File Ref.No.Ac.A3/Faculty of Technology/2023

COCHIN UNIVERSITY OF SCIENCE AND TECHNOLOGY

(Abstract)

Faculty of Technology - Programmes offered at Department of Instrumentation - Resolution of the Academic Council - Communicated - Orders issued.

ACADEMIC A SECTION

No.CUSAT/AC(A).A3/4086/2024 Dated,KOCHI-22,26.09.2024

Read:-Item No. I (f) (2) of the minutes of the meeting of the Academic Council held on 30.04.2024

ORDER

The Academic Council considered along with the recommendations of it's standing committee, the Minutes of the Faculty of Technology held on 08.04.2024 and resolved to approve the following :

i. Regulations and Scheme for B.Tech Instrumentation and Control Engineering with effect from 2024 admission onwards (Appendix I).
ii. Revised syllabus for first year B.Tech Instrumentation and Control Engineering (1-2 semesters) with effect from 2024 admission onwards (Appendix II).
iii. Revised syllabus for 1-4 semesters for M.Tech Instrumentation Technology with effect from 2024 admission onwards (Appendix III).
iv. The change in nomenclature for M.Tech Instrumentation Technology to M.Tech in Electronic Instrumentation and Control Engineering from 2025 admission onwards.

Orders are issued accordingly.

Dr. Arun A U *
Registrar

To:

1. The Dean, Faculty of Technology
2. Chairperson, BoS under Faculty of Technology
3. The Head, Deparftment of Instrumentation
4. All AR/DR Examination wing - with a request to forward to concerned sections
5. The Director, IQAC/ DoA
6. CIRM/Conference Sections
7. PS To VC/PVC;PA To Registrar/CE.

* This is a computer generated document. Hence no signature is required.

Appendix - V (B)

REGULATIONS AND CURRICULUM

B. Tech. Degree Programme in Instrumentation and Control Engineering
Offered by the Department of Instrumentation Under
Faculty of Technology

(With effect from 2024 Admission)

COCHIN UNIVERSITY OF SCIENCE AND TECHNOLOGY
COCHIN – 682 022

Regulations for the B. Tech. degree programme in Instrumentation and Control Engineering offered by the Department of Instrumentation under Faculty of Technology

The following regulations are made applicable to the B Tech. programme in Instrumentation and Control Engineering offered by The Department of Instrumentation, Cochin University of Science and Technology, under Faculty of Technology with effect from the academic year 2024 -25.

1. Admission requirements

Candidates seeking admission to the B. Tech Degree program in Instrumentation and Control Engineering shall be required to possess the following qualifications.

1.1 The candidate shall have passed the plus two (12^{th}) examination of any state/national board with Mathematics, Physics and Chemistry as optional subjects or any other examination accepted as equivalent by the Cochin University of Science and Technology.

1.2 The candidate shall have secured a minimum of 50% marks in Mathematics and 50% marks in Mathematics, Physics and Chemistry put together.

1.3 Relaxations in marks shall be followed for candidates belonging to SC/ST and socially and educationally backward classes as prescribed by the University.

1.4 The candidates shall also satisfy the conditions regarding physical fitness as may be prescribed by the University.

1.5 Admission to the course shall be through the Common Admission Test (CAT) conducted by the University every year and admission will be based on the rank in the admission test. If a candidate, after getting admission based on his/her CAT rank, fails to meet the admission requirements as specified in clauses 1.1, 1.2 and 1.3 above before the commencement of the first-semester examination, he/she shall be terminated from continuing the course.

1.6 10% additional seats may be created in a batch in the third semester for lateral entry. Candidates seeking admission through lateral entry shall have 3-year diploma in Instrumentation or Electronics awarded by a board recognized by the Department of Technical Education, Govt. of Kerala, with not less than 60% marks. The maximum age limit will be 25 years as on 1st July of the academic year.

2. Duration of the course

The duration of the B Tech. programme shall be eight semesters spanning over four academic years as prescribed in the curriculum. Each semester shall consist of a minimum of 16 weeks.

3. Course Registration

It is mandatory for the students to register for the courses in each semester.

3.1 Before registration, the students should Clear all dues including any fees to be paid and should not have any disciplinary issues pending.

3.2 The Department will announce the dates for registration in its academic calendar. Late registration will be allowed up to 7 working days from the commencement of the semester with late registration fee.

4. Mode of Evaluation

4.1 The performance of the students in theory courses will be evaluated based on continuous assessment and semester-end examination. In the case of laboratory courses, the evaluation will be based on continuous assessment and semester-end assessment, which will be carried out internally.

4.2 For theory courses, there will be 50% weightage for internal assessment and 50% weightage for semester-end examination. For practical courses, continuous assessment and semester-end assessment will carry 50% weightage each.

4.3 For theory courses, the assessment pattern will be as follows:

Continuous assessment:

a) First periodical test - Maximum marks: 15
b) Second periodical test - Maximum marks: 15
c) Assignments - Maximum marks: 15
d) Attendance - Maximum marks: 5

Semester End Examination:

a) Examinations shall be of 3 hours duration.
b) Maximum marks: 50

4.4 For laboratory courses, the assessment pattern will be as follows:
Continuous Assessment:

The marks may be awarded on the basis of the performance of the student in the laboratory sessions. The break-up of marks for continuous assessment of laboratory courses shall be:

a) Practical records/Outputs - Maximum weightage: 20%
b) Lab work - Maximum weightage: 30%

Semester end assessment:

The semester end assessment will consist of an examination and a viva voce. Maximum weightage for semester end examination: 50%

4.5 At the end of the semester, semester examination will be conducted in all the theory courses offered in that semester and they will be of three hours duration unless otherwise specified. The Controller of Examinations will make necessary arrangements for setting the question papers and valuation of answer books for the semester end examination of theory courses.

4.6 The department shall conduct the semester end assessment for the laboratory courses internally.

4.7 In the case of project work, the project guide concerned shall make the continuous assessment. A committee consisting of the Project Coordinator (nominated by the Head of the Department), project guide, and at least one senior faculty member will carry out the assessment of the project report and final review.

The weightage for the assessment of project work shall be as follows:

Continuous assessment	: 40 percent
Project report	: 20 percent
Final review	: 40 percent

4.8 The Viva-voce examination at the end of VIII semester will be conducted by a panel of minimum three examiners consisting of the Head of the Department or his/her nominee and two or more faculty members with one senior faculty of the Department.

4.9 A candidate shall not be allowed to improve the continuous assessment marks in theory courses. A candidate who desires to improve his/her marks in the semester end examination in theory courses shall be permitted to do so in the next available chance. This facility will be available only once for a theory course.

4.10 For industry elective courses, the evaluation will be done jointly by the resource persons from the industry who handles the course and the faculty in charge of the course.

5. Course Completion and Earning of Credits.

Students registered for a course have to attend the course regularly and meet the attendance rules of the University and appear for all the internal evaluation procedures for the completion of the course. However, credits can be earned only on completion of the semester end examination and on getting a pass grade. Students, who have completed a course, but could not write the semester end examination for valid reasons, are permitted to write the examination at the next available chance and earn the credits without undergoing the course again.

6. Eligibility to Appear for the Semester End Examination

A candidate who has fulfilled the following conditions shall be deemed to have satisfied the requirements for the completion of a semester.

6.1 A student shall secure not less than 75% of overall attendance in a semester taking into account the total number of periods in all courses attended by the candidate as against the total number of periods in all courses offered during that particular semester.

6.2 The Head of the Department shall have the power to condone shortage of attendance up to 5% (between 75% and 70%) in a particular semester due to medical reasons (hospitalization/accident/specific illness) on production of medical certificate from a registered medical practitioner endorsed by the University Medical Officer and on payment of the required fee. However, such condonation for shortage of attendance shall be given only twice during the entire duration of the B Tech. programme.

6.3 The Vice Chancellor shall have the power to condone shortage of attendance up to additional 5% (between 70% and 65%) in a particular semester due to medical reasons (hospitalization/accident/specific illness) duly verified and recommended by the Head of the Department and on production of Medical certificate from a registered medical practitioner endorsed by the University Medical Officer and on payment of the required fee. However, such condonation for shortage of attendance shall be given only twice during the entire duration of the B Tech. programme.

6.4 Candidates who secure overall attendance of less than 65% (subject to clauses 6.2 and 6.3 above) will not be permitted to write the semester end examinations and will not be permitted to go to the next/subsequent semester. They are required to repeat the incomplete semester in the next academic year.

7. Eligibility to Write the Supplementary Examination

Failed candidates and those who could not write the semester end examination due to health reasons or other contingencies that are approved by the Head of the Department can register for the supplementary examination. Those who wish to improve their performance in the semester end examinations can also register for the same, subject to the provisions of clause 4.9. Grades awarded in the supplementary examination will be taken as semester grades in these subjects and will be based on the semester examination-grading pattern in that subject. In the case of candidates appearing for improvement of marks, the higher mark obtained will be considered for the purpose of grading.

A candidate who fails to obtain a pass in courses having only continuous assessment will be permitted to repeat the course along with the junior batches.

8. Revaluation

A candidate can apply for revaluation of his/her semester end examination answer paper in a theory course, within 2 weeks from the declaration of results, on payment of a prescribed fee along with prescribed application to the Controller of Examinations through the Head of Department. The Controller of Examination will arrange for the revaluation and the results will be intimated to the candidate concerned through the Head of the Department. Revaluation is not permitted for laboratory courses, courses having only continuous assessment, seminar and project work.

