9 PERIODS**

Working with ultrasonic distance sensors - Working with the IR proximity sensor - Working with Inertial Measurement MODULE.

MODULE IV: PYTHON AND ROS **9 PERIODS**

Introduction to OpenCV, OpenNI, and PCL - Programming Kinect with Python using ROS, OpenCV, and OpenNI - Working with Point Clouds using Kinect, ROS, OpenNI, and PCL.

MODULE V: INTERFACING IT INTO ROS, USING PYTHON **9 PERIODS**

Building ChefBot hardware - Writing a ROS Python driver for ChefBot - Understanding ChefBot ROS launch files - Working with ChefBot Python nodes and launch files - The Calibration and Testing of ChefBot - The Calibration of Xbox Kinect using ROS - Wheel odometry calibration - Testing of the robot using GUI.

TOTAL PERIODS:45

COURSE OUTCOMES

On successful completion of the module students will be able to:

- Understand the matrix algebra and Lie algebra for computing the kinematics of robots
- Analyze the forward kinematics and inverse kinematics of serial and parallel robots
- Do the path planning for a robotic system

TEXT BOOKS:

1. Lentin Joseph, ―Learning Robotics using Python‖, PACKT Publishing, 2015.
2. Aaron Martinez and Enrique Fernandez, ―Learning ROS for Robotics Programming‖, PACKT Publishing, 2013, 2nd Ed, 2015.

REFERENCE BOOK:

1. Bill Smart, Brian Gerkey, Morgan Quigley, ― Programming Robots with ROS: A Practical Introduction to the Robot Operating System‖, O'Reilly Publishers, 2015.

RAP -313	PROGRAMMING FOR ROBOTICS LAB	0L:0T:2P	1Credit

LIST OF EXPERIMENTS

1. Creating 2D CAD drawing of a robot using Libre CAD
2. Design 3D model of the robot using Blender.
3. Simulating a Differential Drive Robot Using ROS
4. Interfacing of DC geared motor with Robot Controller.
5. Interfacing of quadrature encoder with Robot Controller
6. Interfacing of ultrasonic distance sensors to the Robot Controller
7. Interfacing of IR proximity sensor to the Robot Controller
8. Write a simple program to control a robot's motion (e.g., moving forward, backward, turning) using programming commands.
9. Control of speed, direction and number of revolutions of a stepper motor using Robot Controller
10. Development of an obstacle avoidance robot using servo motors, ultrasonic and touch sensors.
11. Design of conveyor automation system using PLC, SCADA and Electrical drive.
12. Design of inspection automation system using sensors, PLC, HMI/SCADA
13. Design of simple water management system using PLC, SCADA and Electrical drive
14. Design of simple power system automation

PROJ RA -301	MINI PROJECT	0L:0T:6P	3 Credits

COURSE OBJECTIVES:

The main OBJECTIVES of Mini Project is to let the students apply the knowledge of theoretical concepts which they have learnt as a part of the curriculum of the minor degree using real time problems or situations.

COURSE CONTENTS:

This course is a project type. The plan of conducting this course is given below:

1. Participants will be divided into teams of two members within first week of the starting of the course by the course coordinators/managers depending on the number of participants registered in the course. The benefits of such team-based projects are listed in the Course Outcomes below.
2. The teams will have a team coordinator or leader, which will be identified by the coordinators/managers of the course (may be the first name in the list of a student team).
3. The projects could be of the following types: a) Literature search (LS) type: Studying about an aspect of robotics, say, vision, robot kinematics, dynamic, controls, etc. b) Algorithm development (AD) type: Analyse, say, a robot kinematics using Robo Analyzer or Simulation/Octave/Freemat/Scilab or similar software or write an algorithm using any programming language (Python, etc.). For example, writing forward kinematics of a robot or image processing in Vision. c) Design/synthesis (DS) type: Proposing a new type of system/device for performing certain task. For example, a mobile robot for Covid-19 isolation wards.
4. The teams will be asked to contact their team members within a week and decide their topic with two weeks, i.e., within first 3 weeks of the starting of the course.
5. Students MUST spend about 4 hours in a week to discuss their progress together,study together or individually, write programs, fabricate circuits, etc.
6. During the project session the coordinators will explain how to do literature survey, how to find the sources of hardware, which software to use for a particular purpose,how to select an electric motor, etc., present case studies, etc.
7. At the end of the course duration, each team will submit no more than 10 slides in .pdf file and/or not more than a video of one min to showcase their project hardware/software/plots, etc. generated during the project to a cloud (say, Google Drive).

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

- Understand, plan and execute a Mini Project with team.
- Students will be able to practice acquired knowledge within the chosen area of technology for project development
- Identify, discuss and justify the technical aspects of the chosen project with a comprehensive and systematic approach.
- Communicate and report effectively project related activities and findings.

SUPPLEMENTARY LEARNING MATERIAL:

1.http://www.ddrobocon.in/

2. http://courses.csail.mit.edu/iap

3. https://fabacademy.org/students

AU - 302	INDIAN CONSTITUTION	2L: 0T: 0P	0 Credits

COURSE OBJECTIVES:

- The main objective of this course is to understand and learn the basic rights, duties of a citizen and to understand the functions of parliament and constitutions.

COURSE CONTENTS:

MODULE I: INTRODUCTION

Evolution of Indian Constitution; Significance of Constitution; Composition; Preamble and its Philosophy.

MODULE II: RIGHTS, DUTIES AND DIRECTIVE PRINCIPLES

Fundamental Rights- Writs and Duties, Directive Principles of State Policy.

MODULE III: COMPOSITION OF PARLIAMENT AND FEDERALISM

Union Government, President and Vice President, Houses of the Parliament and their functions; Composition of State Legislature; Powers, Functions and Position of Governor, Function of Chief Ministers, Council of Ministers; The Indian Federal System, Administrative Relationship between Union and States.

MODULE IV: BILLS AND CONSTITUTION AMENDMENT PROCEDURE

Types of Bills, Stages of passing of Bill into an Act, Veto Power, Constitution Amendment Procedure, Various Amendments made and their significance for India.

MODULE V: JUDICIARY

Supreme Court and High Court; Functions and powers, Judicial Review.

COURSE OUTCOMES:

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

- Know the basics of constitutions and its evolution.
- Gain knowledge about the basic rights and duties of a citizen.
- Understand the function of composition and parliament.
- Acquire knowledge about the constitutions and amendment procedure.
- Understand the judiciary system and its function & power.

TEXT BOOKS:

1. Subash C. Kashyap, "Our Constitution", 5th Edition, NBT, India, New Delhi, 2015.
2. Basu D D , "Introduction to the Constitution of India", 20th Edition, Prentice Hall of India, New Delhi, 2011.
3. Briji Kishore Sharma, "Introduction to the Constitution of India", 8th Edition, Prentice Hall of India, New Delhi, 2017.

REFERENCE BOOKS:

1. Hoshiar Singh, "Indian Administration", 1st Edition, Pearson Education, New Delhi, 2011.
2. Jain M C, "The Constitution of India", 5th Edition, State Mutual Book & Periodical Service, Limited, New Delhi, 1988.
3. Shukla V N , "Constitution of India", 13th Edition, Eastern Book Company Limited, New Delhi, 2017.

SEMESTER – VII

SEMESTER VII

HSMC-401	HUMANITIES II	3L:0T:0P	3 Credits

COURSE OBJECTIVES

The goal of the proposed course is to enable students:

- To explore the various ways in which technology has and may in future affect not only themode of delivery of education but also the very nature of education.
- To understand the requirement of education
  a. for becoming an effective member of the society
  b. to fulfil the potential of a learner to the fullest without too much thought of anindividual's responsibility towards the contemporary society.

COURSE CONTENTS:

MODULE I: **9 PERIODS**

Necessity of education for human life, Impact of education on society

MODULE II: **9 PERIODS**

Nature and scope of education (Gurukul to ICT driven), Emotional intelligence Domainsof learning, Approaches to learning, Learning outcomes

MODULE III: **9 PERIODS**

Role of education in technology advancement.

MODULE IV: **9 PERIODS**

Technology and society; management of technology; technology transfer

MODULE V: **9 PERIODS**

Ethical and value implications of education and technology on individual and society

TOTAL PERIODS:45

COURSE OUTCOMES:

On successful completion of this course, the students will be able to

- Integrate their technicaleducation for betterment of society as well motivates them to lead a good human life.

REFERENCE BOOKS:

1. Education and Social order by Bertrand Russel
2. Theories of learning by Bower and Hilgard
3. Technology and Society by Jan L Harrington

PROJ RA -401	SEMINAR	0L:0T:2P	1 Credits

OBJECTIVES:

- To help students break out of shyness.
- To build confidence
- To enhance English communication skills
- To encourage students creative thinking in the field of automation and the emerging trends,

Each one of the students will be assigned a Seminar Topic in the current and frontier areas. The student has to conduct a detailed study/survey of the material available on the assigned topic and prepare a report, running to 30 or 40 pages. The student will make a oral presentation for a period of about 30 minutes, followed by a brief question and answer session. The Seminar (presentation and report) will be evaluated by the internal assessment committee (comprising of the Head of the Department and two faculty members) for a total of 40 marks.

COURSE OUTCOMES

On Completion of the seminar students will be able to

- Extend the knowledge through research and development in the chosen fields of specialization.
- Be more confident
- Speak in front of a large audience without hesitation.

PROJ RA -402	INTERNSHIP	0L:0T:4P	2 credits

- Minimum 6 weeks Internship after the sixth semester
- Evaluation is based on work done, quality of report, performance in viva-voce, presentation etc

AU – 401	INDIAN KNOWLEDGE SYSTEM	2L: 0T: 0P	0 Credits

COURSE OBJECTIVES:

- To impart basic principle of third process reasoning and inference sustainability is at the course of Indian traditional knowledge system,
- To understand the legal framework and traditional knowledge and biological diversity act 2002 and geographical indication act 2003
- To focus on traditional knowledge and intellectual property mechanism of traditional knowledge and protection
- To know the student traditional knowledge in different sector

COURSE CONTENTS:

MODULE I: INTRODUCTION TO TRADITIONAL KNOWLEDGE

Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, the physical and social contexts in which traditional knowledge develop, the historical impact of social change on traditional knowledge systems. Indigenous Knowledge (IK), characteristics, traditional knowledge vis-à-vis indigenous knowledge, traditional knowledge Vs western knowledge traditional knowledge vis-à-vis formal knowledge.

MODULE II: 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.

MODULE III: LEGAL FRAMEWORK AND TK

A: The Scheduled Tribes and Other Traditional Forest Dweller (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmers Rights Act2001 (PPVFR Act); B: The Biological Diversity Ac 2002 and Rules 2004, the protection of traditional knowledge bill, 2016. Geographical indications act 2003.

MODULE IV: TRADITIONAL KNOWLEDGE AND INTELLECTUAL PROPERTY

Systems of traditional knowledge protection, Legal concept for the protection of traditional knowledge, Certain non IPR mechanisms of traditional knowledge protection, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge, global legal FORA for increasing protection of Indian Traditional Knowledge.

MODULE V: TRADITIONAL KNOWLEDGE IN DIFFERENT SECTORS

Traditional knowledge and engineering, Traditional medicine system, TK and biotechnology, 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.

COURSE OUTCOMES:

Upon successful completion of the course, the student will be able to

- Understand the concept of Traditional knowledge and its importance
- Know the need and importance of protecting traditional knowledge
- Know the various enactments related to the protection of traditional knowledge.
- Understand the concepts of Intellectual property to protect the traditional knowledge.
- Understand the importance of Intellectual property in different sectors

TEXT BOOKS:

1. Traditional Knowledge System in India", Amit Jha, 2009, Atlantic publisher.
2. "Traditional Knowledge System and Technology in India", Basanta Kumar Mohantra,Vipin Kumar Singh, 2012, Pratibha Prakashan publisher.

REFERENCE BOOK:

1. "Knowledge Traditions and Practices of India", 2012, Kapil Kapoor, Michel Danino.

E-RESOURCES:

1. https://www.youtube.com/watch?v=LZP1StpYEPM
2. http://nptel.ac.in/courses/121106003/

SEMESTER – VIII

Semester VIII

PROJ RA -403	**PROJECT AND VIVA -VOCE**	**0L:0T:24P**	**12 credits**

COURSE OBJECTIVESS

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
- To train the students in preparing project reports and to face reviews and viva voce examination.

COURSE OUTCOMES

- On Completion of the project work students will be in a position to take up any challenging practical problems and find solution by formulating proper methodology.

Extension and completion of project work started in the previous semester. On completion of the project work, each student has to prepare a project report and submit the same to the department. In the Phase II, the project work and the report will be evaluated by the internal assessment committee by conducting two reviews and one demo for a total of 60 marks. The external university examination, which carries a total of 40 marks, will have report evaluation and viva voce examination conducted by a committee of one external examiner and one internal examiner appointed by the university.

APPENDIX – I:

PROFESSIONAL ELECTIVE COURSES

PROFESSIONAL ELECTIVE COURSES

RAEL - 1	INDUSTRIAL NETWORKING	3L: 0T: 0P	3 Credits

COURSE OBJECTIVES:

- To know the basic knowledge about networking in industries.
- To Understand the evolution of computer networks using the layered network architecture.
- To understand the concepts of data communications.
- To be familiar with the Transmission media and Tools.
- To design computer networks using sub-netting and routing concepts.

COURSE CONTENTS:

MODULE I: INTRODUCTION 9 PERIODS

Modern instrumentation and control systems – Terminology – Topology – Mechanisms - Protocols – Standards – Common problems and solutions – Grounding/shielding and noise - EIA-232 interface standard – EIA-485 interface standard – Current loop and EIA-485 converters - Fibre optic cable components and parameters – Basic cable types – Connection fibers – Troubleshooting.

MODULE II: COMMUNICATION BUS PROTOCOLS 9 PERIODS

Overview – Protocol structure – Function codes – Modbus plus protocol –Data Highway – AS interface (AS-i)-Device Net: Physical layer – Topology – Device taps –Profibus PA/DP/FMS: Protocol stack – System operation.CAN BUS: Concepts of bus access and arbitration – CAN: Protocol-Errors: Properties – Detection – processing – Introduction to CAN 2.0B.

MODULE III: ETHERNET SYSTEMS 9 PERIODS

IEEE 802.3 – Physical layer - Medium access control – Collisions - Ethernet design rules - Fast and gigbit Ethernet systems - design considerations - Internet layer protocol - UDP - TCP/IP - ProfiNet - LAN system components – Structured cabling – Industrial Ethernet – Troubleshooting Ethernet.

MODULE IV: WIRELESS COMMUNICATIONS 9 PERIODS

Radio spectrum – Frequency allocation – Radio modem – Intermodulation – Implementing a radio link – RFID: Basic principles of radio frequency identification – Transponders – Interrogators, Wireless HART.

MODULE V: APPLICATIONS 9 PERIODS

Automotive communication technologies – Design of automotive X-by-Wire systems, - The LIN standard – The IEC/IEEE Train communication network: Applying train communication network for data communications in electrical substations.

TOTAL PERIODS:45

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

- Apply the concepts of data communications and to design computer networks using subnetting and routing concepts.
- Compare the various medium access control techniques.
- Compare and contrast the characteristics of physical layer.
- Analyze the different protocols.
- Compare and contrast the different network components.

TEXT BOOKS:

1. Steve Mackay, Edwin Wright, Deon Reynders and John Park, ―Practical Industrial Data Networks: Design, Installation and Troubleshooting, Newnes (Elsevier), 2004.
2. Dominique Paret, ―Multiplexed Networks for Embedded Systems, John Wiley & Sons, 2007.
3. Richard Zurawski, ―The Industrial Communication Technology Handbook‖, Taylor and Francis, 2005.

REFERENCE BOOKS:

1. Deon Reynders and Edwin Wright, ―Practical TCP/IP and Ethernet Networking, IDC Technologies, 2006.
2. James Powell, Henry Vandelinde, ―Catching the Process Fieldbus an Introduction to PROFIBUS for Process Automation", Momentum Press, 2013.
3. Albert Lozano-Nieto, ―RFID Design Fundamentals and Applications‖, CRC Press, 2011.

RAEL - 2	FIELD AND SERVICE ROBOTICS	3L: 0T: 0P	3 Credits

COURSE OBJECTIVES:

- To study the various parts of robots and fields of robotics.
- To study the various kinematics and inverse kinematics of robots.
- To study about the localization, planning and navigation.
- To study the control of robots for some specific applications.
- To study about the humanoid robots.

COURSE CONTENTS:

MODULE I: INTRODUCTION 9 PERIODS

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.

MODULE II: LOCALIZATION 9 PERIODS

Introduction-Challenges of Localization- Map Representation- Probabilistic Map based Localization- Monte carlo localization- Landmark based navigation-Globally unique localization- Positioning beacon systems- Route based localization.

MODULE III: PLANNING AND NAVIGATION 9 PERIODS

Introduction-Path planning overview- Road map path planning- Cell decomposition path Planning- Potential field path Planning-Obstacle avoidance - Case studies: Tiered robot architectures.

MODULE IV: FIELD ROBOTS 9 PERIODS

Ariel robots- Collision Avoidance-Robots for agriculture, mining, exploration, underwater, Civilian and military applications, Nuclear applications, Space applications.

MODULE V: HUMANOIDS 9 PERIODS

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.

TOTAL PERIODS:45

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

- Explain the basic concepts of working of robot.
- Analyze the function of sensors in the robot.
- Developing programs to use a robot for a typical application.
- Use Robots in different applications.
- Know about the humanoid robot's functions & its operations.