9. Pass Requirements

A candidate has to obtain a minimum of 50% marks for continuous assessment and semester end examination put together with a minimum of 40% marks in the semester end examination for a pass in theory and laboratory courses.

In the case of theory/laboratory courses having only continuous assessment, a candidate has to obtain a minimum of 50% marks in continuous assessment for a pass.

10. Promotion to Higher Semester

10.1 A candidate shall be eligible for promotion from one semester to the next semester only if he / she has

a) A valid registration for the university examination

b) Secured the minimum attendance as per Clause 6

10.2 Supplementary university examinations for all semesters shall be held along with the regular examinations.

10.3 Special supplementary examination may be conducted for the seventh and eighth semesters.

10.4 The total number of chances to appear for the examination in any subject is limited to five only.

11. Eligibility for the Degree

11.1 No candidate shall be eligible for the degree, unless he/she has undergone the prescribed course of study for a period of eight semesters in the university and has passed the prescribed examinations in all the semesters.

11.2 All the requirements for the degree shall be completed by the candidate within a period of eight academic years from the date of admission to the first semester.

12. Grading

12.1 Grades shall be awarded to the students in each course based on the total marks obtained in continuous assessment and at the end semester examination and as per the provisions of clause 4.

The grading pattern shall be as follows:

Marks obtained (Percentage)	Grade	Grade points
90 to 100	S (Outstanding)	10
80 – 90	A (Excellent)	9
70 – 80	B (Very good)	8
60 – 70	C (Good)	7
50 - 60	D (Fair)	6
< 50	F (Fail)	0

Note: Where, in the range "X – Y", 'X' is inclusive and 'Y' exclusive.

12.2 A student is considered to have credited a course or earned credits in respect of a course if he/she secures a grade other than F for that course.

12.3 Grade Point Average.

The Grade Point Average (GPA) indicates the academic performance of a student in a semester.

$$GPA = \frac{G_1C_1 + G_2C_2 + \cdots + G_nC_n}{C_1 + C_2 + \cdots + C_n}$$

where 'G' refers to the grade point and 'C' refers to the credit value of the corresponding course undergone by the student.

The Grade Point Average (GPA) for each semester will be calculated only for those students who have passed all the registered courses of that semester. Similarly, Cumulative Grade Point Average (CGPA) up to any semester will be calculated only for those students who have passed all the courses up to that semester.

12.4 Classification:

On successful completion of the program Cumulative GPA (CGPA) will be calculated as follows

$$CGPA = \frac{GP_1C_1 + GP_2C_2 + \cdots + GP_nC_n}{C_1 + C_2 + \cdots + C_n}$$

where GP_{n} refers to the GPA and C_{n} refers to the total number of credits obtained by a student in Semester n.

The classification based on CGPA is as follows.

CGPA 8 and above	: First Class with distinction
CGPA 6.5 and above, but less than 8	: First Class
CGPA 6 and above, but less than 6.5	: Second Class.

12.5 Conversion of CGPA to Percentage marks

The following formula shall be used to convert the CGPA obtained by a student to percentage marks.

Percentage marks = (CGPA - 0.5) x 10

13. Electives and Open courses

The curriculum for the programme consists of Professional Elective Courses, and open courses. In addition, industry based elective courses shall be offered for students as part of the curriculum. A student shall have the choice of taking up to 20% of credit allotted to electives from such industry base elective courses. Three open elective courses are offered in the final semester. The students shall select these courses from the list of courses available from MOOC offered by

CUSAT, approved national agencies such as, SWAYAM, NPTEL, subject to the approval of the department faculty council. The students are responsible to pay the course fee, if any, attend these online courses, pass the exam and produce the certificate. The percentage of marks/credit will be given according to the marks obtained in the above examination.

14. B. Tech with Minor

14.1 A minor is intended for a student to gain expertise in an area outside his/her major B.Tech. discipline. The department may offer a Minor in the discipline in which it offers a major UG/PG programme.

14.2 All B.Tech. students shall be eligible to register for Minor Programmes.

14.3 The registration for Minor programmes shall be along with the registration of the 3rd semester. The selection of candidates for a minor programme shall be based on the GPA obtained by the candidate in Semester – I.

14.4 To offer a minor programme in engineering, the number of candidates shall be at least 20% of the sanctioned strength of the corresponding major program. The number of seats available for the minor programme shall be decided and announced by the Department at the end of the second semester.

14.5 The student shall earn a minimum of 18 additional credits to be eligible for the award of B.Tech. Degree with Minor.

14.6 For CGPA calculation of B.Tech. programme as per the provision of 12, the credits earned by the student for his/her Minor programme will not be considered.

14.7 There is no transfer of credits from courses of Minor programme to regular B. Tech. programme and vice versa.

14.8 The Department would enlist a set of courses from its curriculum and prescribe a requirement for Minor taking at least six courses from this set. No major and minor courses can overlap by more than two courses, and this shall be ensured by the Department concerned while designing and offering a Minor program.

14.9 Out of the 18 credits, 9 credits shall be earned by undergoing a minimum of two theory courses and a mini project offered by the Department/Division concerned, during the specified period. The remaining 9 credits could be acquired through courses offered by the Department or MOOCs approved by the department council.

14.10 The maximum number of additional credits a student can register (course registration) in a semester is limited to 9 credits in excess of the mandatory credits allotted in the curriculum for that semester.

14.11 The assessment of the courses other than the MOOCs and earning of credits shall be as per the provisions of clause 12. The assessment and certification of the MOOCs shall be as per the prescribed norms of the MOOCs. The candidate shall produce the certification issued by the agency conducting the MOOCs in proof of credit attainment.

14.12 If a student fails in any course of the minor, he/she shall not be eligible to continue the B. Tech Minor. However, the additional credits and grades thus far earned by the student shall be included in the grade card.

14.13 The Undergraduate Degree with minor shall be awarded by the University to the students who fulfill all the academic eligibility requirements for the B.Tech. programme with Minor.

15 B. Tech (Honours)

15.1 Honours is an additional credential a student may earn if he/she opts for the extra 18 credits needed for this in his/her own major B. Tech. discipline. B. Tech students with a minimum CGPA of 8.0 and above obtained in the first attempt in the first and second semesters combined are eligible to register for B.Tech. (Honours).

15.2 The CGPA of the candidate at the end of eighth semester shall be 8.0 or higher to be eligible for the award of B. Tech. (Honours).

15.3 The B.Tech. (Honours) registration shall be along with the registration of the 4th semester.

15.4 If a student fails in any course of the B.Tech. programme or the courses chosen for B.Tech. (Honours), he/she shall not be eligible to continue the B.Tech. (Honours). However, the additional credits thus far earned by the student shall be included in the grade card.

15.5 The student shall earn a minimum of additional 18 credits from the courses chosen for B.Tech. (Honours), to be eligible for the award of B.Tech. (Honours) Degree.

15.6 For CGPA calculation of B.Tech. programme as per the provision of 12, the credits earned by the student for his/her Honours programme will not be considered.

15.7 There is no transfer of credits from courses of Honours programme to regular B. Tech. programme and vice versa.

15.8 Out of the 18 credits, 9 credits shall be earned by undergoing minimum three specified B.Tech.(Honours) Elective courses of the respective discipline. Credits for the B.Tech.(Honours) Elective courses are deemed to be earned only on getting at a "C" grade or better as per the provisions of clause 12.1. A student shall not be permitted to select the normal elective courses of the respective B. Tech programmes for attaining the credit requirements of B.Tech. (Honours). The remaining 9 credits could be acquired through courses offered by the Department or MOOCs of the respective disciplines approved by the department council.

15.9 The maximum number of additional credits a student can register (course registration) in a semester is limited to 9 credits in excess of the mandatory credits allotted in the curriculum for that semester.

15.10 The assessment of the courses other than the MOOCs and earning of credits shall be as per the provisions of clause 12. The assessment and certification of the MOOCs shall be as per the prescribed norms of the MOOCs. The candidate shall produce the certification issued by the agency conducting the MOOCs in proof of credit attainment.

15.11 B.Tech. (Honours) Degree shall be awarded by the University to the students who fulfill all the academic eligibility requirements for the B.Tech. and B.Tech. (Honours) programmes.

16 B.Tech. (Honours) with Minor:

A student has the choice to register for, either a Minor programme or an Honours programme or both Minor and Honours programmes, satisfying the clauses 14 and 15 related to Minor and Honours programmes, respectively. However, the maximum number of credits a student can register for, in a semester, is limited to 9 credits in excess of the mandatory credits allotted in the curriculum for that semester as given in clause 4.9.

17. Faculty Advisor

To help the students in planning their courses of study and for general advice on the academic programme, the Head of the Department will attach a teacher of the Department to each batch of students, this teacher will be the Faculty Advisor for that batch of students throughout their period of study. These Faculty Advisors shall advise the students and monitor the courses taken by the students, check the attendance and progress of the students and counsel them periodically. If necessary, the Faculty Advisor may also discuss with or inform the parents about the progress/performance of the students concerned.

18. Class Committe

A class committee consists of teachers of the class concerned, student representatives and a chairperson who does not handle any subject for the class. It is like the 'Quality Circle' (more commonly used in industries), with the overall goal of improving the teaching- learning process. The functions of the class committee include:

a. Solving problems experienced by students in the classroom and in the laboratories in consultation with Head of the Department.

b. Clarifying the regulations of the degree programme and the details of rules therein.

c. Informing the student representatives, the academic schedule including the dates of assessments and the syllabus coverage for each assessment.

d. Informing the student representatives, the details of regulations regarding weightage used for each assessment.

e. Analyzing the performance of the students of the class after each test and finding ways and means of improving the performance of the students.

f. Identifying the students who are low achievers or weak in their subjects if any, and requesting the teachers concerned to provide some additional help or guidance or coaching to such students.