TEXT BOOKS:

1. Siegwart, Roland- Introduction to autonomous mobile robots. - 2nd ed. / Roland 2011 Massachusetts Institute of Technology
2. Riadh Siaer, The future of Humanoid Robots- Research and applications", Intech Publications, 2012.
3. Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Eastern Economy Edition, Prentice Hall of India P Ltd., 2006.

REFERENCE BOOK:

1. Kelly, Alonzo; Iagnemma, Karl; Howard, Andrew, "Field and Service Robotics ", Springer, 2011

RAEL - 3	DRONE TECHNOLOGIES	3L: 0T: 0P	3 Credits

COURSE OBJECTIVES:

- To understand the basics of drone concepts
- To learn and understand the fundaments of design, fabrication and programming of drone
- To impart the knowledge of a flying and operation of drone
- To know about the various applications of drone
- To understand the safety risks and guidelines of fly safely

COURSE CONTENTS:

MODULE I: INTRODUCTION TO DRONE TECHNOLOGY 9 PERIODS

Drone Concept - Vocabulary Terminology- History of drone - Types of current generation of drones based on their method of propulsion- Drone technology impact on the businesses- Drone business through entrepreneurship- Opportunities/applications for entrepreneurship andemployability.

MODULE II: DRONE DESIGN, FABRICATION AND PROGRAMMING 9 PERIODS

Classifications of the UAV -Overview of the main drone parts- Technical characteristics of the parts - Function of the component parts -Assembling a drone- The energy sources- Level of autonomy- Drones configurations -The methods of programming drone- Download program - Install program on computer- Running Programs- Multi rotor stabilization- Flight modes -Wi-Fi connection.

MODULE III: DRONE FLYING AND OPERATION 9 PERIODS

Concept of operation for drone -Flight modes- Operate a small drone in a controlled environment-Drone Controls Flight operations –management tool –Sensors-Onboard storage capacity - Removable storage devices- Linked mobile devices and applications.

MODULE IV: DRONE COMMERCIAL APPLICATIONS 9 PERIODS

Choosing a drone based on the application -Drones in the insurance sector- Drones in deliveringmail, parcels and other cargo- Drones in agriculture- Drones in inspection of transmission lines and power distribution -Drones in filming and panoramic picturing.

MODULE V: FUTURE DRONES AND SAFETY 9 PERIODS

The safety risks- Guidelines to fly safely -Specific aviation regulation and Standardization-Drone license- Miniaturization of drones- Increasing autonomy of drones -The use of drones in swarms.

TOTAL PERIODS:45

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- Know about a various type of drone technology, drone fabrication and programming.
- Execute the suitable operating procedures for functioning a drone
- Select appropriate sensors and actuators for Drones
- Develop a drone mechanism for specific applications
- Create the programs for various drones

TEXT BOOKS:

1. Daniel Tal and John Altschuld, “Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation”, 2021 John Wiley & Sons, Inc.
2. Terry Kilby and Belinda Kilby, “Make:Getting Started with Drones “,Maker Media, Inc, 2016
3. John Baichtal, “Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs”, Que Publishing, 2016

REFERENCE BOOK:

1. Zavrsnik, “Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance”, Springer, 2018.

RAEL - 4	DESIGN OF MECHANICAL TRANSMISSION SYSTEMS	3L: 0T: 0P	3 Credits

COURSE OBJECTIVES:

- To design the engine parts like piston, connecting rod and analyze design procedure different loading conditions
- To introduce the concept, procedures, and data to analyze machine elements in power transmission systems.
- To apply principles of design and analyze the forces in mechanical power transmission elements such gears Implement basic principles for the design of power screws and the forces, couples, torques etc,

COURSE CONTENTS:

MODULE I : DESIGN OF FLEXIBLE ELEMENTS 9 PERIODS

Transmission of power by Belt and Rope drives, Transmission efficiencies, Belts – Flat and V types.

MODULE II : DESIGN OF I.C ENGINE PARTS 9 PERIODS

Connecting Rod: Thrust in connecting rod – stress due to whipping action on connecting rod ends – Pistons, Forces acting on piston – Construction, Design and proportions of piston.

MODULE III : MECHANICAL ENERGY STORING ELEMENTS 9 PERIODS

Stresses and deflections of helical springs – Extension and compression springs – Design of springs for fatigue loading – natural frequency of helical springs – Energy storage capacity – helical torsion springs.

MODULE IV : SPUR & HELICAL GEARS 9 PERIODS

Spur gears & Helical gears- important Design parameters – Design of gears using AGMA procedure involving Lewis and Buckingham equations. Check for wear.

MODULE V : DESIGN OF POWER SCREWS 9 PERIODS

Design of screw, Square ACME, Buttress screws, compound screw, differential screw.

TOTAL PERIODS:45

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

- Understand the types belt drives and select suitable belt drives and associated elements from manufacturers catalogues under given loading conditions to design the springs for different loading conditions

- Calculate the design parameter for energy storage element and engine components, connecting rod and piston
- Select appropriate gears for power transmission on the basis of given load and speed Design gears based on the given conditions Apply the design concepts to estimate the strength of the gear Analyze power screws subjected to loading.

TEXT BOOKS:

1. Machine Design by R.S.Khurmi and J.K.Gupta, S.Chand Publishers,New Delhi.
2. Machine Design, S MD Jalaludin, Anuradha Publishers. 3. Design of Machine Elements by V. Bhandari TMH.
3. Machine Design Data Book by S MD Jalaludin, Anuradha Publishers

REFERENCE BOOKS:

1. Machine Design Data Book by P.S.G. College of Technology
2. Machine Design by Pandya and Shah, Chortar Publications.
3. Machine Design / R.N. Norton
4. Mechanical Engineering Design / JE Shigley.

RAEL - 5	DESIGN OF ROBOT ELEMENTS	3L: 0T: 0P	3 Credits

COURSE OBJECTIVES

- To introduce the students to the fundamentals of machine design, material selection and to
- solve the basic design problems.
- To learn to derive various parameters for modelling links and joints in a robot.
- To learn about Fundamentals of Computer Graphics
- To learn and understand curves and surfaces in robot modelling.
- To learn to derive various parameters for modelling end-effectors of a robot

MODULE I: FUNDAMENTALS OF MECHANICAL DESIGN 9 PERIODS

Fundamentals of Machine Design-Engineering Design, Phases of Design, Design Consideration - Standards and Codes - Design against Static and Dynamic Load –Modes of Failure, Factor of Safety, Principal Stresses, Theories of Failure-Stress Concentration, Stress Concentration Factors, Variable Stress, Fatigue Failure, Endurance Limit, Design for Finite and Infinite Life, Soderberg and Goodman Criteria.

MODULE II: DESIGN OF LINKS AND JOINTS 9 PERIODS

Loads and Forces on Links and Joints - Design of solid and hollow shafts - Rigid and flexible couplings - Threaded fasteners - rolling contact bearings-– Links Design: Path and Motion Synthesis – Cognate Linkages – Design of Spherical Joints.

MODULE III : FUNDAMENTALS OF COMPUTER GRAPHICS 9 PERIODS

Product cycle- Design process - Computer Aided Design – Computer graphics – co-ordinate systems- 2D and 3D transformations- homogeneous coordinates - graphic primitives (point, line, circle drawing algorithms) - Clipping- viewing transformation.

MODULE IV: CURVES AND MODELLING 9 PERIODS

Representation of curves - Hermite cubic spline curve, Bezier curve, B-spline curves, Fundamentals of solid modeling, Different solid representation schemes, Half -spaces, Boundary representation (B-rep), Constructive solid geometry (CSG), Sweep representation, Analytic solid modeling, Perspective, Parallel projection, Hidden line removal algorithms.

MODULE V : DESIGN OF GRIPPERS 9 PERIODS

Grippers – Types of Grippers Mechanisms – Gripping Methods – Gripping Force analysis – Gripper Design – Two Finger gripper – Three Finger Gripper – Magnetic Gripper Design – Vacuum Gripper Design – Hooks – Scoops – Spools – Miscellaneous Grippers

TOTAL PERIODS:45

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

- State the design parameters for designing the components of a robot.
- Apply the CAD modelling techniques in designing a Robot
- Analyse the design parameters for designing the components of a robot.
- Formulate the methods for designing the entire robot assembly
- Create a Robot CAD Mode

TEXT BOOKS:

1. Joseph Edward Shigley, Charles R. Mischke “Mechanical Engineering Design”,McGraw Hill, International Edition, 1992
2. Sharma. C.S. and Kamlesh Purohit, “Design of Machine Elements”, Prentice Hall of India Private Limited, 2003
3. Ibrahim Zeid, “CAD/CAM theory and Practice”, Tata McGraw Hill, 2nd edition, 2008

REFERENCE BOOKS:

1. Bhandari. V.B., “Design of Machine Elements”, Tata McGraw-Hill Publishing Company Limited, 2003.
2. Robert L. Norton, “Machine Design – An Integrated Approach”, Prentice Hall International Edition, 2000.
3. Charles. J. A. and Crane. F. A. A, “Selection and Use of Engineering Materials”, second edition, Butterworth-Heinemann Ltd., 3rd edition 2005.
4. Kevin Otto, Kristin Wood, “Product Design”, Pearson Education, 7th Reprint, 2011.
5. Mikell P. Groover, "Industrial Robotics", McGraw Hill, 2nd edition, 2012.
6. Dragomir N. Nenchev, Atsushi Konno, Teppei Tsujita, “Humanoid Robots: Modelling and Control”, Butterworth-Heinemann, 2018
4. Ashby. M.F., “Materials Selection in Mechanical Design”, Third edition, ButterworthHeineman, New York, 16th edition, 2012

RAEL - 6	AUTOMATION SYSTEM DESIGN	3L: 0T: 0P	3 Credits

COURSE OBJECTIVES

- To know about the basic concepts in industrial automation
- To know about transfer lines and automated assembly
- To design of mechatronic systems for material handling applications.
- To learn programmable automation and design for high-speed automatic assembly

COURSE CONTENTS:

MODULE I: FUNDAMENTAL CONCEPTS OF INDUSTRIAL AUTOMATION 9 PERIODS

Fundamental concepts in manufacturing and automation, definition of automation, reasons for automating. Types of production and types of automation, automation strategies, levels of automation. Selection of motor for automation system, sizing of servo motor for a specific application, importance of sizing.

MODULE II: TRANSFER LINES AND AUTOMATED ASSEMBLY 9 PERIODS

General terminology and analysis, analysis of transfer lines without storage, partial automation. Automated flow lines with storage buffers. Automated assembly-design for automated assembly, types of automated assembly systems, part feeding devices, analysis of multi-station assembly machines. AS/RS, RFID system, AGVs, modular fixturing. Flow line balancing.

MODULE III: DESIGN OF MECHATRONIC SYSTEMS FOR MATERIAL HANDLING APPLICATIONS 9 PERIODS

Stages in design, traditional and mechatronic design, possible design solutions. Case studies-pick and place robot, engine management system. belt conveyor elements, selection of belt, drive, greasing of idlers, Plow Vs Trippers, magnetic pulley, skirt boards, training of belt conveyors, weighing material in motion, shuttle belt conveyor, pinion – swivel arrangement, troughing, suspended idlers, belt cleaners, transfer of material from belt to belt, cover, safety protection at pulleys, belt speeds and widths, design of a belt conveyor, belt conveyor calculation, minimum pulley diameters, enclosures for conveyors, idler selection, conveyor belt troubles.

MODULE IV: PROGRAMMABLE AUTOMATION 9 PERIODS

Special design features of CNC systems and features for lathes and machining centers. Drive system for CNC machine tools. Introduction to CIM; condition monitoring of manufacturing systems. CNC architecture for intelligent machine tool – case study – CNC machine parts and working with block diagram.

MODULE V: DESIGN FOR HIGH-SPEED AUTOMATIC ASSEMBLY 9 PERIODS

Introduction, Design of parts for high-speed feeding and orienting, high speed automatic insertion. Analysis of an assembly. General rules for product design for automation.

TOTAL PERIODS:45

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- Knowledge of industrial automation by transfer lines and automated assembly lines. Ability to design an automated system.
- Understanding of mechatronic systems for material handling applications
- Ability to learn programmable automation and design for high-speed automatic assembly

TEXT BOOKS:

1. Mikell P Groover, "Automation Production Systems and Computer- Integrated Manufacturing" Pearson Education, New Delhi, 2015.
2. Bolton W, "Mechatronics", Pearson Education, 2011.
3. Mikell P Groover, "Industrial Robots – Technology Programmes and Applications" , McGraw Hill , New York, USA. 2012.

REFERENCE BOOKS:

1. Steve F Krar, "Computer Numerical Control Simplified", Industrial Press, 2001.
2. Geoffrey Boothroyd, Peter Dewhurst and Winston A. Knight, "Product Design for manufacture and Assembly", CRC Press, 2011
3. Radhakrishnan , " CAD/CAM/CIM ", New age International Publishers , 2018.

RAEL - 7	VISION GUIDED ROBOTICS	3L: 0T: 0P	3 Credits

COURSE OBJECTIVES:

- To impart knowledge in the field of computer vision applied to guidance of manipulators and mobile Robots.

COURSE CONTENTS: **9 PERIODS**

MODULE I: INTRODUCTION

Vision for robot manipulation and Navigation-Motivation. Modeling velocity of a rigid object- Camera configurations in vision guided Robots-Triangulation-Vision based pose estimation.

MODULE II: VISUAL SERVOING **9 PERIODS**

Mathematical formulation of visual servo problem-classification of visual servoing Architectures-Image based visual servoing (IBVS), Interaction matrix derivation-Geometrical interpretation of IBVS, stability analysis-Case study: IBVS with stereo vision system-IBVS with other geometrical features, direct estimation-Position based visual servoing: Point feature based motion, pose based motion-Calibration for visual servoing systems**.**

MODULE III: VISION FOR MOBILE ROBOTS **9 PERIODS**

Introduction to simultaneous localization and mapping, visual SLAM (VSLAM)-VSLAM Approaches-Introduction to visual odometry (VO). VO: Motion from Image feature correspondences, motion from 3D structure. Comparison between VSLAM and VO calibration Techniques-Case study of VSLAM and VO application.

MODULE IV: MOTION ANALYSIS **9 PERIODS**

Formulation of the motion Analysis-Motion field of Rigid objects, Aperture Problem-Optical flow and motion field, brightness constancy equation and Validity-Estimating motion field: Differential techniques, feature based techniques. Target tracking: Challenges and solutions, Kalman filtering basics-Kalman tracking.

MODULE V: INTRODUCTION ADVANCED TOPICS **9 PERIODS**

Hybrid visual serving, partitioned visual serving, switching -schemes in visual serving. Joint space control of eye-in-hand and eye-to-hand Systems-Motion based segmentation. Structure from motion (SFM), multi-view SFM-3-D structure and motion from motion field.

TOTAL PERIODS:45

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- Understand the foundations of the field of computer vision required for Robot vision.
- Explain the Mathematics and Implementation of vision guidance for manipulators.
- Formulate the various ways to utilize computer vision for mobile Robots.
- Develop algorithms for Motion analysis.
- Apply the computer vision algorithms for suitable applications involving Manipulators and mobile Robots.

TEXT BOOKS:

1. Emanuele Trucco, Alessandro Verri, “Introductory Techniques for 3D Computer Vision”, Prentice Hall of India, April 11-13, 2018.
2. Bruno Siciliano, Oussama Khatib, “Springer Handbook of Robotics”, Springer, 2008.
3. D. Scaramuzza and F. Fraundorfer, "Visual Odometry [Tutorial]", IEEE Robotics & Automation, Magazine, vol. 18, no. 4, pp. 80-92, December, 2011.

REFERENCE BOOKS:

1. F. Fraundorfer and D. Scaramuzza, "Visual Odometry: Part II: Matching, Robustness, Optimization, 1 EE Robotics & Automation Magazine, Vol 18, Issue 4, 2011.
2. Revisiting Visual Odometry for Real-Time Performance, Gaurav Singh, Meiqing Wu, S. Lam, Published 27 May 2019.

RAEL - 8	MEDICAL ROBOTICS	3L: 0T: 0P	3 Credits

COURSE OBJECTIVES:

- To introduce the basics of Robotics, Kinematics, Inverse Kinematics, vision and motion planning.
- To have an exposure to kinematics in robotics.
- To have an insight into Robot vision.
- To know about the concept of planning in robotics.
- To be made aware of applications or robotics in medical practice.

COURSE CONTENTS:

MODEL I: INTRODUCTION 9 PERIODS

Definition of a Robot - Basic Concepts - Robot configurations - Types of Robot drives - Basic robot motions - Point to point control - Continuous path control.

MODEL II: KINEMATICS 9 PERIODS

Basic control system concepts - control system analysis - robot actuation and fed back, Manipulators - director and inverse kinematics, Coordinate transformation - Brief Robot dynamics. Types of Robot and effectors - Grippers - Tools as end effectors - Robot/End - effort interface.

MODEL III: SENSING AND ROBOT VISION 9 PERIODS

Range sensing - Proximity sensing - Touch sensing - Force and Torque sensing. Introduction to Machine vision - Sensing and digitizing - Robot Vision Image representation, Image processing and analysis.

MODEL IV:AI AND ROBOTICS 9 PERIODS

Artificial intelligence - Knowledge representation - Search techniques -Adaptive approaches to robot control- Reinforcement learning for control- Model Based learning approaches to control Learning Maps-Evolutionary approaches of AI and robotics.

MODEL V: APPLICATIONS 9 PERIODS

Applications in Biomedical Engineering, Applications in rehabilitation, Nanobots in medicine, Clinical diagnosis and Surgery –Cardiac and abdominal procedures with teleoperated robots, Orthopedic surgery with cooperative robots

TOTAL PERIODS:45

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- Explain the basics of robotics.
- Illustrate kinematics in robotics.
- Explain the robotic sensing vision.
- Plan the robotic control using AI
- Elaborate the application of robotics in medical practice.

TEXT BOOKS:

1. Fu Gonzales and Lee, Robotics, McGraw Hill, 1987.
2. Robert Schilling, Fundamentals of Robotics-Analysis and control, Prentice Hall of India,2003.
3. J.J, Craig, Introduction to Robotics, Pearson Education, 2005.

REFERENCE BOOKS:

1. Mittal, Nagrath, Robotics and Control, Tata McGraw Hill publications, 2003.
2. Niku, Introduction to Robotics, Pearson Education, 2011.
3. Grover, Wiess, Nagel and Oderey, Industrial Robotics, McGraw Hill, 2012.

RAEL - 9	AGRICULTURAL ROBOTICS AND AUTOMATION	3L: 0T: 0P	3 Credits

COURSE OBJECTIVES:

- To learn about Farming Related Machines.
- To understand the global position and information system in machines.
- To know about traction and testing
- To familiarize the concept on weed management
- To learn about machinery selection.

COURSE CONTENTS:

MODEL I: INTRODUCTION **9 PERIODS**

History of Mechanized Agriculture - Farming Operations and Related Machines - Tillage, PlantingCultivation, and Harvesting, Agricultural Automation - Agricultural Vehicle Robot.

MODEL II: PRECISION AGRICULTURE **9 PERIODS**

Sensors — types and agricultural applications, Global Positioning System (GPS) - GPS for civilian use, Differential GPS, Carrier-phase GPS, Real-time kinematic GPS, Military GPS, Geographic Information System, Variable Rate Applications and Controller Area Networks.

MODELIII: TRACTION AND TESTING **9 PERIODS**

Hitching- Principles of hitching, Types of hitches, Hitching and weight transfer, Control of hitches,Tires and Traction models, Traction predictor spread sheet, Soil Compaction, Traction Aids, Tractor Testing.

MODEL IV: SOIL TILLAGE AND WEED MANAGEMENT **9 PERIODS**

Tillage Methods and Equipment, Mechanics of Tillage Tools, Performance of Tillage Implements,Hitching of Tillage Implements, Weed Management - Conventional Cropping Systems, Tools, Crop Rotation, Mechanical Cultivation.

MODEL V: MACHINERY SELECTION **9 PERIODS**

Screw Conveyors, Pneumatic Conveyors, Bucket Elevators, Forage Blowers and MiscellaneousConveyors, Machinery Selection - Field Capacity and Efficiency, Draft and Power Requirements,Machinery Costs.

TOTAL PERIODS:45

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- Recognize the areas in agricultural process where robotics can be applied.
- Integrate sensor and system for a required specific process in agricultural applications.
- Apply Mechanics to the design various robot parameters
- Convert various mechanisms into robot by providing actuation at specific links and jointsof the mechanism.
- Develop suitable robotic system for specific agricultural tasks.

TEXT BOOKS:

1. Ajit K. Srivastava, Carroll E. Goering, Roger P. Rohrbach, Dennis R. Buckmaster, "Engineering Principles of Agricultural Machines", ASABE Publication, 2012.
2. Myer Kutz, "Handbook of Farm, Dairy and Food Machinery Engineering", Academic Press, 2019.
3. Qin Zhang, Francis J. Pierce, "Agricultural Automation Fundamentals and Practices", CRC Press, 2016.

REFERNCE BOOKS:

1. Stephen L Young, Francis J. Pierce, "Automation: The Future of Weed Control inCropping Systems", Springer, Dordrecht Heidelberg New York London, 2014.
2. R.A. Kepner, Roy Bainer, E.L. Barger, "Principles of Farm Machinery", 3rd Edition,CBS Publishers, New Delhi, 2005.
3. Guangnan Chen, "Advances in Agricultural Machinery and Technologies", 1st Edition,CRC Press, 2021.

RAEL - 10	COBOT (COLLABORATIVE ROBOTICS)	3L: 0T: 0P	3 Credits

COURSE OBJECTIVES:

- To gain the knowledge on basics of Ladder Logic, Basic programming, Safety for Hydraulics and Pneumatics, Robot Safety, Robotic Drives, Hardware, and Components, Robot Installations, Vision Systems, and Robot Troubleshooting.

COURSE CONTENTS:

MODULE I: REVIEW OF THE BASICS OF INDUSTRIAL ROBOTICS 9 PERIODS

Identify and describe the basic components of a robot's body and arms- Description of the axis of movement for the robotic arm - Describe the coordinate systems used to program a robot's movement, and review stationary and mobile industrial robots and appropriate applications for each.

MODULE II: ROBOTIC DRIVES, HARDWARE AND COMPONENTS 9 PERIODS

Describe and demonstrate items used in robots such as frames and frame material, robot joints, bearings, hydraulics drives, pneumatic drives, servomotors and encoders, transmissions, ballscrews, sensors, wiring and hoses- the methods robotic axis control, and describe sensors for robots.

MODULE III: ROBOT INSTALLATION 9 PERIODS

Packing/unpacking and transporting the robot, installing the robot and the controller, making connections of power, grounding and other cables, robotic start-up, writing and loading programs, and troubleshooting the robotic assembly.

MODULE IV: VISION SYSTEMS 9 PERIODS

Vision system for Industrial Robots including the concepts of linear array, matrix arrays, machine vision, pixel display, camera mounting, image intensity, Vidicon vs. Solid State cameras, lighting, lighting devices, laser vision and machine vision applications.

MODULE V: ROBOT TROUBLESHOOTING 9 PERIODS

Basic troubleshooting process, useful troubleshooting tools, and common robotic malfunction root causes and corrective actions. Collection and organization of troubleshooting information, as well as the use of troubleshooting manuals and flow charts, assessment of troubleshooting costs, working backwards, the 5 Whys Technique, implementation of corrective actions, temporary vs. permanent corrective actions, and system testing following corrective action.

TOTAL PERIODS:45

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- Gain a greater understanding of Industrial robotics, including types, applications, and programming methods.
- Understand the importance of "Robot Safety" by reviewing and demonstrating the different ways to prevent robot accidents.
- Gain a greater understanding of the physical components of industrial and collaborative robots, and how these components operate and allow the robot to perform work.
- Demonstrate the basic steps for installing and maintaining industrial and/or collaborative robots.
- Learn the use of a systematic approach in solving issues that cause robotic malfunction.

TEXT BOOKS:

1. Peter Matthews, Steven Greenspan, Automation and Collaborative Robotics- A Guide to the Future of Work, APress 2020.
2. M.A. Reshkin, J.E. Colgate, C.A. Moore, Cobot Architecture, I EEE Transaction on Robotics & Automation, Vol 17, issue 4, 2001.
3. VDMA “Safety in Human-Robot Collaboration” (http://rua.vdma.org/en/article/-/articleview/4217015)

REFERENCE BOOKS:

1. ISO 10218 Part 1 & Part 2 (2011)
2. ANSI/RIA R15.06 2012

RAEL - 11	CNC MACHINE AND METROLOGY	3L: 0T: 0P	3 Credits

COURSE OBJECTIVES

- Understand evolution and principle of CNC machine tools
- Write simple programs for CNC turning and machining centres
- Generate CNC programs for popular CNC controllers
- Describe about linear and angular measurements in metrology
- Study about the advancement in metrology

COURSE CONTENTS:

MODULE I: INTRODUCTION TO CNC MACHINE TOOLS 9 PERIODS

Evolution of CNC Technology, principles, features, advantages, applications, CNC and DNC concept, classification of CNC Machines – turning centre, machining centre, grinding machine, EDM, types of control systems, CNC controllers, characteristics, interpolators– Computer Aided Inspection, CNC Machine building, structural details, configuration and design, guide ways – Friction, Anti friction and other types of guide ways.

MODULE II: DRIVES AND WORK HOLDING DEVICES 9 PERIODS

Spindle drives – DC shunt motor, 3 phase AC induction motor, feed drives –stepper motor, servo principle, DC and AC servomotors, Axis measuring system – synchro, synchro-resolver, gratings, moiré fringe gratings, encoders, inductosysn, laser interferometer, work holding devices for rotating and fixed work parts, economics of CNC, maintenance of CNC machines.

MODULE III: CNC PROGRAMMING 9 PERIODS

Coordinate system, structure of a part program, G & M Codes, tool length compensation, cutter radius and tool nose radius compensation, do loops, subroutines, canned cycles, mirror image, parametric programming, machining cycles, programming for machining centre and turning centre for well known controllers such as Fanuc, Heidenhain, Sinumerik etc., generation of CNC codes from CAM packages.

MODULE IV: LINEAR AND ANGULAR MEASUREMENTS 9 PERIODS

Linear Measuring Instruments – Evolution – Types – Classification – Limit gauges – gauge design – terminology – procedure – concepts of interchange ability and selective assembly – Angular measuring instruments – Types – Bevel protractor clinometers angle gauges, spirit levels sine bar – Angle alignment telescope – Autocollimator – Applications.

MODULE V: ADVANCES IN METROLOGY **9 PERIODS**

Basic concept of lasers Advantages of lasers – laser Interferometers – types – DC and AC Lasers interferometer – Applications – Straightness – Alignment. Basic concept of CMM – Types of CMM – Constructional features – Probes – Accessories – Software – Applications – Basic concepts of Machine Vision System – Element – Applications.

TOTAL PERIODS:45

COURSE OUTCOMES

On successful completion of the module students will be able to

- To understand about the basic in CNC machineries
- Understand Evolution and principle of CNC machine tools and different measurement technologies. Able to write simple programs for CNC machinery
- Impart knowledge about linear and angular measurements in metrology
- Know about the advancement in metrology

TEXT BOOKS:

1. M.D. Singh, J.G. Joshi, "Mechatronics", HMT, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2006.
2. Warren S.Seamers, "Computer Numeric Control", Fourth Edition, Thomson Delmar, 2002.
3. Jain R.K. "Engineering Metrology", Khanna Publishers, 2005.

REFERENCE BOOKS:

1. Gupta. I.C., "Engineering Metrology", Dhanpatrai Publications, 2005.
2. Charles Reginald Shotbolt, "Metrology for Engineers", 5th edition, Cengage Learning EMEA,1990.
3. Backwith, Marangoni, Lienhard, "Mechanical Measurements", Pearson Education , 2006.
4. Peter Smid, "CNC Programming Hand book", Industrial Press Inc., 2000
5. Berry Leathan – Jones, "Introduction to Computer Numerical Control", Pitman, London, 1987.
6. Radhakrishnan P "Computer Numerical Control Machines", New Central Book Agency, 2002.

RAEL - 12	TOTALLY INTEGRATED AUTOMATION	3L: 0T: 0P	3 Credits

COURSE OBJECTIVES

- To gain knowledge in automation in industries.
- To gain knowledge in various electrical and electronic programmable automations and their applications.
- To know about the basic in SCADA and DCS systems.
- To gain knowledge in communication protocols in an integrated system
- To know about the advanced in automation industries

COURSE CONTENTS:

MODULE I: TOTALLY INTEGRATED AUTOMATION 9 PERIODS

Need for TIA - TIA Architecture - Components of TIA systems - Selection of TIA Components – Programmable Automation Controllers (PAC) - Vertical Integration structure.

MODULE II: SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA) 9 PERIODS

Overview – Developer and runtime packages – Architecture – Tools – Tags – Graphics - Alarm logging – Tag logging – Trends – History – Report generation, VB & C Scripts for SCADA application.

MODULE III: COMMUNICATION PROTOCOLS OF SCADA 9 PERIODS

Proprietary and open Protocols – OLE/OPC – DDE – Server/Client Configuration – Messaging – Recipe – User administration – Interfacing of SCADA with PLC, drive, and other field device.

MODULE IV: DISTRIBUTED CONTROL SYSTEMS (DCS): 9 PERIODS

DCS – architecture – local control unit- programming language – communication facilities – operator interface – engineering interfaces.

MODULE V: INDUSTRIAL PLANT DESIGN 9 PERIODS

Design criteria – Process sequencing - Plant layout modeling – Selection of industrial power and automation cables, Overview of plant simulation software.Case Studies: Case studies of Machine automation, Process automation.

TOTAL PERIODS:45

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- Knowledge of PLC& PAC automation
- Ability to apply SCADA and usage of C programming for report generation
- Acquiring information's on communication protocols in automation systems
- Ability to design and develop automatic control system using distributed control systems.
- Knowledge in automation of industries.

TEXT BOOKS:

1. David Bailey, Edwin Wright, -Practical SCADA for industry, Newnes, Burlington, 2003.
2. Gordon Clarke, Deon Reynders,Edwin Wright, -Practical Modern SCADA Protocols: DNP3, 60870.5 and Related systems‖, Newnes Publishing, 2004.

APPENDIX – II:

OPEN ELECTIVE COURSES

RAOE - 1	ROBOT OPERATING SYSTEMS	3L: 0T: 0P	3 Credits

COURSE OBJECTIVES:

- To acquaint with the operating systems in context with the robotic operating systems.
- To understand the linux commands and its processing.
- To comprehend and explain the operating system architectures
- To focus on methods of computation graph levels
- To understand and describe the debugging and visualization process.

COURSE CONTENTS:

MODULE I: INTRODUCTION TO ROS **9 PERIODS**

Introduction - history - distributions - difference from other meta - operating systems -services - ROS framework - operating system – releases

MODULE II: INTRODUCTION TO LINUX COMMANDS **9 PERIODS**

UNIX commands - file system - redirection of input and output - File system security - Changing access rights - process commands - compiling, building and running commands –handling variables.

MODULE III: ARCHITECTURE OF OPERATING SYSTEM **9 PERIODS**

File system - packages - s tacks - messages - services – catkin workspace - working with catkin workspace - working with ROS navigation and listing commands

MODULE IV: COMPUTATION GRAPH LEVEL **9 PERIODS**

Navigation through file system - Understanding of Nodes - topics - services - messages - bags - master - parameter server - interfacing of Sensors and Actuators

MODULE V: DEBUGGING AND VISUALIZATION **9 PERIODS**

Debugging of Nodes - topics - services - messages - bags - master parameter - visualization using Gazebo - Rviz - URDF modeling - Xacro - launch files. Applications**:** Navigation stack - tf - sensors - odometer - imu - laser scan - base controller - robot configuration - cost map - base local planner - global planner - localization - sending goals - tele operation of robot using joystick and mapping.

TOTAL PERIODS:45

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- Explain the basic concepts of robotic operating system
- Understand the linux commands for the robotic operating system
- Differentiate the various architecture of operating system
- Analyze the computation and graph level
- Understand and analyze the debugging and visualization.

TEXT BOOKS:

1. Aaron Martinez, Enrique Fernández, Packt Publishing Ltd, "Learning ROS for Robotics Programming", 2013.
2. Jason M O'Kane Create Space, "A Gentle Introduction to ROS", 2013.
3. Morgan Quigley , Brian Gerkey , William Smart, Programming Robots with ROS: A Practical Introduction to the Robot Operating System, 1st Edition, 2015.

REFERENCE BOOKS:

1. Enrique Fernandez , Luis Sanchez Crespo ,Anil Mahtani , Learning ROS for Robotics Programming, Packt Publishing,2nd Edition,2015.
2. Anil Mahtani ,Luis Sanchez , Enrique Fernandez , Aaron Martinez, Effective Robotics Programming with ROS, ,Packt Publishing,3rd Edition,2016.

RAOE - 2	UAV AND UNDERWATER ROBOTICS	3L: 0T: 0P	3 Credits

COURSE OBJECTIVES:

- To recognize and describe the role of unmanned aerial vehicles (UAVs) in past, present, and future society.
- To comprehend and explain various components of UAVs.
- To comprehend and explain basics of flight and flight control systems.
- To understand and describe basics of underwater robots.

COURSE CONTENTS:

MODULE I: OVERVIEW AND BACKGROUND 9 PERIODS

Definitions- History of UAVs - classifications of UAVs scale- lift generation method- contemporary applications- military- government- civil-societal impact and future outlook- operational considerations- liability / legal issues- insurance- ethical implications- human factors- LOS / BLOS.

MODULE II: PAYLOAD FOR UAV 9 PERIODS

Introduction – Types – Non dispensable Payloads - Electro-optic Payload Systems - Electrooptic Systems Integration - Radar Imaging Payloads - Other Non dispensable Payloads -Dispensable Payloads - Payload Development.

MODULE III: UNMANNED AERIAL SYSTEM (UAS) COMPONENTS 9 PERIODS

Platforms- configurations- characteristics-applications- propulsion- Internal combustion - on-board flight control- payloads- sensing / surveillance- weaponized- delivery-communications- command/control- telemetry - launch / recovery systems- Ground control stations.

MODULE IV: UNDERWATER ROBOTICS 9 PERIODS

Robotics in Water - Basics Representation of Underwater Robot - Types and Classification of Underwater Robotics - Differentiating Aerial and Underwater Robotics - Overview about Environmental Factors affecting object in water.

MODULE V: CONTROL SYSTEM AND MANIPULATOR 9 PERIODS

Control System and Types of Control Systems in Underwater Robotics - Sensors Connected with the Underwater Robotics - Introduction to Underwater Manipulators - Introduction to Hydraulics on Underwater Vehicles - Applications of Underwater Vehicles. **A**utonomous Underwater Systems: Introduction to AUVS - Development of AUVs,ROV in Market - Case Study on AUV Control System Basics - Case Study on Subsea Manipulator - Case Study on Technologies Used.