The Head of the Department will constitute the class committee. The class committee shall be constituted within a week from the date of commencement of a semester. At least 4 student representatives from the respective class (usually 2 boys and 2 girls) shall be included in the class committee.

The student representatives shall be nominated based on their academic performance since the first semester of the B Tech. programme. In the case of first and second semesters, the rank obtained in the Common Admission Test (CAT) shall be the criterion for nominating the student representatives. The Chairperson of the class committee may invite the Faculty Advisor(s) and the Head of the Department to the meeting of the class committee. The Chairperson of the class committee is required to prepare the minutes of every meeting, submit the same to the Head of the Department within two days of the meeting and arrange to circulate the same among students concerned and teachers. If there are some points in the minutes requiring action by the University, the same shall be brought to the attention of the Head of the Department and the Registrar.

The first meeting of the class committee shall be held within fifteen days from the date of commencement of the semester. The nature and weightage of internal assessments shall be decided in the first meeting, within the framework of the regulations and the same shall be communicated to the students. Two or three subsequent meetings in a semester may be held at suitable intervals. During these meetings the student members representing the entire class, shall meaningfully interact and express their opinions and suggestions of the class to improve the effectiveness of the teaching-learning process.

19. Discipline

Every student is required to observe discipline and decorous behaviour both inside and outside the campus and refrain from any activity, which may tarnish the image of the University as per the provisions of the Cochin University Students' (Conduct and Disciplinary) Code - 2005. Any act of indiscipline, misbehaviour including unfair practice in examinations will be referred to the authorities of the University that will make a detailed enquiry on the matter and decide on the course of action to be taken.

20. Amendment to Regulations

Notwithstanding all that has been stated above, the University has the right to modify any of the above regulations from time to time.

21. Course Structure and Scheme of Evaluation.

The programme of instruction will consist of the following:

a) Basic Science Courses (BSC) comprising Mathematics, Physics, Chemistry etc;

b) Engineering Science Courses (ESC) introducing the student to the foundations of engineering.

c) Professional Core Courses (PCC) introducing the students to the foundations of Instrumentation and Control engineering.

d) Elective Courses (EC) enabling the student to opt and undergo a set of courses of interest to him/her.

e) Professional practice including project, seminar, and industrial training.

f) Humanities courses (HC) on soft skills; and

g) Mandatory Courses (MC) on Indian Constitution and Environmental Science, in addition to Induction training.

The B Tech. programme will have a curriculum and syllabus for the courses approved by the Academic Council.

The B Tech. programme will follow the credit system.

The curriculum of the B Tech. programme has a total of 160 credits.

SEMESTER I

Course category	Course Code and Title of the Course	Hours per week			Credit	Evaluation		
		L	T	P		Int.	Ext.	Total
BSC	24-219-0101 Calculus	3	1	0	3	50	50	100
BSC	24-219-0102 Engineering Physics	3	1	0	3	50	50	100
ESC	24-219-0103 Basic Electronics	3	1	0	3	50	50	100
ESC	24-219-0104 Electrical Engineering - I	3	1	0	3	50	50	100
ESC	24-219-0105 Mechanical Engineering	3	1	0	3	50	50	100
HSC	24-219-0106 Soft Skill Development	1	1	0	1	100	0	100
HSC-L	24-219-0107 Language Lab	0	0	1	1	50	0	50
ESC-L	24-219-0108 Engineering Graphics	1	0	3	2	100	0	100
ESC-L	24-219-0109 Electrical and Mechanical Workshop	0	0	3	1	50	0	50
MC	Induction Training	-	-	-	-	-	-	-
MC	Indian Constitution	-	-	-	-	-	-	-

Total Credits: 20.

Total marks: 800

SEMESTER II

Course category	Course Code and Title of the Course	Hours per week			Credit	Evaluation		
		L	T	P		Int.	Ext.	Total
BSC	24-219-0201 Linear Algebra and Transforms	3	1	0	3	50	50	100
ESC	24-219-0202 Engineering Chemistry	3	1	0	3	50	50	100
ESC	24-219-0203 Analog Electronics	3	1	0	3	50	50	100
ESC	24-219-0204 Electrical Engineering II	3	1	0	3	50	50	100
ESC	24-219-0205 Engineering Mechanics	3	1	0	3	50	50	100
ESC	24-219-0206 Network Theory	3	1	0	3	50	50	100
ESC-L	24-219-0207 Computer Programming	1	1	1	2	100	0	100
ESC-L	24-219-0208 Basic Electronics Lab	0	0	3	1	100	0	100
MC	Environmental Science	-	-	-	-	-	-	-

Total Credits: 21.

Total marks: 800

SEMESTER III

Course category	Course Code and Title of the Course	Hours per week			Credit	Evaluation		
		L	T	P		Int.	Ext.	Total
BSC	24-219-0301 Complex Analysis and Partial Differential Equations	3	1	0	3	50	50	100
ESC	24-219-0302 Electrical Measurements and Instrumention	3	1	0	3	50	50	100
PCC	24-219-0303 Digital Electronics	3	1	0	3	50	50	100
PCC	24-219-0304 Linear Integrated Circuits	3	1	0	3	50	50	100
PCC	24-219-0305 Transducers - I	3	1	0	3	50	50	100
PCC	24-219-0306 Principles of Measurements and Instrumentation	3	1	0	3	50	50	100
ESC-L	24-219-0307 Scientific Computing Lab	0	0	3	1	100	0	100
ESC-L	24-219-0308 Electrical Machines Lab	0	0	3	1	100	0	100

Total Credits: 20

Total Marks: 800

SEMESTER IV

Course category	Course Code and Title of the Course	Hours per week			Credit	Evaluation		
		L	T	P		Int.	Ext.	Total
BSC	24-219-0401 Numerical and Statistical Methods	3	1	0	3	50	50	100
PCC	24-219-0402 Transducers - II	3	1	0	3	50	50	100
PCC	24-219-0403 Control Engineering -I	3	1	0	3	50	50	100
PCC	24-219-0404 Power Electronics	3	1	0	3	50	50	100
PCC	24-219-0405 Pneumatics and Hydraulics	3	1	0	3	50	50	100
ESC	24-219-0406 Signals and Systems	3	1	0	3	50	50	100
PCC-L	24-219-0407 Digital Electronics Lab	0	0	3	1	100	0	100
PCC-L	24-219-0408 Analog Electronics Lab	0	0	3	1	100	0	100

Total Credits: 20

Total Marks: 800

SEMESTER V

Course category	Course Code and Title of the Course	Hours per week			Credit	Evaluation		
		L	T	P		Int.	Ext.	Total
PCC	24-219-0501 Control Engineering II	3	1	0	3	50	50	100
PCC	24-219-0502 Digital Signal Processing	3	1	0	3	50	50	100
PCC	24-219-0503.Microprocessors & micro controllers	3	1	0	3	50	50	100
PCC	24-219-0504 Analytical Instruments	3	1	0	3	50	50	100
HSC	24-219-0505 Engineering Management	3	1	0	3	50	50	100
PCC-L	24-219-0506 Control Systems Lab	0	0	3	1	100	0	100
PCC-L	24-219-0507 Transducer Lab	0	0	3	1	100	0	100
PEC	24-219-05** Elective - I	3	1	0	3	50	50	100

Total Credits: 20

Total Marks: 800

SEMESTER VI

Course category	Course Code and Title of the Course	Hours per week			Credit	Evaluation		
		L	T	P		Int.	Ext.	Total
PCC	24-219-0601 Vacuum and cryogenic Instrumentation	3	1	0	3	50	50	100
PCC	24-219-0602. Embedded Systems	3	1	0	3	50	50	100
PCC	24-219-0603 Process Control	3	1	0	3	50	50	100
PCC	24-219-0604 Optoelectronic Instrumentation	3	1	0	3	50	50	100
PCC-L	24-219-0605 Microprocessor Lab	0	0	3	1	100	0	100
PCC-L	24-219-0606 Virtual Instrumentation Lab	0	0	3	1	100	0	100
	24-219-0607 Seminar	1	0	0	1	50	0	0
PEC	24-219-06** Elective II	3	1	0	3	50	50	100
PEC	24-219-06** Industry Elective	2	1	0	2	50	50	100

Total Credits: 20

Total marks: 800

SEMESTER VII

Course category	Course Code and Title of the Course	Hours per week			Credit	Evaluation		
		L	T	P		Int.	Ext.	Total
PCC	24-219-0701 Biomedical Instrumentation	3	1	0	3	50	50	100
PCC	24-219-0702 Advanced Process control	3	1	0	3	50	50	100
PCC	24-219-0703 Power plant & Industrial Instrumentation	3	1	0	3	50	50	100
PCC	24-219-0704 Communication Systems and Telemetry	3	1	0	3	50	50	100
PCC	24-219-0705 Robotics and automation	3	1	0	3	50	50	100
PCC-L	24-219-0706 Process control Lab	0	0	3	1	100	0	100
PCC-L	24-219-0707 Digital Signal Processing Lab	0	0	3	1	100	0	100
	24-219-0708 Mini Project	0	0	0	1	50	0	50
PEC	24-219-07** Elective III	3	1	0	3	50	50	100

Total Credits: 21

Total marks: 850

SEMESTER VIII

Course category	Course Code and Title of the Course	Hours per week			Credit	Evaluation		
		L	T	P		Int.	Ext.	Total
	24-219-0801 Project work	-	-	-	10	300	0	300
	24-219-0802 Viva- Voce	-	-	-	2	150	0	150
OEC	24-219-08** MOOC 1	-	-	-	2	-	-	100
OEC	24-219-08** MOOC 2	-	-	-	2	-	-	100
OEC	24-219-08** MOOC 3	-	-	-	2	-	-	100

Total Credits: 18

Total Marks: 750

Program total:

Credits: 160

Marks: 6400

Appendix - V (C)

Syllabus for I and II Semester BTech Degree Programme in Instrumentation and Control Engineering

offered by

Department of Instrumentation under Faculty of Technology, Cochin University of Science and Technology.