TOTAL PERIODS:45

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- Understand the challenges in developing autonomous mobile Robots.
- Abstract kinematic control of wheeled mobile Robots.
- Understand the challenges involved in sensory perception for mobile Robots.
- Develop localization and path planning algorithms for mobile Robot navigation.
- Comprehend the challenges and configurations of legged, aerial and underwater Mobile Robots.

TEXT BOOKS:

1. Roland Siegwant & Illah R. Nourbakhsh, Introduction to Autonomous Mobile Robots, MIT Press, 2004.
2. ASA Test Prep. Remote Pilot Test Prep — UAS: Study & Prepare. Wellfleet Press, 2016. 978-1577151326
3. Austin, Unmanned Aircraft Systems: UAVS Design, Development and Deployment. Wiley, 2010. 978-0-470-05819-0

REFERENCE BOOKS:

1. Baichtal, Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs. Que Publishing,2016. 978-0789755988
2. Beard & McLain, Small Unmanned Aircraft: Theory and Practice. Princeton University Press, 2012. 978-0691149219
3. Cares & Dickmann, Operations Research for Unmanned Systems. Wiley, 2016. 978-1-118-91894-4
4. Gianluca Antonelli, ―Underwater Robots‖, Springer, 2014.

RAOE - 3	INDUSTRIAL IOT AND AUTOMATION	3L: 0T: 0P	3 Credits

COURSE OBJECTIVES:

- To understand Smart Objects and IoT Architectures
- To learn about various IOT-related protocols
- To build simple IoT Systems using Arduino and Raspberry Pi.
- To understand data analytics and cloud in the context of IoT
- To develop IoT infrastructure for popular applications

COURSE CONTENTS:

MODULE I: BASICS OF IoT **9 PERIODS**

Evolution of Internet of Things - Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT models – Simplified IoT Architecture and Core IoT Functional Stack -– Fog, Edge and Cloud in IoT – Functional blocks of an IoT ecosystem – Sensors, Actuators, Smart Objects and Connecting Smart Objects

MODULE II: IoT PROTOCOLS **9 PERIODS**

IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4,802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN – Network Layer: IP versions, Constrained Nodes and Constrained Networks – Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks – Application Transport Methods: Supervisory Control and Data Acquisition – Application Layer Protocols: CoAP and MQTT

MODULE III: DESIGN AND DEVELOPMENT **9 PERIODS**

Design Methodology - Embedded computing logic - Microcontroller, System on Chips - IoT system building blocks - Arduino - Board details, IDE programming - Raspberry Pi - Interfaces and Raspberry Pi with Python Programming.

MODULE IV: DATA ANALYTICS AND SUPPORTING SERVICES **9 PERIODS**

Structured Vs Unstructured Data and Data in Motion Vs Data in Rest – Role of Machine Learning –No SQL Databases – Hadoop Ecosystem – Apache Kafka, Apache Spark – Edge Streaming Analytics and Network Analytics – Xively Cloud for IoT, Python Web Application Framework – Django – AWS for IoT – System Management with NETCONF- YANG

MODULE V: CASE STUDIES/INDUSTRIAL APPLICATIONS **9 PERIODS**

Cisco IoT system - IBM Watson IoT platform – Manufacturing - Converged Plantwide Ethernet Model (CPwE) – Power Utility Industry – Grid Blocks Reference Model - Smart and Connected Cities: Layered architecture, Smart Lighting, Smart Parking Architecture and Smart Traffic Control

TOTAL PERIODS:45

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- Explain the concept of IoT.
- Analyze various protocols for IoT.
- Design a PoC of an IoT system using Raspberry Pi/Arduino
- Apply data analytics and use cloud offerings related to IoT.
- Analyze applications of IoT in real time scenario in Automation Control

TEXT BOOKS:

1. IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017.
2. Arshdeep Bahga, Vijay Madisetti, ―Internet of Things – A hands-on approach‖, Universities Press, 2015
3. Olivier Hersent, David Boswarthick, Omar Elloumi, . The Internet of Things – Key applications and Protocols, Wiley, 2012

REFERENCE BOOKS:

1. Jan Ho¨ ller, Vlasios Tsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence", Elsevier, 2014.
2. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), ―Architecting the Internet of Things‖, Springer, 2011.
3. Michael Margolis, Arduino Cookbook, Recipes to Begin, Expand, and Enhance Your Projects, 2 nd Edition, O'Reilly Media, 2011.

RAOE - 4	COGNITIVE ROBOTICS	3L: 0T: 0P	3 Credits

COURSE OBJECTIVES:

- To provide brief introduction to robot cognition and perception
- To understand the concepts of path planning algorithms.
- To gain knowledge on the robot programming packages used in localization and mapping.

COURSE CONTENTS:

MODULE I: CYBERNETIC VIEW OF ROBOT COGNITION AND PERCEPTION 9 PERIODS

Introduction to the Model of Cognition — Visual Perception - Visual Recognition Machine Learning - Soft Computing Tools and Robot Cognition.

MODULE II: MAP BUILDING 9 PERIODS

Introduction - Constructing a 2D World Map - Data Structure for Map Building - Explanation of the Algorithm An Illustration of Procedure Traverse Boundary - An Illustration of Procedure Map Building – Robot Simulation - Execution of the Map Building Program.

MODULE III: RANDOMIZED PATH PLANNING 9 PERIODS

Introduction - Representation of the Robot's Environment - Review of configuration spaces - Visibility Graphs - Voronoi diagrams - Potential Fields and Cell Decomposition - Planning with moving obstacles - Probabilistic Roadmaps - Rapidly exploring random trees - Execution of the Quadtree- Based Path Planner Program.

MODULE IV: SIMULTANEOUS LOCALIZATION AND MAPPING (SLAM) 9 PERIODS

Problem Definition - Mathematical Basis - Example: SLAM in Landmark Worlds - Taxonomy of the SLAM Problem - Extended Kalman filter - Graph-Based Optimization Techniques - Particle Methods Relation of Paradigms.

MODULE V: ROBOT PROGRAMMING PACKAGES 9 PERIODS

Robot Parameter Display - Program for Bot Speak - Program for Sonar Reading Display - Program for Wandering Within the Workspace - Program for Tele-operation - A Complete Program for Autonomous Navigation

TOTAL PERIODS:45

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

- Discuss about the basics of robot cognition and perception
- Illustrate the different methods of map building and the robot simulation and execution of a program
- Analyze the various path planning techniques by briefing about the robot's environment and explaining about the programs used
- Develop knowledge about simultaneous localization and mapping based techniques and paradigms.
- Elaborate the various robot programming packages for display, tele-operation and other applications.

TEXT BOOKS:

1. Patnaik, Srikanta, "Robot Cognition and Navigation An Experiment with Mobile Robots",Springer-Verlag Berlin and Heidelberg,2007.
2. HowieChoset,KevinLynchSethHutchinson,GeorgeKantor,WolframBurgard,LydiaKavraki,SebastianThrun,"Principles of Robot Motion -Theory,Algorithms,andImplementation",MITPress,Cambridge,2005.
3. LaxmidharBehera, Indrani Kar, Intelligent Systems and Control Principles and Applications, Oxford UniversityPress,2010.

REFERENCE BOOKS:

1. SebastianThrun,WolframBurgard,DieterFox, Probabilistic Robotics", MIT Press, 2005.
2. Margaret E.Jefferies,Wai-KiangYeap, Robotics and Cognitive Approaches to Spatial Mapping",Springer-VerlagBerlinHeidelberg,2008.
3. Hooman Samani , Cognitive Robotics CRC Press ,1st Edition,, 2015.

RAOE - 5	INDUSTRIAL DRIVES FOR AUTOMATION	3L: 0T: 0P	3 Credits

COURSE OBJECTIVES

- To know about stepper motors.
- To know about switched reluctance motors
- To know about permanent magnet brushless d.c. Motors
- To know about permanent magnet synchronous motors
- To know about linear motors

MODULE I: STEPPER MOTORS 9 PERIODS

Types - Constructional features – principle of operation – variable reluctance motor – single and Multistack configurations – Permanent Magnet Stepper motor – Hybrid stepper motor. Different modes of Excitation - theory of torque predictions – Drive systems and circuit for open loop and closed loop control of stepper motor.

MODULE II: SWITCHED RELUCTANCE MOTORS 9 PERIODS

Constructional features – principle of operation –Torque Equation - Power Converters for SR Motor – Rotor Sensing Mechanism & Logic Controller – Sensorless Control of SR motor - Applications.

MODULE III: PERMANENT MAGNET BRUSHLESS D.C. MOTORS 9 PERIODS

Principle of operation – Types – Magnetic circuit analysis – EMF and torque equations – Power controllers – Motor characteristics and control – Applications.

MODULE IV: PERMANENT MAGNET SYNCHRONOUS MOTORS 9 PERIODS

Principle of operation, EMF, power input and torque expressions, Phasor diagram, Power Controllers, Torque speed characteristics, Self control, Vector control, Current control Schemes – Applications.

MODULE V: LINEAR MOTORS 9 PERIODS

Linear Induction motor (LIM) classification – construction – Principle of operation – Concept of current sheet – goodness factor – DC Linear motor (DCLM) types – circuit equation - DCLM control applications – Linear Synchronous motor(LSM) – Types–Applications Servomotors: Types – Constructional features, principle of operation - control applications.

TOTAL PERIODS:45

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

- Understanding principles of operation, types and applications of stepper motors
- Understanding principles of operation, types and applications of switched reluctance motors
- Knowledge in evaluating the performance of dc motors
- Evaluate knowledge in permanent magnet synchronous motors.
- Ability to understand the working and applications linear motors and servo motors.

TEXT BOOKS:

1. K. Venkataratnam," Special Electrical Machines", Universities Press (India) Private Limited, India,2009.
2. Kenjo, T and Naganori, S "Permanent Magnet and brushless DC motors", Clarendon Press,Oxford, 1989
3. Naser A and Boldea L,"Linear Electric Motors: Theory Design and Practical Applications", Prentice Hall Inc., New Jersey 1987.

REFERENCE BOOKS:

1. Kenjo T, "Stepping Motors and their Microprocessor Controls", Clarendon Press London, 2003.
2. Miller T J E, "Brushless Permanent Magnet and Reluctance Motor Drives", Clarendon Press, Oxford, 1989 .
3. Floyd E Saner," Servo Motor Applications", Pittman USA, 1993.
4. WILLIAM H YEADON, ALAN W YEADON, Handbook of Small Electric Motors, McGraw Hill, INC,2001

RAOE - 6	APPLIED ROBOTICS	3L: 0T: 0P	3 Credits

COURSE OBJECTIVES:

To address the applications of robots in some specific areas where the use of robots has significantly improved productivity.

COURSE CONTENTS:

MODULE I: APPLICATIONS OF ROBOTS IN INDUSTRIES 9 PERIODS

Introduction to robotics - overview, a short history of industrial Robots - Applications of Robots in Welding, car body assembly, painting- Applications of Robot in Machining, material transfer- Kinematics and mechanisms review, tasks descriptions, teaching and programming- End-effectors and system integration.

MODULE II: COOPERATIVE AND SWARM ROBOTS 9 PERIODS

Cooperative manipulation, Challenges in cooperative manipulation- Case studies for Cooperative manipulation for Industrial and Service applications- Introduction to swarm Robots, comparison with other multi-agent systems, challenges and benefits of swarm systems- Algorithms for swarm Robots, application, case study of swarm Robots.

MODULE III: FIELD ROBOTICS 9 PERIODS

Forestry, Robot locomotion, forestry automation, SLAM in forestry- autonomous Robots for silviculture and treatment- Broad acre Applications: Automatic guidance, sowing, weeding, spraying and broad-acre harvesting, Horticulture: picking of fruits- Robot milking, sheep shearing, slaughtering, livestock inspection- Robots in construction, unsolved problems in construction, Future directions- Robots for hazardous applications, enabling technologies- Search and Rescue robotics: Disaster characteristics-Impact on Robots, Robots actually used at disaster, promising robots, open issues – case studies.

MODULE IV: ROBOTS IN SURGERY AND REHABILITATION 9 PERIODS

Medical robotics, Core concepts, Technology- Medical robotic systems, Research areas and applications- Rehabilitation and Health care robotics: Overview, physical therapy and training Robots- Aids for people with disabilities- Smart prostheses and orthoses, diagnosis and monitoring.

MODULE V: ENTERTAINMENT AND PERSONAL ROBOTICS 9 PERIODS

Cleaning Robots, lawn moving Robots- Smart appliances and smart homes- The role of Robots in education, Educational robotic platforms-. Robots and informal learning venue.

TOTAL PERIODS:45

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- Understand the various types of Industrial, field and service Robots and their characteristics and capabilities.
- Equip with the knowledge of Mathematical modeling of specialized Robots.
- Familiarize with the operation of Robots and processes involved.
- Select the right Robot with required configurations and specifications for applications.
- Familiarize with the applications of various field and service Robots.

TEXT BOOKS:

1. Bruno Siciliano, OussamaKhatib, “Springer Handbook of Robotics”, Springer-Verlag Berlin Heidelberg 2008.
2. Yangsheng Xu Huihuan Qian Xinyu Wu, "Household and Service Robots", Elsevier Ltd, 2015.
3. Springer Handbook of Robotics (Springer Handbooks) 2nd Edition, Kindle, 2nd edition (27 July 2016).

REFERENCE BOOKS:

1. AleksandarLazinica, “Mobile Robots Towards New Applications”, Advanced Robotic Systems International, 2006.
2. L Marques,A de Almeida,Mo Tokhi,GSVirk, “Advances in Mobile Robotics”, World Scientific Publishing Co. Pte. Ltd. 2008.
3. Gregory Dudek,Michael Jenkin, “Computational Principles of Mobile Robotics”, 2nd edition, Oxford University Press, 2010.

RAOE - 7	ROBOTIC PROCESS AUTOMATION & DEVELOPMENT	3L: 0T: 0P	3 Credits

COURSE OBJECTIVES:

- To uunderstand the basics of automation process and RPA
- To impart basic principle automation, different variables used in automation
- To know the advanced automation techniques
- To focus on how to handle user events and exceptions in robotic automation process.
- To acquaint deploying and maintenance of BOTs.

COURSE CONTENTS:

MODULE I: RPA BASICS 9 PERIODS

Scope and techniques of automation, Robotic process automation - What can RPA do? Benefits of RPA, Components of RPA, RPA platforms, The future of automation. History of Automation - What is RPA - RPA vs Automation - Processes & Flowcharts - Programming Constructs in RPA - What Processes can be Automated - Types of Bots - Workloads which can be automated

MODULE II: RPA TOOL INTRODUCTION AND BASICS 9 PERIODS

Introduction to RPA Tool - The User Interface - Variables - Managing Variables - Naming Best Practices - The Variables Panel - Generic Value Variables - Text Variables - True or False Variables - Number Variables - Array Variables - Date and Time Variables - Data Table Variables - Managing Arguments - Naming Best Practices - The Arguments Panel - Using Arguments - About Imported Namespaces - Importing New Namespaces- Control Flow - Control Flow Introduction - If Else Statements - Loops - Advanced Control Flow - Sequences - Flowcharts - About Control Flow - Control Flow Activities

MODULE III: ADVANCED AUTOMATION CONCEPTS & TECHNIQUES 9 PERIODS

Recording Introduction - Basic and Desktop Recording - Web Recording - Input/Output Methods - Screen Scraping - Data Scraping - Scraping advanced techniques - Selectors - Defining and Assessing Selectors - Customization - Debugging - Dynamic Selectors - Partial Selectors - RPA Challenge - Image, Text & Advanced Citrix Automation - Introduction to Image & Text Automation - Image based automation

MODULE IV: HANDLING USER EVENTS & ASSISTANT BOTS, EXCEPTION HANDLING 9 PERIODS

What are assistant bots? - Monitoring system event triggers - Hotkey trigger - Mouse trigger - System trigger - Monitoring image and element triggers - An example of monitoring email - Example of monitoring a copying event andblocking it - Launching an assistant bot on a keyboard event.

MODULE V: DEPLOYING AND MAINTAINING THE BOT **9 PERIODS**

Publishing using publish utility - Creation of Server - Using Server to control the bots - Creating a provision Robot from the Server - Connecting a Robot to Server - Deploy the Robot to Server - Publishing and managing updates - Managing packages - Uploading packages - Deleting packages

TOTAL PERIODS:45

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- Describe RPA, where it can be applied and how it's implemented.
- Describe the different types of variables, Control Flow and data manipulation techniques.
- Identify and understand Image, Text and Data Tables Automation.
- Describe how to handle the User Events and various types of Exceptions and strategies.
- Understand the Deployment of the Robot and to maintain the connection.

TEXT BOOKS:

1. Alok Mani Tripathi, "Learning Robotic Process Automation", Packt Publishing, 2018.
2. The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems Paperback – 29 February 2020, by Tom Taulli.
3. Frank Casale, Rebecca Dilla, Heidi Jaynes, Lauren Livingston, "Introduction to Robotic Process Automation: a Primer", Institute of Robotic Process Automation,1st Edition 2015.

REFERENCE BOOKS:

1. Richard Murdoch, Robotic Process Automation: Guide to Building Software Robots, Automate Repetitive Tasks & Become an RPA Consultant", Independently Published, 1st Edition 2018.
2. Srikanth Merianda, Robotic Process Automation Tools,Process Automation and their benefits: Understanding RPA and Intelligent Automation", Consulting Opportunity Holdings LLC, 1st Edition 2018.
3. Lim Mei Ying, "Robotic Process Automation with Blue Prism Quick Start Guide: Create software robots and automate business processes", Packt Publishing, 1st Edition 2018.