(With effect from 2024 admissions onwards)

SEMESTER 1

24-219-0101 CALCULUS

L	T	P	C
3	1	0	3

Pre-requisites: Nil

Total Hours: 64

Course Outcomes: After completion of this course the student will be able to:

CO1: Solve ordinary differential equations and linear differential equations of higher orders with constant coefficients and apply them to engineering problems.

CO2: Estimate the maxima and minima of multi-variable functions.

CO3: Evaluate area as double integrals and volume as triple integrals in engineering applications.

CO4: Illustrate the application and physical meaning of gradient, divergence, and curl.

Mapping of course outcomes with PO's: **Level - Low (1), medium (2) and high (3)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	3	2	-	-	-	-	-	-	-	-	1
CO2	3	3	2	-	-	-	-	-	-	-	-	1
CO3	3	3	2	-	-	-	-	-	-	-	-	1
CO4	3	3	2	-	-	-	-	-	-		-	1

Module 1 (16 hours, End semester marks 25%)

Ordinary differential equations:
First-order differential equations - exact differential equations, Bernoulli's equations--Methods of solution and Simple applications.

Linear differential equations of higher orders with constant co-efficient-Methods of solution of these equations. Cauchy's linear differential equations. Simultaneous linear differential equations- Simple applications of linear differential equations in engineering problems.

Module 2 (16 hours, End semester marks 25%)

Partial differentiation:
Partial differentiation-Concept of partial derivative - Chain rule, Total derivative- Euler's theorem for homogeneous functions, Differentials and their applications in errors and approximations, Jacobians - Maxima minima of functions of two variables (Proof of the result not required)-Simple applications.

Co-ordinate systems: Rectangular co-ordinates- Polar co-ordinates-In plane and in Space Cylindrical polar co-ordinates-Spherical polar co-ordinates.

Module 3 (16 hours, End semester marks 25%)

Integral calculus: Application of definite integrals: Area, Volume, Arc length, Surface area.
Multiple integrals: Evaluation of double integrals-Change of order of integration. Evaluation of triple integrals-Change of Variables in integrals.
Applications of multiple integrals. Plane Area, Surface area &Volumes of solids.

Module 4 (16 hours, End semester marks 25%)

Vector calculus: Scalar and vector point functions, gradient and directional derivative of a scalar point function, divergence and curl of vector point functions, their physical meaning. Evaluation of line integral, surface integral, and volume integrals, Gauss's divergence theorem, Stoke's theorem (No proofs), conservative force fields, scalar potential.

References:

1. Sastry, S.S. Engineering mathematics: Vol1. (Forty Fourth edition). PHI Learning, New Delhi. (2008).
2. Erwin Kreyzig. Advanced engineering mathematics (Tenth edition). John Wiley& Sons, Hoboken, NJ. (2020)
3. Veerarajan, T. Engineering mathematics. (third edition). Tata McGraw Hill Publishers, New Delhi. (2011)
4. Grewal, B.S. Higher Engineering Mathematics. (Forty Third Edition). Khanna Publishers, New Delhi. (2013).
5. Online courses from swayam (https://swayam.gov.in/), Stanford online (https://online.stanford.edu/) and MIT Open Courseware (https://ocw.mit.edu/).

24-219-0102 ENGINEERING PHYSICS

L	T	P	C
3	1	0	3

Pre-requisites: Nil

Total Hours: 64

Course Outcomes: After completion of the course, students will be able to demonstrate the ability to:

CO1: Explain wave phenomena and interpret optical phenomena involving interference and diffraction.

CO2: Explain the polarization of light and its applications.

CO3: Understand atomic phenomena based on the principles of quantum and statistical theories.

CO4: Explain the fundamentals of acoustics and ultrasonics.

CO5: Explain crystal structure and x-ray diffraction techniques.

Mapping of course outcomes with PO's: **Level - Low (1), medium (2) and high (3)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	3	2	-	-	-	-	-	-	-	-	1
CO2	3	3	2	-	-	-	-	-	-	-	-	1
CO3	3	3	2	-	-	-	-	-	-	-	-	1
CO4	3	3	2	-	-	1	1	-	-	-	-	1
CO5	3	3	2	-	-	-	-	-	-	-	-	1

Module 1 (16 hours, End semester marks 25%)

Waves: One dimensional wave - differential equation and solution. Three dimensional waves - differential equation and solution (no derivation) - transverse and longitudinal waves- transverse vibrations of a stretched string.

Interference of light: Analytical treatment of interference- coherent sources -derivation of expression for fringe width in in double slit experiment - white light fringes - fringe shift with thin transparent plate - interference on thin films - Newton's rings - air wedge - planeness of surfaces - anti reflection coatings.

Module 2 (16 hours, End semester marks 25%)

Diffraction of light: - Fresnel and Fraunhofer diffraction - zone plates - plane diffraction grating - measurement of wavelength - dispersive power of grating - resolving power – Raleigh's criterion - resolving power of telescope and grating.

Polarization of light: polarization by reflection - refraction - Brewster's law - double refraction

- negative and positive crystals - Nicol prism - quarter and half wave plates - production and detection of circularly and elliptically polarized lights - rotatory polarization - half shade polarimeter - applications of polarized light.

Module 3 (16 hours, End semester marks 25%)

Quantum Mechanics: wave particle duality - de Broglie's concept of matter waves - Davison & Germer experiment - uncertainty principle - postulates of quantum mechanics- formulation of time independent and time dependent Schrodinger equation - energy and momentum operators - eigen values and functions - one dimensional infinite square well potential - tunnelling (qualitative ideas only).

Statistical mechanics: macrostates and microstates - phase space - basic postulates of Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics and their distribution functions (no derivation) - Fermi level and its significance.

Module 4 (16 hours, End semester marks 25%)

Acoustics: Intensity of sound - loudness - absorption coefficient - reverberation - significance of reverberation time - Sabine's formula (no derivation) - acoustics of buildings.

Ultrasonics: production of ultrasonic waves - magnetostriction and piezoelectric oscillators - detection of ultrasonics - thermal and piezoelectric methods - applications of ultrasonics - NDT and medical applications.

Crystal structure: - space lattice – unit-cell - crystal systems - lattice planes - spacing between lattice planes - Miller indices - x-ray diffraction - Bragg's law - powder diffraction method - production of x-rays- continuous and characteristic x-rays.

References:

1. Aruldas, G., Engineering Physics, PHI Ltd.
2. Beiser, A., Concepts of Modern Physics, McGraw Hill India Ltd.
3. Bhattacharya and Tandon, Engineering Physics, Oxford India.
4. Raghuvanshi, G. S., Prentice Hall of India.
5. Brijlal and Subramanyam, A Textbook of Optics, S. Chand & Co.
6. Philip J., A Textbook of Engineering Physics, Educational Publishers.
7. Vasudeva A. S., A Textbook of Engineering Physics, S. Chand& Co.
8. Kittel C., Introduction to Solid State Physics; 8th edition, Wiley, 2018.

24-219-0103 BASIC ELECTRONICS

L	T	P	C
3	1	0	3

Pre-requisites: Nil

Total Hours: 64

Course Outcomes: After completion of the course, students will be able to demonstrate the ability to:

CO1: Understand the basics of semiconductors and operation of p-n junction devices.

CO2: Understand the working of diode circuits and their applications.

CO3: Understand the basics of bipolar junction transistors and transistor biasing.

CO4: Understand different types of field effect transistors, their working principles, and applications.

Mapping of course outcomes with PO's: **Level - Low (1), medium (2) and high (3)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	3	2	-	-	-	-	-	-	-	-	1
CO2	3	3	2	-	-	-	-	-	-	-	-	1
CO3	3	3	2	-	-	-	-	-	-	-	-	1
CO4	3	3	2	-	-	-	-	-	-	-	-	1

Module 1 (15 hours, End semester marks 25%)

P-N junction diode: Semiconductors - band structure of semiconductors - intrinsic and extrinsic semiconductors - doping. Law of mass action - P-N junction - V-I characteristics - Zener diode, LEDs, photodiodes, and solar cells.

Module 2 (15 hours, End semester marks 25%)

Diode circuits: Diode as a circuit element - piecewise linear model - clipping and clamping circuits - voltage multiplier - rectifiers -half wave, full wave, and bridge circuits- voltage equations - capacitive filters- Zener diode voltage regulator.

Module 3 (15 hours, End semester marks 25%)

Bipolar Junction Transistor: Construction and principle of operation - current components, CE, CB, and CC configurations - BJT characteristics - BJT as an amplifier.

Transistor Biasing: Operating point - fixed-bias and self-bias - bias stabilization - bias compensation - thermal runaway - thermal stability.

Module 4 (15 hours, End semester marks 25%)

Field effect transistors: The junction field effect transistor - pinch-off voltage - JFET V-I characteristics - FET small signal model - MOSFET-structure and characteristics - MOSFET gate protection and CMOS - low frequency common source and common drain amplifiers - biasing the FET - FET as a voltage variable resistor (VVR) - the common-source amplifier at high frequencies - the common drain amplifier at high frequencies.