RAOE - 8	INDUSTRIAL ROBOTICS AND MATERIAL HANDLING SYSTEMS	3L: 0T: 0P	3 Credits

COURSE OBJECTIVES:

- To understand the latest material handling system used in industry.
- To study about the concept of Automated Guided Vehicle System.

COURSE CONTENTS:

MODULE I: FUNDAMENTALS OF MATERIAL HANDLING 9 PERIODS

Material Handling – Functions, Types, analysis, Importance & Scope, Principles, - Part feeding device – types of material handling system – Unit material movement & Unit loads – Receiving, Shipping, in process handling – bulk handling equipment & methods.

MODULE II: DOT AND CROSS PRODUCTS 9 PERIODS

Dot and cross products, Co-ordinate frames, Rotations, Homogeneous Coordinates, Link coordinates, D-H Representation, Arm equation -Two axis, three axis, four axis, five axis and six axisrobots. Inverse Kinematic problem, General properties of solutions, Tool configuration, Inverse Kinematics of Two axis Three axis, Four axis and Five axis robots.

MODULE III: WORKSPACE ANALYSIS 9 PERIODS

Workspace analysis of Four axis, Five axis and Six axis robots, Perspective transformation, structured illumination, Camera calibration, Work envelope of Four and Five axis robots, Workspace fixtures.

MODULE IV: DIFFERENTIAL MOTION AND STATICS 9 PERIODS

The too Configuration jacobian matrix for three axis and, four axis robots, joint space singularities, resolved motion rate control, manipulator jacobian for three and four axis joint space singularities, induced joint torques and forces.

MODULE V: DYNAMIC ANALYSIS AND FORCES 9 PERIODS

Introduction, Langrangian mechanics, Effects of moments of Inertia, Dynamic equation for two axis planar articulated robot. Trajectory planning, Pick and place operations, Continuous path motion, Interpolated motion, Straight-line motion.

TOTAL PERIODS:45

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- Learn about the basic concepts, parts of robots and types of robots.
- Design automatic manufacturing cells with robotic control using the principle behind robotic
- Drive system, end effectors, sensor, machine vision robot kinematics and programming.
- Ability in selecting the required robot
- Know various applications of robots
- Apply their knowledge in handling the materials.

TEXT BOOKS:

1. Robert J. Schilling, ―Fundamentals of Robotics Analysis and Control‖, PHI Learning, 2011.
2. Niku S B, ―Introduction to Robotics, Analysis, Systems, Applications‖, Prentice Hall, 2001.
3. John J Craig, ―Introduction to Robotics: Mechanics and control, Pearson, 2009,4th Ed, 2018.

REFERENCE BOOKS:

1. Deb S R and Deb S, ―Robotics Technology and Flexible Automation‖, Tata McGraw Hill Education Pvt. Ltd, 2010.
2. Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Eastern Economy Edition, Prentice Hall of India P Ltd., 2006.
3. Saha S K, ―Introduction to Robotics‖, Tata McGraw Hill Education Pvt. Ltd,2010, 2nd Ed, 2014.

RAOE - 9	MICRO ROBOTICS	3L: 0T: 0P	3 Credits

COURSE OBJECTIVES:

- To understand micro systems and scaling laws for MEMS
- To acquaint actuators and sensors used for micro robots.
- To understand and gain knowledge about microrobots
- To apply the knowledge gained about micro robots in the real time application
- To integrate micro fabrications and micro assembly into micro robots

COURSE CONTENTS:

MODULE I: SCALING LAWS AND MATERIALS FOR MEMS 9 PERIODS

MST (Micro System Technology) - Micromachining - Working principles of Microsystems - Applications of Microsystems. Introduction - Scaling laws - Scaling effect on physical properties scaling effects on Electrical properties - scaling effect on physical forces - Physics of Adhesio - Silicon - compatible material system - Shape memory alloys - Material properties - Piezoresistivity, Piezoelectricity and Thermoelectricity

MODULE II: FLEXURES, ACTUATORS AND SENSORS 9 PERIODS

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

MODULE III: MICROROBOTICS 9 PERIODS

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.

MODULE IV: IMPLEMENTATION OF MICROROBOTS 9 PERIODS

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.

MODULE V: MICROFABRICATION AND MICROASSEMBLY 9 PERIODS

Micro-fabrication principles-Design selection criteria for micromachining - Packaging and Integration aspects - Micro-assembly platforms and manipulators

TOTAL PERIODS:45

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

- Explain the basic concept of microrobots.
- Understand the sensors and actuators used in basic mechanisms of micro robots.
- Acquire knowledge about fabrication of micro robots.
- Apply the knowledge of micro robots in real time applications.
- Understand the fabrication and assembly of micro robots.

TEXT BOOKS:

1. Mohamed Gad-el-Hak , "The MEMS Handbook", CRC Press, New York, 2002.
2. Yves Bellouard, "Microrobotics Methods and Applications", CRC Press, Massachusetts, 2011.
3. Nadim Maluf and Kirt Williams, "An Introduction to Microelectromechanical systems Engineering", Artech House, 2002.

REFERENCE BOOKS:

1. Julian W Gardner, "Microsensors: Principles and Applications", John Wiley & Sons, 1994.
2. Metin Sitti, "Mobile Microrobotics", MIT Press, 2017.
3. Nicolas Chaillet, Stephane Regnier, "Microrobotics for Micromanipulation", John Wiley & Sons, 2013.

RAOE - 10	ROBOT VISION AND INTELLIGENCE	3L: 0T: 0P	3 Credits

COURSE OBJECTIVES

- To understand the basics concepts of optics and vision systems.
- To learn and understand the fundamentals of image processing
- To impart knowledge on object recognition and feature extraction.
- To understand algorithms in image processing.
- To demonstrate the various applications of machine vision system.

MODULE I: IMAGE ACQUISITION **9 PERIODS**

The Nature of Vision- Robot vision – Need, Applications - image acquisition – Physics of Light –Interactions of light – Refraction at a spherical surface – Thin Lens Equation – Illumination techniques - linear scan sensor, planar sensor, camera transfer characteristic, Raster scan, Image capture time, volume sensors, Image representation, picture coding techniques.

MODULE II: IMAGE PROCESSING FUNDAMENTALS **9 PERIODS**

Introduction to Digital Image Processing - Image sampling and quantization – Image enhancement: Gray Value Transformations, Radiometric Calibration, Image Smoothing– Geometric transformation– Image segmentation– Object Recognition and Image Understanding - Feature extraction: Region Features, Gray Value Features, Contour Features–Morphology– Edge extraction– Fitting and Template matching.

MODULE III: OBJECT RECOGNITION AND FEATURE EXTRACTION **9 PERIODS**

Image segmentation- Edge Linking-Boundary detection-Region growing-Region splitting and merging-Boundary Descriptors-Freeman chain code-Regional Descriptors- recognition structural methods-Recognition procedure, mahalanobic procedure

MODULE IV: COLLISON FRONTS ALGORITHM **9 PERIODS**

Introduction, skeleton of objects. Gradients, propagation, Definitions, propagation algorithm, Thinning Algorithm, Skeleton lengths of Top most objects.

MODULE V: ROBOT VISION APPLICATION **9 PERIODS**

Case study-Automated Navigation guidance by vision system – vision based de palletizing- line tracking-. Automatic part Recognition. Image processing techniques implementation through Image Processing software

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- Know the various types of sensors, lightings, hardware and concept of machine vision.
- Acquire the image by the appropriate use of sensors, lightings and hardware.
- Apply the various techniques of image processing in real time applications.
- Select the suitable sensors, lightings and hardware.
- Apply the vision techniques in Robot vision system.

TEXT BOOKS:

1. Yi Ma, Jana Kosecka, Stefano Soatto, Shankar Sastry, "An Invitation to 3-D Vision From Images to Models", First Edition, 2004
2. Rafael C. Gonzales, Richard. E. Woods, "Digital Image Processing Publishers", Fourth Edition, 1992.
3. Emanuele Trucco, Alessandro Verri, "Introductory Techniques For 3D Computer Vision",First Edition,2015

REFERENCE BOOKS:

1. Fu .K.S, Gonzalez .R.S, Lee .C.S.G, "Robotics – Control Sensing, Vision and Intelligence",Tata McGraw-Hill Education, 2008.
2. RafelC.Gonzalez, Richard E.Woods,StevenL.Eddins, "Digital Image Processing using MATLAB", 2nd edition, Tata McGraw Hill, 2010.

RAOE - 11	ARTIFICIAL INTELLIGENCE FOR ROBOTICS	3L: 0T: 0P	3 Credits

COURSE OBJECTIVES:

- To introduce students about the basic concepts and techniques of Machine Learning
- To become familiar with regression methods, classification methods, clustering methods.
- To become familiar with Dimensionality reduction Techniques.
- To expose the students to the fundamentals of AI and expert systems and its application in Robotics

COURSE CONTENTS:

MODULE I: HISTORY OF AI **9 PERIODS**

Introduction – History, Definition of AI, Emulation of human cognitive process, Intelligent agents – The concept of rationality, the nature of environments, the structure of agents.

MODULE II: MACHINE LEARNING **9 PERIODS**

Machine learning – Varieties of Machine learning – Learning Input- Output functions: Types of learning – Input Vectors – Outputs – Training regimes – Noise – Performance Evaluation. Foundations of Supervised Learning: Decision trees and Inductive bias – Geometry and nearest neighbors – Logistic regression – Perceptron – Binary classification.

MODULE III: ADVANCED SUPERVISED LEARNING **9 PERIODS**

Linear models and gradient descent – Support Vector machines – Naive Bayes models and probabilistic modeling – Model selection and feature selection – Model Complexity and Regularization.

MODULE IV: UNSUPERVISED LEARNING **9 PERIODS**

Curse of dimensionality, Dimensionality Reduction, PCA, Clustering – K-means – Expectation Maximization Algorithm – Mixtures of latent variable models – Supervised learning after clustering – Hierarchical clustering – Case studies.

MODULE V: AI IN ROBOTICS **9 PERIODS**

Robotic perception, localization, mapping- configuring space, planning uncertain movements, dynamics and control of movement, Ethics and risks of artificial intelligence in robotics.

TOTAL PERIODS: 45

COURSE OUTCOMES:

On successful completion of this course, the student will be able to

- Gain knowledge about basic concepts of Machine Learning Environment.
- Identify machine learning techniques suitable for a given problem.
- Understand the basic concepts of artificial intelligence
- Apply the acquired knowledge of AI in the robotics field.

TEXT BOOKS:

1. Russell Stuart, Norvig Peter, "Artificial Intelligence Modern Approach", Pearson Education series in AI, 3rd Edition, 2010.
2. Artificial Intelligence for Robotics Build intelligent robots that perform human tasks using AI Techniques,Francis X. Govers,August 2018.
3. Peter Flach, Machine Learning: The Art and Science of Algorithms that make sense of data, Tom Mitchell, Machine Learning ', McGraw Hill, 2015.

REFERENCE BOOKS:

1. Donald.A.Waterman, "A guide to Expert Systems", Pearson, 2002
2. Dan.W.Patterson, "Introduction to Artificial Intelligence and Expert Systems", PHI Learning, 2009.
3. David MacKay, Information Theory, Inference and Learning Algorithms',Cambridge, 2003.
4. EthemAlpaydin,'Introduction to Machine Learning',The MIT Press, 2004
5. Hal Daume III,A course in Machine Learning', Todo, 2015.

RAOE - 12	HUMANOID ROBOTICS	3L: 0T: 0P	3 Credits

COURSE OBJECTIVES

- To know the basic knowledge about Humanoid robots.
- To impart knowledge in kinematics of humanoids.
- To learn about the dynamics in humanoid robots.
- To understand the basic in biped walking.
- To know about the different walking patterns.

MODULE I: INTRODUCTION **9 PERIODS**

Historical development of Humanoids, Human Likeness of a Humanoid Robot, Trade-Offs in Humanoid Robot Design, Human-Friendly Humanoid Robot Design, characteristics of humanoid robots.

MODULE II: KINEMATICS **9 PERIODS**

Kinematic structure, forward and inverse kinematic problems, differential kinematics, Twist, Spatial Velocity, and Spatial Transform, Inverse Differential Kinematic Relations. Differential kinematics at singular configurations-Gait Analysis

MODULE III: ZMP AND DYNAMICS **9 PERIODS**

ZMP Overview,2D Analysis,3D Analysis, Measurement of ZMP, General Discussion- ZMP of Each Foot, ZMP for Both Feet Contact, Dynamics of Humanoid Robots, Humanoid Robot Motion and Ground Reaction Force, Momentum, Angular Momentum, Angular Momentum and Inertia Tensor of Rigid Body, Calculation of Robot's Center of Mass, Link Speed and Angular Velocity, Calculation of Robot's Momentum and Angular Momentum

MODULE IV: BIPED WALKING **9 PERIODS**

Two Dimensional Walking Pattern Generation, Two Dimensional Inverted Pendulum, Behavior of Linear Inverted Pendulum, Orbital Energy, Support Leg Exchange, Planning a Simple Biped Gait, Extension to a Walk on Uneven Terrain.

MODULE V: WALKING PATTERN GENERATION **9 PERIODS**

ZMP Based Walking Pattern Generation, Cart-Table Model, Off-Line Walking Pattern Generation, Stabilizer, Principles of Stabilizing Control, Stabilizing Control of Honda Humanoid Robot, Advanced Stabilizers.

TOTAL PERIODS: 45

COURSE OUTCOMES

On successful completion of this course, the student will be able to

- Describe about the evolution of Humanoid robots
- Expose the basic knowledge in kinematics of humanoids.
- Calculate the Humanoid Robot Motion and Ground Reaction Force.
- Identify Two-Dimensional Walking pattern on different terrain.
- Create the Walking Pattern models

TEXT BOOKS:

1. Dragomir N. Nenchev, Atsushi Konno, “Humanoid Robots Modeling and Control”, Butterworth Heinemann, 2019
2. Shuuji K, Hirohisa H, Kensuke H, Kazuhito, Springer-Verlag GmbH ”Introduction to Humanoid Robotics”, Springer, London, 2014.
3. Goswami Ambarish, Vadakkepat Prahlad, "Humanoid Robotics: A Reference", Springer, 2019.

REFERNCE BOOKS:

1. J. Craig, "Introduction to Robotics: Mechanics and Control", Fourth Edition, Pearson, 2022
2. J K. Harada, E. Yoshida, K. Yokoi (Eds.), “Motion Planning for Humanoid Robots”,Springer, London, 2010.
3. Lorenzo Sciavicco and Bruno Siciliano, "Modelling and Control of Robot Manipulators", second edition, Springer, 2000.
4. Jean-Claude Latombe, "Robot Motion Planning", Kluwer Academy Publishers, 2004.

APPENDIX – III:
HONOUR DEGREE COURSES
(ROBOTICS AND AUTOMATION)

RAHO -1	INTELLIGENT CONTROL OF ROBOTIC SYSTEM	3L:0T:0P	3 Credits

COURSE OBJECTIVES:

- To understand the role and applications of learning in robotics.
- To implement efficient learning control techniques for manipulation robots using feedforward neural networks.
- To apply fuzzy logic principles to design and synthesize fuzzy controllers for specific robotic tasks.
- To apply Genetic Algorithms to design and optimize solutions for specific robotic tasks and challenges.
- To analyze the effectiveness of neuro-fuzzy approaches in robotics through real-world examples .

COURSE CONTENTS:

Module I: INTRODUCTION TO INTELLIGENT CONTROL IN ROBOTICS 9 PERIODS

Introduction - Hierarchical intelligent robotic systems - Role and Application of Learning in Robotics: Introduction to robot learning -Application of robot learning.

Module II: NEURAL NETWORK APPROACH IN ROBOTICS 9 PERIODS

Introduction - Connectionist Models with Application in Robotics - Learning Principles and Learning Rules Applied in Robotics - Neural Network Issues in Robotics -Efficient Learning Control for Manipulation Robots by Feedforward Neural Networks.

Module III: FUZZY LOGIC APPROACH IN ROBOTICS 9 PERIODS

Introduction - Mathematical foundations: Fuzzy sets - Operations on fuzzy sets - Fuzzy relations - Fuzzy logic - Fuzzy controller: Condition interface - Fuzzy set definition base - Control rules - Inference mechanism - Action interface - Direct applications - Synthesis of fuzzy controller - example from robotics - Fuzzy algorithms in robotics.

Module IV: GENETIC ALGORITHMS IN ROBOTICS 9 PERIODS

Introduction - Definition and characteristics of Genetic Algorithms - Role of Genetic Algorithms in optimization and problem-solving- Advantages and limitations of using Genetic Algorithms in robotics. Synthesis of GA : Representation of solutions using chromosomes and genes- Genetic Operators: Crossover, Mutation, and Selection- Fitness function and evaluation criteria in Genetic Algorithms: - example from robotics - GAs in Robotics

Module V: HYBRID INTELLIGENT APPROACHES IN ROBOTICS 9 PERIODS

Introduction - Basic Ideas of Neuro-Fuzzy Approach - Neuro-Fuzzy Algorithms in Robotics: Hybrid genetic approaches in robotics

TOTAL PERIODS:45

COURSE OUTCOMES:

On successful completion of this course, the students will be able to

- Understand and apply learning in robotics for enhanced capabilities and practical applications.
- Develop the ability to implement efficient learning control techniques for manipulation robots by utilizing feedforward neural networks effectively.
- Gain proficiency in applying fuzzy logic principles to design and synthesize fuzzy controllers tailored for specific robotic tasks.
- Acquire the skills to apply Genetic Algorithms for designing and optimizing solutions tailored to specific robotic tasks and challenges.
- Develop the ability to analyze the effectiveness of neuro-fuzzy approaches in robotics by examining real-world examples and applications.

TEXT BOOKS :

1. Katic, Dusko, and Miomir Vukobratovic. Intelligent control of robotic systems. Vol. 25. Springer Science & Business Media, 2013.
2. Behera, Laxmidhar, Swagat Kumar, Prem Kumar Patchaikani, Ranjith Ravindranathan Nair, and Samrat Dutta. Intelligent control of robotic systems. CRC Press, 2020.
3. Liu, Jinkun. Intelligent control design and Matlab simulation. Singapore: Springer, 2018.

REFERENCE BOOKS:

1. Liu, Dikai, Lingfeng Wang, and Kay Chen Tan, eds. *Design and control of intelligent robotic systems*. Vol. 177. Springer, 2009.
2. Raol, Jitendra R., and Ajith K. Gopal, eds. Mobile intelligent autonomous systems. CRC Press, 2016.

RAHO-2	AUTOMATION FOR ROBOTICS	3L:0T:0P	3 Credits

COURSE OBJECTIVES:

- To understand about linear systems, state space representation, and modelling of mechanical and robotic systems for practical engineering applications.
- To utilize simulation methods like Euler's and Runge-Kutta methods to model dynamic systems, such as a pendulum, car, and tricycle.
- To apply knowledge of transfer functions for elementary and composite systems, and analyse the relationship between state and transfer representations.
- To apply state feedback control and output feedback control techniques in engineering systems, and design controllers for specific applications
- Analyse the behaviour and stability of linearized systems and their relationship with the original nonlinear systems

COURSE CONTENTS :

MODULE I :MODELING OF LINEAR SYSTEMS IN ROBOTICS 9 PERIODS

Linear systems – State space representation of First and Second order system- Mechanical systems - Servomotors – dynamic and kinematic model of pendulum -Modelling a tank - Modelling a car- Car-trailer system -Omnidirectional robot - Direct current motor- three containers – RLC circuit .

MODULE II :VECTOR FIELDS AND SIMULATION TECHNIQUES IN ROBOTICS 9 PERIODS

Concept of vector field - Vector field of the predator–prey system -Vector field of a simple pendulum- Graphical representation: Patterns- Rotation Matrix-Homogeneous coordinates -Simulation of a pendulum by Euler's method - Simulation of Van der Pol system by both Euler's and Runge–Kutta method – Simulation of car using Euler's method - Integration by Taylor's method - Three-dimensional simulation of a tricycle.

MODULE III :LAPLACE TRANSFORM AND STATE-SPACE REPRESENTATION IN ROBOTICS 9 PERIODS

Laplace transform - Laplace variable - Input–output relation - transfer functions of elementary systems - Transfer function of composite systems - Relationship between state and transfer representations - change of basis- change of basis toward a companion matrix- Solution of a continuous-time linear state equation - solution of a discrete-time linear state equation - State equations of a wiring system - canonical observation form- Jordan normal form.

MODULE IV : CONTROL TECHNIQUES IN ROBOTICS 9 PERIODS

Controllability and observability- State feedback control - Output feedback control - Kalman decomposition - Control for a pump-operating motor - State feedback for a linear system in canonical control form - State feedback with integral effect, monovariate case

MODULE V: LINEARIZATION AND STABILIZATION OF NONLINEAR SYSTEMS 9 PERIODS

Linearization: Linearization of a function - Linearization of a dynamic system - Linearization around an operating point - Stabilization of a nonlinear system

TOTAL PERIODS:45

COURSE OUTCOMES:

On successful completion of this course, the students will be able to

- Understand linear systems, state space representation, and modeling of mechanical and robotic systems for practical engineering applications.
- Utilize simulation methods (Euler's and Runge-Kutta) to model dynamic systems like pendulums, cars, and tricycles.
- Apply knowledge of transfer functions for analyzing elementary and composite systems and understand the relationship between state and transfer representations.
- Implement state feedback and output feedback control techniques for engineering systems and design controllers for specific applications.
- Analyze the behavior and stability of linearized systems and their relationship with the original nonlinear systems.

TEXT BOOKS:

1. Jaulin, Luc. Automation for robotics. John Wiley & Sons, 2015.
2. Renfrew, Alasdair. "Introduction to robotics: Mechanics and control." International Journal of Electrical Engineering & Education 41, no. 4 (2004): 388.
3. Spong, Mark W., Seth Hutchinson, and Mathukumalli Vidyasagar. Robot modeling and control. John Wiley & Sons, 2020.

REFERENCE BOOKS:

1. Spong, Mark W., Seth Hutchinson, and Mathukumalli Vidyasagar. Robot modeling and control. John Wiley & Sons, 2020.
2. Strogatz, Steven H. Nonlinear dynamics and chaos with student solutions manual: With applications to physics, biology, chemistry, and engineering. CRC press, 2018.
3. Ogata, Katsuhiko. Modern control engineering fifth edition. 2010.
4. Kaiser, Mark J. "Control systems engineering: by Norman S. NISE; ; Benjamin/Cummings; Redwood City, CA, USA; 1995.
5. Khalil, Hassan K. Nonlinear Systems. Prentice Hall, 2002.

RAHO- 3	NON-LINEAR CONTROL OF ROBOTS	3L:0T:0P	3 Credits

COURSE OBJECTIVES:

- To understand robotic manipulators, including kinematic chains, dynamics, and applications.
- To apply feedbck linearization techniques in control theory for designing advanced control systems in robotics and engineering.
- To analyse the stability of nonlinear systems using Lyapunov's first method and apply phase plane techniques.
- To design, simulate, and assess the performance of feedback controllers for robotic manipulators to achieve desired motion tasks.
- To apply, and evaluate adaptive control techniques in robotics, fostering higher-order thinking skills for designing and implementing robust control strategies.

COURSE CONTENTS

MODULE I : FUNDAMENTALS OF KINEMATIC CHAINS AND MANIPULATORS 9 PERIODS

Introduction - Constraining kinematic chains: Manipulators -The Lagrangian formulation of dynamics - Application to manipulators: Parallel and serial manipulators - Dynamics of planar manipulators: Two-link planar manipulators - The SCARA manipulator - A two-link manipulator on a moving base -A planar manipulator: The two-arm manipulator with extendable arms - The multi-link serial manipulator -The multi-link parallel manipulator: The four-bar mechanism - A rotating planar manipulator: The PUMA 560 four-link model .

MODULE II FEEDBACK LINEARIZATION AND LIE ALGEBRA IN ROBOTIC 9 PERIODS

Introduction - Lie derivatives, Lie brackets and Lie algebra - Feedback linearization: Pure feedback systems - Input–output feedback linearization - Partial state feedback linearization - Input to state feedback linearization - Applications of feedback linearization - Feedback decoupling - Dynamic feedback linearization -Partial feedback linearization of the ACROBOT .

MODULE III NONLINEAR SYSTEMS ANALYSIS AND STABILITY IN ROBOTICS 9 PERIODS

Introduction - The phase plane - Equilibrium and stability: Lyapunov’s first method - Response of nonlinear vibrating systems: Geometric and algebraic approaches - Examples of nonlinear systems and their analysis- Features of nonlinear system responses,

MODULE IV MOTION CONTROL AND COMPUTER SIMULATION OF ROBOTIC MANIPULATORS 9 PERIODS

Introduction - Geometric path generation - Motion control of a robot manipulator - Computer simulation of robotic manipulators - The computed torque control concept -Proportional–derivative (PD) and proportional–integral–derivative (PID) auxiliary control laws - Choosing the demanded joint angles - Simulation of robot dynamics and the feedback controller .

MODULE V ADAPTIVE CONTROL TECHNIQUES IN ROBOTICS 9 PERIODS

The adaptive control concept - Basics of adaptive control - Self-tuning control - Methods of parameter identification - Model reference adaptive control - Indirect and direct adaptive control -Inverted pendulum on a cart model - Adaptive control of a two-link serial manipulator - PID tracking control and the sliding surface: The general approach - Robust adaptive control of a linear plant - Robust adaptive control of a robot manipulator - Neural network–based adaptive control - Model predictive control .

TOTAL PERIODS:45

COURSE OUTCOMES:

On successful completion of this course, the students will be able to

- Demonstrate a comprehensive understanding of robotic manipulators, including kinematic chains, dynamics, and applications.
- Apply feedback linearization techniques in control theory to design advanced control systems in robotics and engineering.
- Analyze the stability of nonlinear systems using Lyapunov's first method and apply phase plane techniques.
- Design, simulate, and evaluate the performance of feedback controllers for robotic manipulators, achieving desired motion tasks.
- Apply and evaluate adaptive control techniques in robotics, fostering higher-order thinking skills for designing and implementing robust control strategies.

TEXT BOOKS:

1. Vepa, Ranjan. Nonlinear control of robots and unmanned aerial vehicles: an integrated approach. Crc Press, 2016.
2. Lantos, Béla, and Lőrinc Márton. Nonlinear control of vehicles and robots. Springer Science & Business Media, 2010.
3. Siciliano, Bruno, Lorenzo Sciavicco, Luigi Villani, and Giuseppe Oriolo. "Robotics: modelling, planning and control." New YorN, NY, USA: Springer (2010): 415-418.

REFERENCE BOOKS:

1. Guo, Qing, and Dan Jiang. Nonlinear Control Techniques for Electro-Hydraulic Actuators in Robotics Engineering. CRC Press, 2017.
2. Behal, Aman, Warren Dixon, Darren M. Dawson, and Bin Xian. Lyapunov-based control of robotic systems. Vol. 36. CRC Press, 2009

RAHO- 4	ROBOTICS AND AUTOMATION IN THE FOOD INDUSTRY	3L:0T:0P	3 Credits

COURSE OBJECTIVES:

- To understand the robotics and automation in the food industry, highlighting importance, benefits, safety, and challenges for implementation.
- To understand robotic applications in food processing and analyse case studies of robotics in the food industry.
- To apply automated quality control techniques for food safety and compliance.
- To apply automated material handling techniques for food transportation and warehouse management.
- To utilize robotics in precision agriculture, AI in food processing, robotics for personalized nutrition, sustainability in automated food production, and R&D for novel food products.

COURSE CONTENTS:

MODULE I: INTRODUCTION TO ROBOTICS AND AUTOMATION IN THE FOOD INDUSTRY

9 PERIODS

Overview of Robotics and Automation - Importance and Benefits of Automation in the Food Industry-Types of Robots and Automation Systems used in Food Processing - Safety and Hygiene Considerations in Robotic Applications for Food - Current Challenges and Opportunities in Implementing Robotics and Automation.

MODULE II: ROBOTIC APPLICATIONS IN FOOD PROCESSING AND PACKAGING 9 PERIODS

Robotic Applications in Food Processing: Cutting, Slicing, and Peeling- Robotic Sorting and Grading of Food Products- Robotic Packaging and Labeling Systems- Automation in Filling, Capping, and Sealing of Food Containers- Case Studies: Successful Implementations of Robotics in Food Processing and Packaging

MODULE III: AUTOMATION IN QUALITY CONTROL AND INSPECTION OF FOOD PRODUCTS

9 PERIODS

Automated Quality Control Techniques for Food Safety and Compliance- Vision Systems and Image Processing in Food Inspection- Non-Destructive Testing and Sensing Technologies in Food Quality Assurance- Robotics in Food Traceability and Tracking- Regulatory Standards and Certifications for Automated Food Inspection

MODULE IV: ROBOTICS AND AUTOMATION IN FOOD HANDLING AND MATERIAL TRANSPORT

9 PERIODS

Automated Material Handling Systems in Food Production-Conveying and Palletizing Robots in the Food Industry-Robotic Pick-and-Place Applications for Food Handling- Autonomous Vehicles and Drones for Food Transportation-Integration of Robotics in Warehouse Management and Logistics

MODULE V : FUTURE PROSPECTS IN FOOD ROBOTICS AND AUTOMATION 9 PERIODS

Robotics in Precision Agriculture and Smart Farming for Food Production- AI and Machine Learning in Food Processing and Quality Control- Robotics for Personalized Nutrition and Food Customization-Sustainability and Energy Efficiency in Automated Food Production-Research and Development in Robotics for Novel Food Products

TOTAL PERIODS:45

COURSE OUTCOMES:

On successful completion of this course, the students will be able to

- Understand robotics and automation in the food industry, including their importance, benefits, safety considerations, and implementation challenges.
- Analyze case studies of robotic applications in food processing to comprehend their practical use and impact in the food industry.
- Apply automated quality control techniques for food safety and compliance, using vision systems, image processing, non-destructive testing, sensing technologies, and robotics for traceability and tracking.
- Implement automated material handling techniques for efficient food transportation and warehouse management.
- Utilize robotics in precision agriculture, apply AI in food processing and quality control and engage in research and development for novel food products with robotics and automation integration.

TEXT BOOKS:

1. Caldwell, Darwin G., ed. Robotics and automation in the food industry: current and future technologies. Elsevier, 2012.
2. Moore, Colin Anthony. Automation in the food industry. Springer Science & Business Media, 2012.
3. Groover, Mikell P. Automation, production systems, and computer-integrated manufacturing. Pearson Education India, 2016.

REFERENCE BOOKS:

1. McFarlane, Ian. Automatic control of food manufacturing processes. Springer Science & Business Media, 1995.

RAHO -5	ADAPTIVE CONTROL OF ROBOT MANIPULATOR	3L:0T:0P	3 Credits

COURSE OBJECTIVES:

- To understand adaptive control techniques to enhance robot manipulators' performance and adaptability.
- To apply Lyapunov stability and convergence analysis for Model Reference Adaptive Control in robot manipulators.
- To apply robust adaptive control for uncertain robot dynamics, including backstepping, sliding mode control, and compare with nonlinear adaptive control approaches.
- To apply adaptive control for parameter identification, disturbance rejection, and combined adaptive and robust control strategies in multi-link robot manipulators.
- To Implement various adaptive control techniques for robot manipulators.

COURSE CONTENTS

MODULE I : INTRODUCTION TO ROBOT MANIPULATORS AND CONTROL 9 PERIODS

Overview of Robot Manipulators and their Kinematics - Control of Robot Manipulators: Classical Approaches and Limitations - The Need for Adaptive Control in Robot Manipulators -Introduction to Adaptive Control Concepts and Techniques

MODULE II : ADAPTIVE CONTROL FUNDAMENTALS 9 PERIODS

Mathematical Background: Lyapunov Stability and Convergence Analysis - Model Reference Adaptive Control (MRAC) for Robot Manipulators - Adaptive Control Laws and Parameter Update Rules - Lyapunov-Based Adaptive Control Design

MODULE III : ROBUST AND NONLINEAR ADAPTIVE CONTROL 9 PERIODS

Robust Adaptive Control for Uncertain Robot Dynamics - Backstepping Control and Adaptive Backstepping for Nonlinear Robot Manipulators - Sliding Mode Control and Adaptive Sliding Mode Control - Comparison of Robust and Nonlinear Adaptive Control Approaches

MODULE IV: ADAPTIVE CONTROL FOR PARAMETER UNCERTAINTY AND DISTURBANCE REJECTION 9 PERIODS

Adaptive Control for Parameter Identification and Estimation - Disturbance Rejection using Adaptive Control - Combined Adaptive and Robust Control Strategies - Application of Adaptive Control to Multi-Link Robot Manipulators

MODULE V : ADVANCED TOPICS IN ADAPTIVE CONTROL OF ROBOT MANIPULATORS

9 PERIODS

Regressor-Free Adaptive Control Approaches - Practical Considerations for Implementing Adaptive Control on Real Robot Manipulators - Learning-Based Adaptive Control and Reinforcement Learning for Robot Manipulators - Adaptive Control for Cooperative Manipulation and Human-Robot Interaction - Emerging Trends and Future Directions in Adaptive Control of Robot Manipulators

TOTAL PERIODS:45

COURSE OUTCOMES:

On successful completion of this course, the students will be able to

- Enhance robot manipulator performance and adaptability with adaptive control techniques.
- Apply Lyapunov stability and convergence analysis for Model Reference Adaptive Control.
- Implement robust adaptive control for uncertain robot dynamics and compare with nonlinear approaches.
- Utilize adaptive control for parameter identification, disturbance rejection, and combined strategies in multi-link robot manipulators.
- Apply various adaptive control techniques effectively.

TEXT BOOKS:

1. Huang, An-Chyau, and Ming-Chih Chien. Adaptive control of robot manipulators: a unified regressor-free approach. World scientific, 2010.
2. Ioannou, Petros, and Bariş Fidan. Adaptive control tutorial. Society for Industrial and Applied Mathematics, 2006.
3. Åström, Karl Johan, and Björn Wittenmark. Adaptive Control. Dover Publications, 2008.

REFERENCE BOOKS:

1. Lavretsky, Eugene, and Kevin Wise. Robust and Adaptive Control: With Aerospace Applications. Springer, 2017.
2. Khalil, Hassan K. Nonlinear Systems. Pearson, 2002.

RAHO - 6	SLIDING-MODE CONTROL IN ROBOTICS	3L:0T:0P	3 Credits

COURSE OBJECTIVES:

- To understand the sliding mode control and its sliding surface design, focusing on analyzing and applying chattering reduction techniques.
- To apply Sliding Mode Control techniques in continuous and discrete systems.
- To apply Sliding Mode Control for SISO and MIMO systems, as well as for time-delay and uncertain systems.
- To apply higher-order Sliding Mode Control techniques and explore intelligent and robust approaches using fuzzy and neural network-based methods.
- To analyze, apply, and evaluate the use of Sliding Mode Control in Robotics and Automation, Power Electronics and Drives, Aerospace and Flight Control, and Process Control and Manufacturing,

COURSE CONTENTS:

MODULE I : INTRODUCTION TO SLIDING MODE CONTROL 9 PERIODS

Overview of Control Systems and Feedback Control - Introduction to Sliding Mode Control: Concept and Advantages - Sliding Surface Design: Linear and Nonlinear Sliding Surfaces - Chattering Phenomenon: Causes and Chattering Reduction Techniques.