References:

1. Jacob Millman, Christos C. Halkias, and Chetan D Parikh– Integrated Electronics 2/e– Tata McGraw Hill. (2017).
2. Jacob Millman and Arvin Grabel – Microelectronics 2/e– McGraw Hill Education (2017).
3. Adel S. Sedra, Kenneth C. Smith, Arun N. Chandorkar - Microelectronic Circuits: Theory and Applications 7E (Ia) (2017)
4. Sunipa Roy, Chandan Kumar Ghosh, Sayan Dey, Abhijit Kumar Pal - Solid State & Microelectronics Technology (2023)
5. Online courses from Swayam (https://swayam.gov.in/), Stanfrd online (https://online.stanford.edu/) and MIT OpenCourseware (https://ocw.mit.edu/).

24-219-0104 ELECTRICAL ENGINEERING I

L	T	P	C
3	1	0	3

Pre-requisites: Nil

Total Hours: 64

Course Outcomes: After completion of this course, the student will be able to

CO1: Understand and apply the fundamental laws governing electric and magnetic fields, solve problems related to electrostatics and magnetic circuits, and explain the principles of electromagnetic induction.

CO2: Understand the fundamentals of ac voltage generation and the definition of various terms.

CO3: Define and apply various theorems for solving voltage and currents in DC circuits.

CO4: Analyze AC series and parallel circuits, as well as DC transients in R-L and R-C circuits.

CO5: Gain fundamental knowledge about three-phase power systems.

Mapping of course outcomes with PO's: **Level - Low (1), medium (2) and high (3)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	2	2	-	-	-	-	-	-	-	-	2
CO2	3	2	2	-	-	-	-	-	-	-	-	2
CO3	3	3	2	-	-	-	-	-	-	-	-	2
CO4	3	3	2	-		-	-	-	-		-	2
CO5	3	2	2	-	-	-	-	-	-	-	-	2

Module 1 (16 Hours, End semester marks 25%)

Electrostatics: Electric charge, Coulomb's law of electrostatics, Electric field, Electric potential, capacitor, and capacitance.

Electromagnetism: Magnetic field, Biot-Savart law, Magnetic field of an infinite linear conductor, field strength due to circular loop, field strength inside a solenoid, force on current carrying conductor in a magnetic field, hysteresis.

Magnetic Circuits: Magnetomotive force, magnetic field strength, reluctance, laws of magnetic circuits, ampere-turns of magnetic circuit.

Module 2 (16 Hours, End semester marks 25%)

Electromagnetic induction: Relation between magnetism and electricity, Faraday's laws of electromagnetic induction, direction and induced emf, magnitude of induced emf in a coil, dynamically induced emf, statically induced emf.

Fundamentals of AC: generation of alternating current and Voltage, emf equation, phase, and phase difference, rms value, average value form factor, peak factor and vector diagram.

Module 3 (16 Hours, End semester marks 25%)

DC circuit theory: Kirchoff's laws, source transformation, superposition theorem, Thevenin's theorem, Norton's theorem, reciprocity theorem, substitution theorem and maximum power transfer theorems

Single-phase series ac circuits: Purely resistive, capacitive, and inductive ac circuits. R-L, R-C and R-L-C series ac circuits. Resonance, Q-actor, power, and power factor in ac series circuits.

Single-phase parallel ac circuits: R-L, R-C, L-C, L-R-C parallel ac circuits, parallel resonance, Q factor and power factor improvement.

DC transients in R-L and R-C circuits: rise and fall of current, time constant and energy stored in R-L and R-C circuits.

Module 4 (16 Hours, End semester marks 25%)

Three phase system: generation of three phase voltage, star connection and delta connection, star to delta and delta to star conversion, power in 3 phase system, and measurement of 3 phase power in balanced and unbalanced systems.

Symmetrical components: Positive sequence components, negative sequence components and zero sequence components.

Power Transmission Methods and Devices: Introduction to Power Transmission, Belt, Rope, Chain and Gear Drive. Length of belt open and crossed. Ratio of belt tensions (Elementary problems only). Different types of gears (Elementary ideas only). Types and functioning of clutches.

References:

1. John Bird - Electrical Circuit Theory and Technology (Fourth Edition) - Routledge (2010)
2. DP Kothari, I J Nagrath - Basic Electrical Engineering (4th Edition) - McGraw-Hill (2019)
3. Abhijit Chakrabarti, Sudipta Nath, Chandan Chanda - McGraw Hill Education (2017)
4. U. A. Bakshi, A. V. Bakshi - Electromagnetic Field Theory - TECHNICAL PUBLICATIONS
5. David J. Griffiths - Introduction to Electrodynamics (Fourth Edition) - Cambridge University Press (2017)
6. https://onlinecourses.nptel.ac.in/noc22_ee113/preview Fundamentals of Electrical Engineering

24-219-0105 MECHANICAL ENGINEERING

L	T	P	C
3	1	0	3

Pre-requisites: Nil

Total Hours: 64

Course Outcomes: After completion of this course, the student will be able to

CO1: Understand the basics of thermodynamics and the working of steam turbines.

CO2: Understand the basics of internal combustion engines, refrigeration and air conditioning.

CO3: Acquire an understanding of the operation and functioning of air compressors, power plants, and pumps.

CO4: Identify manufacturing methods encountered in engineering practice and understand the mechanism of power transmission.

Mapping of course outcomes with PO's: **Level - Low (1), medium (2) and high (3)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	2	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-
CO4	3	2	3	-	3	-	-	-	-	1	-	-

Module 1 (16 Hours, End semester marks 25%)

Thermodynamics: Thermodynamics systems – open, closed, and isolated systems, equilibrium state of a system, property and state, process, cycle, Zeroth law of thermodynamics – concept of temperature, temperature scales. First law – internal energy, enthalpy, work and heat, different processes (isobaric, isochoric, isothermal, adiabatic and polytropic processes). Second law – Kelvin-Planck and Clausius statements and their equivalence, Carnot Cycle (Elementary problems only).

Thermodynamic properties of Steam, Steam generator. Different types of boilers, boiler mountings, and accessories. Formation of steam at constant pressure, working of steam turbines, compounding of turbines.

Module 2 (16 Hours, End semester marks 25%)

Internal Combustion Engines: Air standard cycles – Otto and Diesel cycles, working of two stroke and four stroke Petrol and Diesel engines, carburetted and MPFI engines, fuel pump, fuel injector, ignition system, cooling system, lubricating system.

Refrigeration & Air-conditioning: Introduction to refrigeration and air-conditioning, rating of refrigeration machines, coefficient of performance, simple refrigeration vapour compression cycle (Elementary problems only), summer and winter air conditioning.

Module 3 (16 Hours, End semester marks 25%)

Air compressors: Reciprocating air compressors – Mechanical details – Shaft work – Multistage air compressors with intercooling – Introduction to condensers and cooling towers.

Power plants: Hydro-electric power plants, thermal power plants, nuclear power plants, diesel power plants, windmills, solar energy (working principles using schematic representations only)

Pumps: Centrifugal-Reciprocating-Classifications.

Module 4 (16 Hours, End semester marks 25%)

Introduction to Manufacturing Systems: Welding - different types of welding, resistance welding, arc welding, gas welding, brazing, and soldering, different welding defects. Casting - different casting processes, sand casting, casting defects, rolling - hot rolling and cold rolling, two high, three high, cluster rolling mills, wire drawing, forging, extrusion, heat treatment of steel, elementary ideas of annealing, hardening, normalizing, and surface hardening. Principle of CAD/CAM, Rapid and Additive manufacturing.

Power Transmission Methods and Devices: Introduction to Power Transmission, Belt, Rope, Chain and Gear Drive. Length of belt open and crossed. Ratio of belt tensions (Elementary problems only). Different types of gears (Elementary ideas only). Types and functioning of clutches.

References:

1. Nag, P.K. Engineering thermodynamics. (Fifth edition). McGraw Hill Education (India) Pvt. Ltd., New Delhi. (2015)
2. Stoecker, W.F. Refrigeration and air conditioning (Second edition). Tata McGraw Hill, New Delhi. (2014)
3. V Ganesan. Internal Combustion Engines. (4th Edition). McGraw-Hill Education. (2017)
4. Arora, C.P. Refrigeration and Air Conditioning. (Fourth edition). McGraw Hill Education (India) Pvt. Ltd. (2020)
5. Jagadish Lal. Hydraulic Machines Including Fluidics Metropolitan Book Co., New Delhi. (2016)
6. Rajendar Singh. Introduction to basic manufacturing processes and workshop technology (Third Edition), New Age International, New Delhi. (2022)
7. Radhakrishnan, P, Subramanyan S and Raju V. CAD/CAM/CIM. New Age International Pvt Ltd; Fourth edition (2018)
8. https://nptel.ac.in/courses/112105123
9. https://onlinecourses.nptel.ac.in/noc20_me42/preview

24-219-0106 SOFT SKILLS DEVELOPMENT

L	T	P	C
1	1	0	2

Pre-requisites: Nil

Total Hours: 32

Course Outcomes: After completion of this course, the student will be able to

CO1: Speak English at the formal and informal levels and use it for daily conversation, presentation, group discussion and debate.

CO2: Read, comprehend, and answer questions based on literary, scientific and technological texts.

CO3: Develop self-motivation, raised aspiration, belief in one's own abilities and commitment to achieving one's goal

CO4: Demonstrate emotional maturity and emotional health.

Mapping of course outcomes with PO's: **Level - Low (1), medium (2) and high (3)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	-	-	-	-	-	2	1	-	-	3	2	-
CO2	-	-	-	-	-	2	1	-	-	3	2	-
CO3	-	-	-	-	-	2	1	-	-	3	2	3
CO4	-	-	-	-	-	2	1	-	-	3	2	2

Module 1

Role and importance of verbal communication, Everyday active vocabulary, Common words used in transitions, enhancing vocabulary, affixes and changes in pronunciation and grammatical functions, words often confused in pronunciation and usage. Passage comprehension- skimming, scanning techniques, note making, note taking and summarizing. Deciphering meaning from contexts. Two types of meaning- literal and contextual. Constructive criticism of speeches and explanations.

Module 2

Fundamental grammar, Simple structures, passivizing the active sentences, reported speech, the judicious use of tenses and moods of verbs, forming questions and conversion from questions to statements and vice versa, forming open–ended and close-ended questions. Words and style used for formal and informal communication. Practice converting informal language to formal, the diction, and the style of writing. Dealing with the nuances of ambiguous constructions in language. Learning authoritative writing skills, polite writing, and good netiquette. Writing for internships and scholarships.

Module 3

Kinesics, Proxemics, Haptics, and other areas of non-verbal communication, fighting communication barriers, positive grooming, and activities on the same. Different types of interviews, and presentations - oral, poster, PPT. Organizing ideas for group discussions, the difference between GD and debates. Effective listening and seeking to understand others' perspectives. Non-violent negotiation and persuasion, communicating across age groups, cultures, or identity groups. Higher-order thinking and evaluation, information-seeking, research, independent learning, synthesis, creativity, problem analysis, and problem-solving. Decision-making, Self-reflection, and learning from experience.

Module 4

Developing positive self: Understanding oneself, a realistic awareness of oneself and one's abilities, strengths and potential, Self-esteem, Self-efficacy, and steps for improvement. Intra-personal skills – Self-control, emotional regulation and self-discipline, conscientiousness, dutifulness, reliability, truthfulness, honesty, and trustworthiness. Goal orientation and initiative. Time management – prioritizing work. Interpersonal skills – cross-cultural competence and valuing diversity of perspectives, respecting and expressing concern for others. Empathy and ability to notice the effect of one's actions on others, tolerance for disagreement, conflict management, and resolution. Civic engagement and social responsibility – Global and local awareness (issues, challenges, priorities). Vision is the ability to imagine something new or improved. Social responsibility and willingness to take constructive action.

Assessment:

1. 'Soft Skills Development' is a practical and activity-oriented course which has a continuous assessment for 50 marks based on classroom interaction, activities, and assignments. The activities may include 'Just a Minute' (JAM) sessions, group discussion, role-play, debate, and extempore speech.

    The Marks for the different components shall be as follows:
    Classroom interaction – 10 marks
    Activities – 30 marks
    Assignments (mainly from Modules I and II) – 10 marks

2. Semester End Examination is not envisaged.
3. A student should secure a minimum of 50% marks in continuous assessment for a pass in the course.

24-219-0107 LANGUAGE LAB

L	T	P	C
1	1	0	2

Pre-requisites: Nil

Total Hours: 32

Course Outcomes: After completion of this course, the student will be able to

CO1: Test pronunciation skills through stress on word accent, intonation, and rhythm.

CO2: Use the English language effectively for writing business letters, resumes, minutes of meetings, and reports.

CO3: Use the English language effectively to face interviews, group discussions, and public speaking.

Mapping of course outcomes with PO's: **Level - Low (1), medium (2) and high (3)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	-	-	-	-	-	-	-	1	-	3	-	3
CO2	3	-	-	-	-	-	-	1	2	3	3	2
CO3	-	-	-	-	-	-	-	1	2	3	3	3

The following course content is prescribed for the Language Laboratory sessions:

1. Introduction to the Sounds of English- Vowels, Diphthongs & Consonants.
2. Introduction to Stress and Intonation.
3. Preparing business letters
4. Preparing a resume
5. Conducting a meeting and writing the minutes
6. Writing a report
7. Situational Dialogues / Role Play.
8. Oral Presentations- Prepared and Extempore.
9. 'Just A Minute' Sessions (JAM).
10. Describing Objects / Situations / People.
11. Debate
12. Group discussion

24-219-0108 ENGINEERING GRAPHICS

L	T	P	C
1	0	3	2

Pre-requisites: Nil

Total Hours: 64

Course Outcomes: After completion of this course, the student will be able to

CO1: Sketch orthographic projection of points and lines as per BIS code of practice for general engineering drawing.

CO2: Draw (a) orthographic projection of solids & sectioned solids (b) development of surfaces of solid and truncated solids.

CO3: Draw (a) curves of intersection of solids, and perspective drawings of objects. (b) Construct isometric scale and isometric projections.

CO4: Draw (a) orthographic views from isometric view of a solid (b) 2D and 3D models of simple solids in modelling software.

Mapping of course outcomes with PO's: **Level - Low (1), medium (2) and high (3)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	2	3	-	-	-	-	-	-	-	-	2
CO2	3	2	3	-	-	-	-	-	-	-	-	2
CO3	3	2	3	-	-	-	-	-	-	-	-	2
CO4	3	2	3	-	3	-	-	-	-		-	2

Module 1 (16 Hours, End semester marks 25%)

Relevance of technical drawing in the engineering field, Drawing instruments, Types of lines, Dimensioning, and BIS code of practice for technical drawing.

Orthographic projection of points and lines: Projection of points in different quadrants, projection of straight lines inclined to either one or both reference planes.

True length and inclination of lines with reference planes; Traces of lines. Application problems of lines.

Module 2 (16 Hours, End semester marks 25%)

Orthographic projection of solids in simple position, axis inclined to either one of the reference planes and axis inclined to both reference planes. Section of solids with section plane inclined to any of the reference planes.

The true shape of the section. Development of surfaces of the solid, truncated solids, Application-based problems.

Module 3 (16 Hours, End semester marks 25%)

Intersection of surfaces: Intersection of prism in prism and cylinder in cylinder - axis bisecting at right angles only.

Perspective projections: Perspective projections of simple solids- Visual ray and vanishing point methods.

Isometric projections: Isometric projections and views of plane figures of simple and truncated solids in simple positions including sphere and hemisphere and their combinations.

Module 4 (16 Hours, End semester marks 25%)

Multi-view projection: Conversion of isometric view of objects to orthographic views.

Introduction to Computer Aided Drawing: Role of CAD in design and development of new products, Advantages of CAD. Creating two-dimensional drawings with dimensions using suitable software. Introduction to Solid Modelling: Creating 3D models of various components using suitable modelling software.

References:

1. N.D. Bhatt - Engineering Drawing - Charotar Publishing House
2. P.I. Varghese - Engineering Graphics with AutoCAD - VIP Publishers
3. N.D. Bhat and V.M. Panchal - Machine Drawing Charotar Publishing House
4. John, K.C. Engineering Graphics, Prentice Hall India Publishers
5. Agrawal, B. and Agrawal, C.M., Engineering Drawing, Tata McGraw Hill Publishers."

24-219-0109 ELECTRICAL AND MECHANICAL WORKSHOP

L	T	P	C
0	0	3	1

Pre-requisites: Nil

Total Hours: 48

Course Outcomes: After completion of this course, the student will be able to

CO1: understand the safety precautions to be taken in a mechanical workshop.

CO2: understand different tools and equipment used in a mechanical workshop.

CO3: acquire skills for the preparation of different fitting and welding models

CO4: understand different operating of different machining tools used in a mechanical workshop.

CO5: understand the safety precautions to be taken while dealing with electric circuits.

CO6: understand and analyse different types of wiring circuits, both domestic and industrial.

Mapping of course outcomes with PO's: **Level - Low (1), medium (2) and high (3)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	-	-	-	-	-	-	-	-	-	-	1
CO2	3	-	2	-	2	-	-	-	-	-	-	1
CO3	3	2	2	2	-	-	-	-	-	-	-	1
CO4	3	-	2	2	2	-	-	-	-	-	-	1
CO5	3	-	-	-	-	-	-	-	-	-	-	1
CO6	3	2	2	2	-	-	-	-	-	-	-	1

List of Exercises/ Experiments for Mechanical Engineering Workshop (24 hours, End semester marks 50%)

Safety rules: Understand the safety rules in mechanical engineering workshops.

General: Study of mechanical tools such as screwdrivers, spanners, Allen keys, cutting pliers etc.

Sheet metal works: Make cylindrical, conical, and prismatic shaped jobs from sheet metals**.**

Welding: Make joints using electric arc welding - butt joint, comer joint, T-joint and lap joint.

Fitting: Exercise on one simple fitting job involving practice of chipping, filing, drilling, tapping, cutting etc.

Machines: Demonstration and application of drilling machine, grinding machine, shaping machine, milling machine and lathe.

List of Exercises/ Experiments for Electrical Workshop (24 hours, End semester marks 50%)

Safety rules: Understand the safety rules in electrical engineering labs.

Component identification: Identify different electric wiring components such as different types of wires/cables, fuses, and fuse carriers, MCB, ELCB, MCCB and their uses**.**

Wiring exercises:

1. Simple light controlling circuit, PVC conduit wiring.
2. Light control circuit using the two-way switch.
3. Godown wiring, PVC conduit wiring.
4. Wiring of power distribution arrangement using single phase MCB distribution board with ELCB, main switch, and energy meter.
5. Measurement of voltage, current, and power in a single-phase circuit using voltmeter, ammeter, and Wattmeter. Calculation of the power factor of the circuit.