MODULE II : SLIDING MODE CONTROL DESIGN 9 PERIODS

Sliding Mode Control Law: SMC-Reaching and SMC-Relay Techniques - Sliding Mode Stability Analysis: Lyapunov Approach - Sliding Mode Control for Continuous and Discrete Systems - Robustness and Performance Trade-offs in Sliding Mode Control

MODULE III : SLIDING MODE CONTROL FOR LINEAR SYSTEMS 9 PERIODS

Sliding Mode Control for Single-Input Single-Output (SISO) Systems - Sliding Mode Control for Multi-Input Multi-Output (MIMO) Systems - Sliding Mode Control for Time-Delay Systems - Sliding Mode Control for Uncertain Systems

MODULE IV : ADVANCED TOPICS IN SLIDING MODE CONTROL 9 PERIODS

Higher-Order Sliding Mode Control: Chattering Suppression and Robustness - Intelligent Sliding Mode Control: Fuzzy and Neural Network-Based Approaches - Discrete-Time Sliding Mode Control - Non-Sliding Mode Control Techniques: Comparison and Applications

MODULE V : SLIDING MODE CONTROL APPLICATIONS IN ENGINEERING 9 PERIODS

Sliding Mode Control in Robotics and Automation - Sliding Mode Control in Power Electronics and Drives- Sliding Mode Control in Aerospace and Flight Control - Sliding Mode Control in Process Control and Manufacturing

TOTAL PERIODS:45

COURSE OUTCOMES:

On successful completion of this course, the students will be able to

- Understand Sliding Mode Control and sliding surface design, including chattering reduction techniques.
- Apply Sliding Mode Control in continuous and discrete systems.
- Apply Sliding Mode Control for SISO and MIMO systems, time-delay, and uncertain systems.
- Apply higher-order Sliding Mode Control techniques and explore intelligent and robust approaches using fuzzy and neural network-based methods.
- Analyze and evaluate the applications of Sliding Mode Control in Robotics and Automation, Power Electronics and Drives, Aerospace and Flight Control, and Process Control and Manufacturing.

TEXT BOOKS:

1. Yu, Xinghuo, Liang Huo, and Yong Feng. Variable Structure Control of Complex Systems: Analysis and Design. CRC Press, 2017.
2. Edwards, Christopher, Sarah K. Spurgeon, and Chris H. Edwards. Sliding Mode Control in Engineering. 2nd ed., CRC Press, 2016.
3. Sotnikov, Oleg S., and Andrey V. Medvedev. Sliding Mode Control Using MATLAB. Springer, 2018.

REFERENCE BOOKS:

1. Utkin, Vadim I., Juri N. Shkolnikov, and Andrey G. Salukvadze. Sliding Mode Control: Theory and Applications. CRC Press, 2016.
2. Fridman, Leonid. Variable Structure Systems with Sliding Modes. John Wiley & Sons, 2014.

APPENDIX – IV :

MINOR DEGREE COURSES FOR OTHER DEPARMENTS

(DRONE TECHNOLOGY)

RAMD -1	INTRODUCTION TO DRONE TECHNOLOGY	3L: 0T: 0P	3 Credits

COURSE OBJECTIVE:

- To impart introductory knowledge of Drones, their components and introduction to drone materials.

COURSE CONTENTS:

MODULE I: INTRODUCTION TO DRONES 9 PERIODS

Definition and history of drones, Types of drones and their applications, Drone components and terminology, Regulations and Guidelines for drone usage.

MODULEII: DRONE DESIGN AND ASSEMBLY 9 PERIODS

Design considerations for drone airframe and propulsion systems, Selecting and assembling drone components such as motors, batteries, flight controllers, and cameras, Basic wiring and soldering techniques.

MODULE III: DRONE MOTORS AND ESC 9 PERIODS

Working, Types: Brush and Brushless Motors, motor sizing and identification, mounting patterns and thread size, Thrust to Weight ratio, KV ratings, advanced motor selection, Electronic Speed Controller (ESC).

MODULE IV: FLIGHT MECHANICS AND DYNAMICS 9 PERIODS

Basic principles of flight mechanics, flight controller board, Selection of drone controller with example, Factors affecting drone flight performance and efficiency.

MODULE V: APPLICATIONS OF DRONE 9 PERIODS

Overview of commercial and industrial drone applications, Case studies and examples of successful drone deployments, GPS based navigation system, Drone Camera Systems, Agro application, Drone Delivery, Future trends and developments in the drone industry.

TOTAL PERIODS 45

COURSE OUTCOMES:

On successful completion of this course, the students will be able to

- Learn about the various types of Drones and its applications.
- Learn about the various components of drone design.
- Design basic types of drone systems.

TEXT BOOKS:

1. Mark LaFay ,Drones For Dummies, For Dummies,1st edition, 21 July 2015.
2. E. Tooley, Practical Drones: Building, Programming, and Applications, Apress, 2021.
3. D. Levy, Drone Programming: A Guide to Code Your Own Drones, Packt Publishing.

REFERENCE BOOKS:

1. D. Saxby, Drone Aerial Photography and Video: Techniques and Stories from the Field, Cengage Learning, 2018.
2. D. McLeod, Getting Started with Drone: How to Build, Fly, and Program Your Own Drone, Apress, 2019.
3. M. A. Banks, Building and Flying Electric Model Aircraft, O'Reilly Media, Inc., 2014.
4. S. K. Kopparthy, Drone Technology: Theory and Practice, Springer, 2020.
5. P. Horowitz and W. Hill, The Art of Electronics, Cambridge University Press, 2015.

RAMD - 2	THEORY OF DRONES	3L: 0T: 0P	3 Credits

COURSE OBJECTIVE:

- To teach the students fundamental mechanical engineering concepts, applied to drone engineering.

COURSE CONTENTS:

MODULE I: DRONE MECHANICS **9 PERIODS**

Concepts of engineering mechanics, definition of mechanics, statics, dynamics, applications of engineering mechanics in practical fields. Free body diagrams types of loads, Principles and concept of moments and its applications, Methods for finding resultant of a force system, equilibrium of coplanar force systems.

MODULE II: CENTER OF GRAVITY **9 PERIODS**

Concepts, definition of centroid of plane figures and centre of gravity of symmetrical solid bodies, determination of centroid of plane and composite lamina using first principle, centroid of areas with removed portions .CG of solid bodies like cone, cylinder, hemisphere and sphere, bodies with removed portions.

MODULE III: FORCE ANALYSIS IN DRONES **9 PERIODS**

Force analysis in drones, forces and force systems during drone operations, aerodynamics of drones-dynamics of aerial systems, forces of flight, principle axes and rotation of aerial systems.

MODULE IV: STABILITY AND CONTROL OF DRONES **9 PERIODS**

stability and control of drones, force balancing of rotating masses.

MODULE V:DYNAMICS OF MACHINES **9 PERIODS**

static and dynamic force analysis, gyroscopic action in machines, gyroscopic motions and their variations, concept of gyroscopic couple.

TOTAL PERIODS 45

COURSE OUTCOMES:

On successful completion of this course, the students will be able to

- Identify and select different drones' mechanical parts, aerodynamics of wings, propellers.
- Gain practical exposure of relevant drone sciences.

TEXT BOOKS:

1. S.Ramamurtham,A textbook of applied mechanics, Bharath-A28KED5E1JUIJA 1 January 1974.
2. R. S. Khurmi , N. Khurmi, A textbook of engineering mechanics , S Chand Publishing,22nd Edition,2018
3. R.K.Rajput, A textbook of applied mechanics ,Laxmi Publications, 22 nd Edition, 1 January 2016.

REFFERENCE BOOKS:

1. V.P.Singh ,Theory of machine,Dhanpat Rai & Co. (P) Limited, 5th Edition, 1 January 2017.
2. Dr.Jagdish Lal ,Theory of machines by,Prentice Hall India Learning Private Limited, 1st Edition, 1 January 2006.

RAMD - 3	ENGINEERING MATERIALS FOR UNMANNED AERIAL VEHICLES	3L: 0T: 0P	3 Credits

COURSE OBJECTIVES:

- Comprehend the basic aviation history and UAV systems.
- Acquire the knowledge of basic aerodynamics, performance, stability and control.
- Understand the propulsion, loads and structures.

MODULE I: INTRODUCTION **9 PERIODS**

Aviation History and Overview of UAV systems, Classes and Missions of UAVs, Definitions and Terminology, UAV fundamentals, Examples of UAV systems-very small, small, Medium and Large UAV

MODULE 2:THE AIR VEHICLE BASIC AERODYNAMICS **9 PERIODS**

Basic Aerodynamics equations, Aircraft polar, the real wing and Airplane, Induced drag, the boundary layer, Flapping wings, Total Air-Vehicle Drag. Performance: Overview, climbing flight, Range and Endurance-for propeller-driven aircraft, range- a jet-driven aircraft, Guiding Flight.

MODULE 3: STABILITY AND CONTROL **9 PERIODS**

Overview, Stability, longitudinal, lateral, dynamic stability, Aerodynamics control, pitch control, lateral control, Autopilots, sensor, controller, actuator, airframe control, inner and outer loops, Flight-Control Classification, Overall Modes of Operation, Sensors Supporting the Autopilot.

MODULE 4: PROPULSION OVERVIEW **9 PERIODS**

Thrust Generation, Powered Lift, Sources of Power, The Two-Cycle Engine, The Rotary Engine, The Gas Turbine, Electric Motors, and Sources of Electrical Power. Loads and Structures Loads, Dynamic Loads, Materials, Sandwich Construction, Skin or Reinforcing Materials, Resin Materials, Core Materials, Construction Techniques.

MODULE 5: MISSION PLANNING AND CONTROL **9 PERIODS**

Air Vehicle and Payload Control, Reconnaissance/Surveillance Payloads, Weapon Payloads, Other Payloads, Data-Link Functions and Attributes, Data-Link Margin, Data-Rate Reduction, Launch Systems, Recovery Systems, Launch and Recovery Tradeoffs.

TOTAL PERIODS 45

COURSE OUTCOMES:

On successful completion of this course, the students will be able to

- Apply the basic concepts of UAV systems.
- Explain the basic aerodynamics, performance, stability and control required for UAV.
- Select the propulsion system and materials for structures.

TEXT BOOKS:

1. Paul GerinFahlstrom, Thomas James Gleason, Introduction to UAV Systems, Wiley Publication 4th Edition,2012.
2. Landen Rosen U,nmanned Aerial Vehicle, Alpha Editions,1st Edition,23 June 2015.

REFERENCE BOOKS:

1. DOD's Acquisition Efforts,Unmanned Aerial Vehicles,T-NSIAD-97-138,1997.
2. Valavanis, Kimon P,Unmanned Aerial Vehicles,Springer,2011 Edition,2011.

RAMD - 4	INTRODUCTION TO UAV ELECTRONICS	3L: 0T: 0P	3 Credits

COURSE OBJECTIVES:

- To impart fundamental knowledge and skills regarding basic electrical and electronics engineering, which students will come across in their professional life while designing circuits for their own Drones.
- To understand the basic concept and principles of batteries, Motors, electronics and electrical components and devices etc.
- To understand the advantages and limitations of various communication devices, sensors , microcontrollers and controllers used in UAVs.

COURSE CONTENTS:

MODULE I: BATTERY AND ITS MANAGEMENT 9 PERIODS

Introduction of Battery, Description of Li-Po Battery, Charging / Discharging of Battery. Back up, Ratings, Shelf Life, Maintenance and safety of Battery. Selection criteria of Battery for Drone application.

MODULE II: MOTORS 9 PERIODS

Difference between AC and DC motors and steeper motor, Brushed and Brushless motors, brief idea of motor capabilities for a drone build. Selection criterion of motor for drone application. Working and application of BLDC motor.

MODULE III: SENSORS 9 PERIODS

Wi fi devices, RADAR and range finder, GPS receiver, Gyro sensor, Speed and Distance sensor, Image sensor, TOF sensor, Chemical sensor. Cameras in drones and selection criteria of camera for different range. Barometers, Accelerometer, Magnetometer, remote control for drone.

MODULE IV:RADIO CONTROL SYSTEM 9 PERIODS

Introduction of radio control system, Controllers, Transmitter and Receiver, Flight Controllers, Electronic Speed Controller, SIMONK & BLHelifirmware software, ,Battery Eliminator Circuit, Universal Battery Eliminator Circuit , OPTO Coupler.

MODULE V: CONNECTIONS AND INTERFACES OF DEVICES IN DRONE 9 PERIODS

Brief introduction of RS232, RS422, RS485, UART ports. Different types of connectors and their specifications. Microcontroller interfacing techniques.

TOTAL PERIODS 45

COURSE OUTCOMES:

On successful completion of this course, the students will be able to

- Identify the battery to be used for UAV application.
- Understand working of motor that can be used in UAV.
- Explain the basic concept of communication system.
- Find out best communication device for given project.
- Understand different types of sensors used in drone technology.
- Classify different microcontrollers and flight controllers.
- Identify different types of ports and connectors.

TEXT BOOKS:

1. Robert L. Boylestad / Louis Nashelsky "Electronic Devices and Circuit Theory", Latest Edition, Pearson Education.
2. D. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill.
3. J.B. Gupta, Basic Electrical Engineering, Kataria& Sons.

REFFERENCE BOOKS:

1. H S Kalsi, "Electronic Instrumentation", Latest Edition, TMH Publication.
2. Behaviour of Lithium-Ion Batteries in Electric Vehicles: Battery Health, Performance, Safety, and Cost (Green Energy and Technology) by Gianfranco Pistoia, Boryann Liaw , Springer.
3. An Introduction to Analog and Digital Communication by Simon Haykin, Wiley Student Edition.
4. Electronics Communication System by Kennedy, Tata McGraw Hill Education Pvt Ltd, New Delhi.
5. Wireless Communications | Second Edition | By Pearson: Principles and Practice.
6. Programmable Microcontrollers With Applications (Cem Unsalan, H. Deniz Gurhan) 10. Drone Technology in Architecture, Engineering and Construction (, Tal Daniel).

RAMD - 5	DRONE METROLOGY, ASSEMBLY AND MAINTENANCE	3L: 0T: 0P	3 Credits

COURSE OBJECTIVES:

- To train the students pertaining various measurements and their processes, assembly practices and execute different maintenances.

COURSE CONTENTS:

MODULE I: INTRODUCTION AND SCOPE OF METROLOGY IN DRONE TECHNOLOGY 9 PERIODS

Basic concepts of metrology, classifications of measurements, need of measurements in drone technology, types of measuring instruments, their accuracy and precision parameters.

MODULE II: DEVELOPMENT AND NEED OF DRONE SENSORS 9 PERIODS

Micro electro mechanical systems (MEMS) based sensors like accelerometer, barometer, gyro sensors and magneto meter, stabilization of drones using above sensors.

MODULE III: SPECIAL PURPOSE DRONE SENSORS 9 PERIODS

Need and application of distance sensors, brief introduction to light-pulse distance sensing (laser), radio detection and ranging, sonarpulse distance sensing (ultrasonic), time of flight (TOF) sensors, thermal and chemical sensors.

MODULE IV: ASSEMBLY OF DRONES 9 PERIODS

Concept of interchangeability, principles of gauging and their applicability in drone assembly, parameters and profile measurements of standard propellers, limits, fits and tolerances. Concepts of drones' assembly using three dimensional modeling.

MODULE V: DRONE MAINTENANCE 9 PERIODS

Need and scope of drone maintenance, types of maintenance, routine drone maintenance and its checklist-introduction, recording basic details, structural inspections, battery check, software/firmware (description not required).Finishing up forward maintenance report, maintenance challenges in small UAVs.

TOTAL PERIODS 45

COURSE OUTCOMES:

- On successful completion of this course, the students will be able to
- Learn and exercise various measuring devices and metrological aspects in drone engineering
- Perform assembly practice of micro and nano drones.
- Learn chronological and technological development of drone sensors
- Understand basic rules and instruments in mechanical measurements
- Perform drone maintenance and understand its challenges
- Prepare maintenance report of UAV

REFFERENCE BOOKS:

1. Garvit Pandya, Basics of Unmanned Aerial Vehicles: Time to start working on Drone Technology, Notion Press, 2021
2. PK Garg, Introduction To Unmanned Aerial Vehicles, New Age International Publishers New Age International Private Limited; First edition, NEW AGE International Pvt Lt, 2020

RAMD - 6	COMPUTER AIDED 3D MODELING FOR DRONE	3L: 0T: 0P	3 Credits

COURSE OBJECTIVES:

- To develop designing/modeling skills in the students by which they can design/model different shapes and make 3D models of the objects used in drones.

COURSE CONTENTS:

MODULE I: INTRODUCTION AND HISTORICAL DEVELOPMENT OF 3D MODELING 9 PERIODS

Definition of three-dimensional modeling, enhancement of animation with the aid of three dimensional modeling, applications of three dimensional modeling, key terms used in three dimensional modeling, advantages and challenges in three dimensional modeling.

MODULE II: TOOLS OF THE TRADE 9 PERIODS

History of operating systems, distinct functions of hardware and software, types of memory.

MODULE III: DIGITAL CITIZENSHIP AND ETHICS 9 PERIODS

Importance of responsible digital citizenship, copyright dynamics and its application in 3D modeling, role of emerging technology in 3d modeling.