References:

1. Lab manual provided by the concerned faculty in charge.
2. Virtual labs (http://www.vlab.eo.in/)

SEMESTER 2

24-219-0201 LINEAR ALGEBRA AND TRANSFORM TECHNIQUES

L	T	P	C
3	1	0	3

Pre-requisites: Nil

Total Hours: 64

Course Outcomes: On completion of this course the student will be able to:

CO1: Solve linear system of equations and to determine Eigen values and vectors of a matrix.

CO2: Evaluation of limits and continuity, Talyor and Maclaurin series.

CO3: Determine Fourier series expansion of functions and transform.

CO4: Solve linear differential equation and integral equation using Laplace transform.

Mapping of course outcomes with PO's: **Level - Low (1), medium (2) and high (3)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	3	-	1	-	2	-	-	-	-	-	1
CO2	3	3	-	1	-	2	-	-	-	-	-	1
CO3	3	3	-	2	-	2	-	-	-	-	-	1
CO4	3	3	-	2	-	2	-	-	-		-	1

Module 1 (16 Hours, End semester marks 25%)

Linear Algebra 1:

Rank of a matrix, solution of linear system of equations- existence, uniqueness, general form- Eigen values, and Eigen vectors- properties of Eigen values –Diagonalization of a matrix- Cayley Hamilton theorem (without proof) Verification-Finding inverse and power of a matrix using it-Quadratic form-orthogonal reduction of quadratic form to Canonical form.

Module 2 (16 Hours, End semester marks 25%)

Limits and continuity: Definition, mean value theorem, L'Hospitals rule for the evaluation of limits of indeterminate forms.

Series: Definition, Taylor series and Maclaurin series, its applications.

Module 3 (16 Hours, End semester marks 25%)

Fourier Analysis:

Periodic function, Fourier series, Functions of arbitrary period, Even and odd functions, Half Range Expansion, Harmonic analysis, Complex Fourier Series, Fourier Integrals, Fourier

Cosine and Sine Transform, Fourier Transform. Isometric projections: Isometric projections and views of plane figures of simple and truncated solids in simple positions including sphere and hemisphere and their combinations.

Module 4 (16 Hours, End semester marks 25%)

Laplace Transforms: Gamma functions and Beta Function-Definition and properties, Laplace transforms. Inverse Laplace Transform, shifting theorem, Transform of Derivative and Integrals, Solution of differential equation and integral equation using Laplace transform, Convolution, Unit step function, Second Shifting theorem, Laplace transform of periodic function.

References:

1. Erwin Kreyzig, Advanced Engineering Mathematics, 10th Edition, Wiley, 2011.
2. Grewal, B. S., Higher Engineering Mathematics, 43rd Edition, Khanna Publishers, 2013.
3. Linear Algebra and Group Representations: Linear algebra and introduction to group representations, Academic Press, 2022.
4. Hsiung, C.Y. and Mao, G.Y.- Linear Algebra, World Scientfic, 1998.
5. Hoffman, K. and Kunze, R., Linear Algebra, Prentice Hall of India, New Delhi 1971.
6. Exercises in algebra: a collection of exercises, in algebra, linear algebra and geometry, CRC Press, 1996.
7. Venkataraman, M. K., Linear Algebra, The National Co., 1999.
8. Online courses from swayam (https://swayam.gov.in/), Stanford online (https://online.stanford.edu/) and MIT Open Courseware (https://ocw.mit.edu/).

24-219-0202 ENGINEERING CHEMISTRY

L	T	P	C
3	1	0	3

Pre-requisites: Nil

Total Hours: 64

Course Outcomes: On completion of this course the student will be able to:

CO1: Get an understanding of the theoretical principles understanding atomic orbitals and electron distribution, molecular structure, bonding, and properties.

CO2: Discover the importance of electrical energy originating from chemical reactions articulate and utilize corrosion prevention strategies and estimate the corrosion behavior of materials and components.

CO3: Acquire knowledge of various organic reaction mechanisms.

CO4: Develop an ability to design and construct engineering products like fuel cells, batteries, composites, and antistatic materials.

Mapping of course outcomes with PO's: **Level - Low (1), medium (2) and high (3)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	3	3	-	-	-	2	-	-	-	-	3
CO2	3	3	3	-	-	-	2	-	-	-	-	3
CO3	3	3	3	-	-	-	2	-	-	-	-	3
CO4	3	3	3	-	-	-	2	-	-	-	-	3

Module 1 (16 Hours, End semester marks 25%)

Atomic Orbitals: Quantum mechanical model of atom and probability distribution function of hydrogen atom – quantum numbers and atomic orbital filling – LCAO approximation for diatomic molecules like N2 and CO – hybridization and molecular shapes.

Module 2 (16 Hours, End semester marks 25%)

Electrochemistry: Galvanic cells – EMF measurement, classification of electrodes – Nernst equation – Electrode potential cell reaction relation between cell potential and thermodynamic quantities, Ni-Cd cell, Hydrogen – Oxygen fuel cell, electro-chemical corrosion.

Corrosion: Theories of corrosion – Factors influencing corrosion – Corrosion Control – Cathode protection – Protective coatings – Metallic coatings – Hot dipping – electroplating, metal spraying, cladding, Non-metallic coatings – properties and functions of ingredients used in paints, varnishes, Enamels and Lacquers – special paints.

Module 3 (16 Hours, End semester marks 25%)

Organic Chemistry: Aliphatic nucleophilic substitution: S N 1 & S N 2 mechanism, structure, reactivity, kinetics and stereochemistry, applications.

Elimination reactions: E1, E2 & E1cb mechanism, structure, reactivity, kinetics and stereochemistry, applications.

Addition reactions: Additions at carbon-carbon multiple bonds, cis-trans addition, structure and reactivity, applications; additions at carbon-oxygen double bonds, structure and reactivity, applications.

Rearrangement reactions: Allylic rearrangement, pinacol-pinacolone rearrangement, Hofmann rearrangement, Beckman rearrangement.

Module 4 (16 Hours, End semester marks 25%)

Fuels: Classification – Calorific value determination of solids, liquids, and Gaseous fuels – solid fuels, wood, peut, lignite, coal and coke proximate analysis of coal – liquid fuels – petroleum and its refining – fractions and their uses – cracking and reforming – petrol knock and octane number – Diesel knock and octane number – Synthetic petrol – Gaseous fuels – Natural cases – Acetylene Combustion calculation

Lubrication: Classification and properties of lubricants – Production of lubricating oils – Synthetic lubricants.

References:

1. K S Tewari & N K Vishnoi – A textbook of organic chemistry – 3 rd edition
2. F A Carey & R J Sundberg - Advanced organic chemistry
3. James E House – Inorganic chemistry
4. Castallan – Physical chemistry – Addison Wesley.
5. Galsitone and Leivis – Elementary Physical Chemistry.
6. G.S. Munku – Theoretical principles of inorganic chemistry.
7. Hendrickson, Cram and Hammond – Organic Chemistry – McGraw Hill.
8. Morrison and Boyd – Organic chemistry – Prentice Hall India.
9. J.C. Kuriakose and Rajaram – Chemistry in Engineering & Technology, Vol.II
10. P.C. Jain and Monika – Engineering Chemistry
11. L. Munree – Chemistry of Engineering Materials.
12. Online courses from Swayam (https://swayam.gov.in/), Stanford online (https://online.stanford.edu/) and MIT OpenCourseware (https://ocw.mit.edu/).

24-219-0203 ANALOG ELECTRONICS

L	T	P	C
3	1	0	3

Pre-requisites: Basic Electronics

Total Hours: 64

Course Outcomes: After completion of the course, students will be able to demonstrate the ability to:

CO1: Explain the basic MOS physics.

CO2: Analyze transistor amplifiers.

CO3: Explain the concept of feedback and the working of oscillators.

CO4: Understand the operation of power amplifiers and their classification.

Mapping of course outcomes with PO's: **Level - Low (1), medium (2) and high (3)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	3	2	-	-	-	-	-	-	-	-	1
CO2	3	3	2	-	-	-	-	-	-	-	-	1
CO3	3	3	2	-	-	-	-	-	-	-	-	1
CO4	3	3	2	-	-	-	-	-	-	-	-	1

Module 1 (16 Hours, End semester marks 25%)

Energy bands in intrinsic and extrinsic silicon, Fermi levels, PN junction formation-Energy band diagram-barrier formation-changes in band diagram with forward and reverse bias.

Metal Insulator semiconductor devices: The ideal MOS capacitor, band diagrams at equilibrium, accumulation, depletion and inversion, surface potential, CV characteristics, effects of real surfaces, work function difference, interface charge, threshold voltage.

Module 2 (16 Hours, End semester marks 25%)

Two port networks-transistor hybrid model-conversion formulas-transistor amplifier analysis using h-parameters-CE and CC-comparison of configurations-Miller's theorem and its dual cascading-simplified CE, CC configurations-CE amplifier with emitter resistance.

Transistors at high frequencies: hybrid pi CE transistor model-CE short circuit current gain single stage CE amplifier response, Gain-BW product – emitter follower at high frequencies.

Module 3 (16 Hours, End semester marks 25%)

Feedback amplifiers: Concept of feedback-positive and negative feedback-Voltage series, current series, voltage shunt, current shunt-effect of feedback on amplifiers-expressions and derivations- practical circuits.

Oscillators: Basic concepts- Barkhausen criteria, RC and LC oscillators-principle, analysis, and design.

Module 4 (16 Hours, End semester marks 25%)

Power amplifiers: - Classification of power amplifiers - Class A, Class B, Class AB and Class C- push-pull power amplifier - transformer less class AB - complementary symmetry power amplifier -harmonic distortion.