MODULE IV: CREATING 3D ENVIRONMENT 9 PERIODS

Understanding the appropriate uses of 3D components of UAV and related digital tools, use of proper digital tools, contrasts among various 3D modeling techniques

MODULE V: VISUAL ELEMENTS 9 PERIODS

Process of visualization applicable to 3D modeling, intensity and applying color theories, visual simulation and uses.

TOTAL PERIODS 45

COURSE OUTCOMES:

On successful completion of this course, the students will be able to

- Understand the concepts of 3D modeling.
- Learning about digital citizenship and their ethics.
- Understand texturing of prepared three-dimensional models.
- Learn about assembly modeling tools.

TEXT BOOKS:

1. T. Jeyapooran, Engineering Drawing with AutoCAD2000, Vikas Publishing House, Delhi.
2. P. NageswaraRao,AutoCAD for Engineering Drawing Made Easy, Tata McGraw Hill, New Delhi.
3. UmeshShettigar and Abdul Khader, AutoVCAD 2000 for you Janatha Publishers, Udupi.

REFFERENCE BOOKS:

1. Auto CAD 2000 by Ajit Singh, TMH, New Delhi.
2. Sham Tickoo ,Designing with Pro Engineer, Dreamtech Press, 1 January 2015

APPENDIX -VII

A Guide to Induction Program

Appendix – I: A Guide to Induction Program

Introduction

In its 49th meeting, held on 14th March 2017, AICTE approved a package of measures for further improving the quality of technical education in the country. This 3-week mandatory Student Induction Program (SIP) based on Universal Human Values (UHV) isone of these key measures.

The SIP is intended to prepare newly admitted undergraduate students for the new stagein their life by facilitating a smooth transition from their home and school environment into the college and university environment.

The present form of the Student Induction Program (SIP) has taken inspiration from and gratefully acknowledges the many efforts in this direction. In particular the Foundation Program at IIT Gandhinagar1 (July 2011) and the course in Universal Human Values and Professional Ethics2 (IIIT Hyderabad, 2005; AKTU Lucknow, 2009 and PTU Jalandhar, 2011; overall about 35 universities); and also, the mentorship, internship and apprenticeship programs3 of several institutions. The SIP amalgamates all the three into an integrated whole, which leads to its high effectiveness in terms of building a healthy lifestyle, creativity, bonding and character. It develops sensitivity towards self and one's relationships, builds awareness about others and society beyond the individual, and also in bonding with their own batch-mates and senior students as well as faculty members.

The purpose of this document along with accompanying details are to help institutions / colleges in understanding the spirit of the Induction Program and implementing it.

It is in line with the thoughts expressed in the NEP 2020:

"*Education is fundamental for achieving* ***full human potential****, developing an* ***equitable and just society****, and promoting* ***National development****".*

IIT Gandhinagar places great emphasis on not only educating successful engineers of the future, but also creating well-rounded personalities, who contribute to society, are respectful of and can adapt to their surroundings, and prove themselves to be great thinkers and problem solvers in all avenues of life. In 2011, in line with this vision, It took the bold step to introduce a five week Foundation Program for incoming 1st year UG students. It involved activities such as games, art, etc.; also science and other creative workshops as well as lectures by eminent resource persons. To enable undivided attention on this, normal classes were scheduled only after this program was over.

2 The foundation course was started in 2005 at IIIT Hyderabad. In 2009, UP Technical University (now AKTU) introduced it in all academic programs across their 550 colleges. From there on, it has been included in the curriculum of many universities, particularly in technical universities, in quite a natural manner, filling a long-felt need. After AKTU, it was IKG-Punjab Technical University in 2011, then Royal University of Bhutan in 2012 and so on. By 2020, more than 40 universities in India and both universities of Bhutan have been offering this foundation course. Since 2017, it has been a

compulsory credit course in AICTE's model curriculum for all UG courses. Faculty from all departments are involved in conducting the course. The content is universal, rational, verifiable and leading to harmony. The mode is a self-exploration (and not sermonising or lecturing). Faculty are to be prepared beforehand. The results have been quite encouraging.

3 Many institutes setup mentor-mentee network under which 1st year students are divided into small groups, each assigned to a senior student as a Student Buddy, and to a faculty member as a Faculty Mentor. Thus, a new student has their guidance through regular interactions. They can discuss their aims and aspirations as well as concerns whether social, psychological, financial, academic, or otherwise.

"The purpose of the education system is to develop good human beings capable of rational thought and action, possessing compassion and empathy, courage and resilience, scientific temper and creative imagination, with sound ethical moorings and values".

"It aims at producing engaged, productive, and contributing citizens for building an equitable, inclusive, and plural society as envisaged by our Constitution".

"Education must build character, enable learners to be ethical, rational, compassionate, and caring, while at the same time prepare them for gainful, fulfilling employment".

"The curriculum must include basic arts, crafts, humanities, games, sports and fitness, languages, literature, culture, and values, in addition to science and mathematics, to develop all aspects and capabilities of learners; and make education more well-rounded, useful, and fulfilling to the learner".

So, when new students join an institution, they are to be welcomed and oriented to the institute, its vision, people, purpose, culture and values, policies, programs, rules and regulations etc. through a well-planned 3-week interaction before regular classes start.

Education aims at developing the students to their full potential, so that they are able to participate meaningfully not only in their profession, but also in their family, society and their natural environment. That requires the development of their values as well as skills.

Engineering colleges were established to train graduates in their respective branch/ department of study, be ready for the job market, but also have a holistic outlook towards life and have a desire and competence to work for national needs and beyond. The graduating student must have the knowledge and skills in the area of his study. However, s(he) must also have a broad understanding of society and relationships. Besides the above, several meta-skills and underlying values are needed. Character

needs to be nurtured as an essential quality by which s(he) would understand and fulfil his/her responsibility as an engineer, a family member, a citizen etc.

The same applies to all other branches of study – be it professional, vocational or any other area of academic. The graduating student must be a good human being and have the skills in their area of study.

Each family, institution, region, community etc. have evolved their way of life, their cultures over a period of time. The new students are going from one culture to another. Today, a major issue is that one culture tends to be opposed to other cultures. This is because their basic assumptions, and therefore thoughts, are different. Even though there are commonalities at the core value level, the conflict is at the level of expression and details.

With this situation, it is imperative to

- Articulate the essence or core aspects of human culture and civilization, i.e. understand universal human values like trust and respect, love and compassion
- Appreciate the various expressions, different approaches taken in different regions

Our effort is in the context of the whole humanity. However, when it comes to exemplifying these essential concepts, we will have to take to local or national expressions.
In SIP, we want to provide an exposure to essence in the context of the whole humanity first. Then we can take a representative cross-section of all cultures as expressions of this essence. A yardstick to evaluate these various options is provided to guide the student towards a humanistic culture founded on the truth and universal human values like love and compassion.
For example: We want to live with fulfilment as a society. This part is common, universal. *To exemplify this, we may expose students to traditional Indian culture and philosophy as well as contemporary western culture and thought.*
The intent is:

- Connecting the basic principles through specific examples
- To see and appreciate various cultures, to see the commonality amongst them, in the light of clarity about human culture and civilisation.
- To evaluate any specific example, system or culture, with a view to fill the gaps, rather than to criticise or reject it. Further, we can also be mutually enriching for other cultures.

Student Induction Program (SIP)

With this background, the SIP has been formulated with specific goals to help students to:

- Become familiar with the ethos and culture of the institution (based on institutional

culture and practices)

- Set a healthy daily routine, create bonding in batch as well as between facultymembers and students
- Get an exposure to a holistic vision of life, develop awareness, sensitivity and understanding of the

  Self---family---Society---Nation---International---Entire Nature
- Facilitate them in creating new bonds with peers and seniors who accompanythem through their college life and beyond
- Overcome weaknesses in some essential professional skills – only for those whoneed it (e.g. Mathematics, Language proficiency modules)

The SIP consists of different activities which includes meeting new students, socializing with teachers and other people in the university. Secondly associating with the Local area or city, knowing different departments, associating with the department heads, local stores and necessary shops for the survival at new place. Basically, getting information about the rules and regulations of the university which includes do's and don'ts. Other activities which may involve students in several creative, cultural and co- curricular activities through which they can explore themselves and get idea about their intrinsic desires and interests which may help them in the long run. In order to make it worth, atthe initial level of joining of student various seminars, lectures by eminent personalities, sessions by the appointed mentor for the student is being done to make them more familiar with the university environment. It has been seen that student after schooling

when moves towards further studies for either under graduation or post-graduation has got so many confusions and false knowledge about the college and the curriculum. They should know the basic idea about the fruits and prospects of the particular course and the university or institute in which they are entering. To have faith about their choices and to know that after completion, they will be well equipped with the values and skills which may aid to their future goals and let them work for their personal motives, societyand the Nation's development.

The various modules or core areas recommended for the 3-week SIP are:

SIP Module 1: Universal Human Values I (UHV I) 22 hours

The purpose is to help develop a holistic perspective about life. A self-reflective methodology of teaching is adopted. It opens the space for the student to explorehis/her role (value) in all aspects of living – as an individual, as a member of afamily, as a part of the society and as a unit in nature. Through this process of self-exploration, students are able to discover the values intrinsic in them. The session-wise topics are given below:

Session No.	**Topic Title**	**Aspirations and Issues**	**Basic Realities (underlying harmony)**
1	Welcome and Introductions	Getting to know each other	Self-exploration
2 and 3	Aspirations and Concerns	Individual academic, career… Expectations of family, peers, society, nation… Fixing one's goals	Basic human aspirations Need for a holistic perspective Role of UHV
4 and 5	Self-Management	Self-confidence, peer pressure, time management, anger, stress… Personality development,self-improvement…	Harmony in the human being
6 and 7	Health	Health issues, healthy diet, healthy lifestyle Hostel life	Harmony of the Self andBody Mental and physical health
8, 9, 10 and 11	Relationships	Home sickness, gratitude towards parents, teachers and others Ragging and interaction Competition and cooperation Peer pressure	Harmony in relationship Feelings of trust, respect… gratitude, glory, love
12	Society	Participation in society	Harmony in the society
13	Natural Environment	Participation in nature	Harmony in nature/existence
14	Sum Up	Review role of education Need for a holistic perspective	Information about UHV-II course, mentor and buddy
15	Self-evaluation and Closure	Sharing and feedback	

SIP Module 2: Physical Health and Related Activities **51 hours**

This module is intended to help understand the basic principles to remain healthyand fit and practice them through a healthy routine which includes exercise,games etc.

SIP Module 3: Familiarization of Department/ Branch and Innovation 06 hours This module is for introducing and relating the student to the institution/department/branch; how it plays a role in the development of thesociety, the state, region, nation and the world at large and how students canparticipate in it.

SIP Module 4: Visit to a Local Area **10 hours** To relate to the social environment of the educational institution as well as thearea in which it is situated through interaction with the people, place, history,politics…

SIP Module 5: Lectures by Eminent People **06 hours**

Listening to the life and times of eminent people from various fields likeacademics, industry etc. about careers, art, self-management and so on enrichesthe student's perspective and provides a holistic learning experience.

SIP Module 6: Proficiency Modules **06 hours**

This module is to help fill the gaps in basic competency required for further inputsto be absorbed. It includes effort to make student proficient in interpersonalcommunication and expression as well as awareness about linguistic andthereafter NLP.

SIP Module 7: Literature / Literary Activities **30 hours**

Through the exposure of local, national and international literature, this moduleis aimed at helping the student learn about traditional as well as contemporaryvalues and thought.

SIP Module 8: Creative Practices **49 hours**

This module is to help develop the clarity of humanistic culture and its creative,joyful expression through practice of art forms like dance, drama, music, painting,pottery, sculpture etc.

SIP Module 9: Extra Curricular Activities **06 hours**

This is a category under which things that are not placed in any of the above maybe placed. Some clubs and hobby group may be made for each of the abovecategories, so that students may pursue them even after SIP.

The recommended hours to be allocated are given above. Depending on the available faculty, staff, infrastructure, playgrounds, class timings, hostellers and day scholars etc., the timetable for these activities may be drawn up. Of course, colleges may conduct an inaugural function at the beginning of the SIP; and they may also conduct a celebratoryclosing ceremony at the end of the SIP.

In particular, during the lockdown phase, appropriate care may be taken and some orall activities may be planned in distance-learning or on-line mode.

Sample 3-week Activity List

Week 1	Inaugural Function Regular SIP Activities (See Hours Plan)
Week 2	Regular SIP Activities (See Hours Plan)
Week 3	Regular SIP Activities (See Hours Plan) Valedictory and Closing Ceremony (Celebration)

Implementation

Every institution/college is expected to conduct the 3-week SIP under the guidance of the Director/Principal or Dean Students or a senior faculty member. For this, the institution is expected to make an SIP Cell / team, which will be responsible for planning, and then implementation of the SIP.

A UHV Cell is expected to be set up at each college and university. At the college, it will bemanaged by the UHV Convener / Coordinator under the chairpersonship of the director/principal. Faculty members and some students will be the members. They will coordinate the UHV activities like UHV-I during SIP, UHV-II, the faculty mentoring program and student buddy program throughout the student's association with the institute/college. The UHV Cell will work to incorporate human values in every aspect of education at the institute/college. Preparing UHV Faculty (Mentors) is one of its important activities.

Follow up

The SIP is only the beginning of the interaction with newly joined students.

An important part of the SIP is to associate one faculty mentor to every small groups of about 20 students; and also associate one senior student buddy to an even smaller groupsof about 5 students for the guidance required for holistic development of the newly joined student throughout his/her time in the institution/college.

These activities are to be continued in the ongoing academic program along with other cultural activities through various student clubs which are largely be managed by students with the help of one or more faculty mentors. One of the main responsibilities of the faculty mentors would be helping the clubs to review their activities in alignment with human values.

Assessing the Implementation and Impact

The institution / college is expected to take feedback and prepare appropriate reports for assessing the impact and for further improvement of SIP. The basic feedback forms are included with the SIP Teaching Materials.

The SIP and its further follow up is expected to positively impact common graduateattributes like:

- Holistic vision of life
- Socially responsible behaviour
- Environmentally responsible work
- Ethical human conduct

Having Competence and Capabilities for Maintaining Health and Hygiene

Appreciation and aspiration for excellence (merit) and gratitude for all

AICTE will conduct periodic assessment to ascertain the implementation efforts andimpact of the SIP and related activities.

Faculty Development

To ensure the implementation of SIP, and in particular to prepare the faculty, the National Coordination Committee for Student Induction (NCC-IP) has been formed. It offers various faculty development programs (FDPs) with the support from AICTE HQ and Regional Offices.

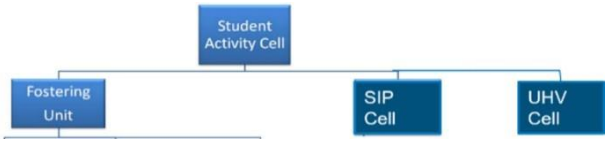
UHV Faculty (Mentors): Every institution is expected to prepare UHV Faculty in the ratio of 1:20 (1 faculty per 20 newly admitted students). Faculty from every teaching department are to be prepared. The basic preparation is participation inan 8-day FDP-SI (UHV).

Faculty for other Modules: Institutions/colleges generally have faculty, coaches, student clubs, alumni for these areas. FDP and comprehensive material will also be made available.

Student Activity Cell (SAC) – SIP Cell, UHV Cell and Fostering Unit

Student Activity Cell will have three cells or units:

- Fostering Unit – for coordinating various student clubs and activities inalignment with human values and IKS through various student clubs
- SIP Cell – for coordinating the annual SIP
- UHV Cell – for coordinating regular UHV activities, including UHV-I duringSIP and UHV-II during future semesters, faculty mentoring and student buddy programs etc.



Each cell / unit will have some axis. E.g. the Fostering Unit will have 3 axis:

- UHV Axis – for UHV inputs and activities after the SIP
- Health Axis – for health oriented inputs and activities after SIP

- Career Axis – for career related inputs

ach axis will have one or more dimensions. E.g. the UHV Axis will have two dimensions:

- UHV Dimension
- Social Work Dimension

- Details of the clubs will be based on local conditions.

- Director or Principal or Dean of Student affairs will be the Chairman of Student Activity Cell

- SIP Cell (or Induction Unit) will be managed by faculty members with the help of student volunteers. 5 to 7 faculty members will be the members. The SIP Cell will be responsible for planning, organization, coordination and reporting of the annual Student Induction Program with the help of other faculty members and student volunteers

- UHV Cell will be managed by the UHV Convener / Coordinator under the chairpersonship of the director/principal. Faculty members and some students will be the members. They will coordinate the UHV activities like UHV-I during SIP, UHV-II 3rd/4th semester, faculty mentoring program and student buddy program throughout the student's association with the institute/college. UHV Cell will work to incorporate human values in every aspect of education at the institute/college. Preparing UHV Faculty (Mentors) is one of its activities

- Fostering unit will largely be managed by students with the help of one fostering unit faculty mentor. Student will be coordinators for axis, dimensions and clubs. Fostering unit will take support from induction unit as and when required. It will be responsible for coordinating various student clubs and activities in alignment with human values andIndian Knowledge System

SIP Teaching Material and More Details

The SIP Handbook as well as detailed guides and material for each of the modules isavailable on the AICTE website (http://www.fdp-si.aicte-india.org/download.php).

Details and Reference Documents:

- G012 SIP Handbook v2
- Teaching Material for UHV-I v2.1
- Teaching Material for SIP modules 2 to 9 v1
- G008 Facilitator (Mentor) Manual Version 2.1
- G911 UHV Cell, Nodal and Resource Centres
- G009 RP Development Process v2