References:

1. Ben G Streetman, Solid State Devices,7th edition, Pearson.
2. V. Suresh Babu, Solid State Devices and Technology,3rd edition, Pearson.
3. Jacob Milman and Christos C. Halkias, Integrated Electronics: Analog and Digital Circuits and Systems, E/2, Tata McGraw-Hill Publishing Co. Ltd.
4. Pulse and Digital Switching Circuits, J. B. Gupta, S. K. Kataria & Sons.
5. Microelectronic Circuits and Devices, Mark A. Horenstein, PHI Learning.
6. Online courses from Swayam (https://swayam.gov.in/), Stanford online (https://online.stanford.edu/) and MIT OpenCourseware (https://ocw.mit.edu/).

24-219-0204 ELECTRICAL ENGINEERING II

L	T	P	C
3	1	0	3

Pre-requisites: Nil

Total Hours: 64

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

CO1: Understand the working principles of transformers, including testing methods and applications.

CO2: Comprehend the working principles of rotating DC machines, their basic characteristics, and applications.

CO3: Explain the working principles of alternators, including starting methods.

CO4: Analyse the working principles of different types of induction motors and their performance.

CO5: Describe the basic methods of electric power generation, distribution, and protection circuits.

Mapping of course outcomes with PO's: **Level - Low (1), medium (2) and high (3)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	2	2	-	-	-	-	-	-	-	-	1
CO2	3	2	1	-	-	-	-	-	-	-	-	1
CO3	3	2	1	-	-	-	-	-	-	-	-	1
CO4	3	2	2	-		-	-	-	-		-	1
CO5	3	2	-	-	-	-	-	-	-	-	-	1

Module 1 (16 Hours, End semester marks 25%)

Transformer: Working principles of ideal transformer – constructional features – emf equation – vector diagram – equivalent circuit – impedance transformation – transformer losses – flux leakage – efficiency – open circuit and short circuit tests – auto transformer – working principle and saving of copper – Basic idea of current transformer and potential transformer.

Module 2 (16 Hours, End semester marks 25%)

Rotating DC Machines: Types of rotating D.C. machines, emf generated in the armature, Torque in DC machine, method of excitation, mmf and flux density wave forms in D.C. machines, commutation process, compensating windings, magnetisation curve. Effect of armature mmf on DC machine calculations. Operating characteristics of DC generators and motors. DC motor starting, speed control of DC machines and DC machine applications.

Module 3 (16 Hours, End semester marks 25%)

Alternator: rotating field, speed, and frequency – effect of distribution of winding – emf equation – losses and efficiency regulation – emf and mmf methods. Synchronous motor – torque equation – starting methods – effect of over/under excitation.

Induction motor: Three phase induction motor – constructional features – principle of operation – Vector Diagram and equivalent circuits – performance calculation using circle diagram – starting and speed control of squirrel cage and wound rotor induction motor.

Principle of operation of single-phase induction motor, stepper motor, universal motor, and Hysteresis motor.

Module 4 (16 Hours, End semester marks 25%)

Generation and distribution of electric power: Introduction to hydroelectric, thermal, nuclear, diesel and gas power stations. Elements of transmission and distribution of electric power – Practical working voltages – underground systems and overhead systems – Typical power scheme – Different systems of transmission and circuits – Different types of line insulators used.

Switchgear and protection: Requirement of circuit breaker, basic principle of operation of circuit breakers and types of circuit breakers.

References:

1. P.S. Bimbhara – Electrical Machinery (Edition seven) – Khanna Publishers (1977)
2. S.L. Uppal – Electrical Power Systems (Generation, Transmission, Distribution, Protection and Utilization of Electrical Energy) (Fifteenth Edition) – Khanna Publishers (1987)
3. I. J. Nagrath and D. P. Kothari - Electrical Machines (Fifth Edition), Tata McGraw Hill Publishers (2017).
4. J.B Gupta - Course in Power Systems - S K Kataria and Sons (2013).
5. B L Theraja, AK Theraja - Textbook Of Electrical Technology: Ac And Dc Machines (volume - 2) (Twenty third Edition)- S Chand (1959)
6. Online courses from Swayam (https://swayam.gov.in/), Stanford online (https://online.stanford.edu/) and MIT OpenCourseware (https://ocw.mit.edu/).

24-219-0205 ENGINEERING MECHANICS

L	T	P	C
3	1	0	3

Pre-requisites: Nil

Total Hours: 64

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

CO1: Understand the principles of mechanics (statics and dynamics), the concept of free body diagrams and resolution of forces.

CO2: Understand the concept of moment of inertia, stress and strain.

CO3: Understand the concept of virtual work, dynamics, kinematics and kinetics.

CO4: Analyse the problems under curvilinear translation motion and rotation of rigid bodies.

Mapping of course outcomes with PO's: **Level - Low (1), medium (2) and high (3)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	2	1	-	-	-	-	-	-	-	-	1
CO2	2	3	1	-	-	-	-	-	-	-	-	1
CO3	2	3	2	-	-	-	-	-	-	-	-	1
CO4	2	2	3	-	-	-	-	-	-	-	-	1

Module 1 (16 Hours, End semester marks 25%)

Introduction to Mechanics: Definition and classification of mechanics – rigid body (statics and dynamics) and deformable body mechanics.

Forces and Force systems: Force and its characteristics, principles of statics – concept of resultant and equilibrant, composition, and resolution of forces force systems.

Coplanar concurrent force system: Equilibrium of two, three and more than three forces, moment of a force, Varignon's theorem of moments, equations of equilibrium, friction and its effects on bodies, engineering applications.

Coplanar parallel force system: Two parallel forces, general case of parallel forces in a plane, centre of parallel forces, centre of gravity, centre of mass, centroids of curves, areas and volumes– regular and composite. Pappu's theorems, equilibrium of distributed forces in a plane, applications of the concept of centroid in engineering practice.

Module 2 (16 Hours, End semester marks 25%)

Moment of Inertia: Concept of moment of inertia and second moment of area, moment of inertia of regular and composite solids, second moment of area of regular and irregular surfaces, Polar moment of inertia / second moment of area, product of inertia, principal moments of inertia and principal axes, applications of the concepts in engineering practice.

Concepts of stress and strain - Hooke's law, elastic constants - thermal strain - shear stress and strain.

Module 3 (16 Hours, End semester marks 25%)

Principle of virtual work: Concept of virtual work and the principle of virtual work, applications in engineering, equilibrium of ideal systems, stable and unstable equilibrium.

Introduction to Dynamics: Definitions, units, divisions – kinematics, kinetics.

Rectilinear translation: Kinematics of rectilinear motion – displacement, velocity, acceleration, kinetics – differential equations of motion, D'Alembert's principle in rectilinear translation and its applications, motion of a particle due to a constant force, motion of a particle due to a force proportional to displacement – simple harmonic motion, momentum and impulse, work and energy, conservation of energy, collision of two bodies – direct central impact.

Module 4 (16 Hours, End semester marks 25%)

Curvilinear translation: Kinematics of curvilinear translation – components of displacement, velocity and acceleration, normal and tangential acceleration, kinetics – differential equations of motion, motion of projectile – projection on horizontal and inclined surfaces, D'Alembert's principle in curvilinear motion and its applications, moment of momentum, work, and energy in curvilinear motion.

Rotation of a rigid body: Kinematics of rotation – angular displacement, velocity and acceleration, RPM, relations of kinematic parameters of linear and angular motions, kinetics – differential equations of motion of a rigid rotating about a fixed axis, rotation under the action of a constant moment, rotation proportional to angular displacement – compound pendulum, D'Alembert's principle in rotation, resultant inertia force in rotation, principle of angular momentum in rotation, energy equation for rotating bodies.

References:

1. S. Timoshenko, D.H. Young, J.V. Rao, Sukumar Pati, "Engineering Mechanics" 5th Edition 2017, McGraw Hill Education ISBN-10: 9781259062667, ISBN-13: 978-1259062667.
2. Dr. Biju N "Engineering Mechanics Statics & Dynamics" 2nd Edition, Educational Publishers and Distributors, ISBN-10: 8187198214, ISBN-13: 978-8187198215.
3. Ferdinand P. Beer, E. Russell Johnston Jr., David Mazurek, Philip J. Cornwell, "Mechanics for Engineers, Volume 1: Statics", 10th Edition 2023, McGraw-Hill Education, ISBN-10: 1337925230, ISBN-13: 978-1337925231.
4. Ferdinand P. Beer, E. Russell Johnston Jr., David Mazurek, Philip J. Cornwell, "Mechanics for Engineers, Volume 2: Dynamics", 10th Edition 2023, McGraw-Hill Education, IISBN-10: 1337925206, ISBN-13: 978-1337925200.
5. J. L. Meriam, L. G. Kraige, James L. Meriam "Engineering Mechanics, Volume 1: Statics" 7th Edition 2017, John Wiley & Sons, ISBN-10: 1118597228, ISBN-13: 978-1118597222.
6. J. L. Meriam, L. G. Kraige, James L. Meriam "Engineering Mechanics, Volume 2: Dynamics" 7th Edition 2017, John Wiley & Sons, ISBN-10: 111859718X, ISBN-13: 978-1118597180.

7. S. Rajasekaran and G. Sankarasubramanian, "Fundamentals of Engineering Mechanics", 3rd Edition, 2017, Vikas Publishing House Pvt. Ltd., New Delhi, ISBN-10: 8125918655, ISBN-13: 978-8125918653.
8. R.C. Hibbeler, "Engineering Mechanics, Volume 1: Statics", 15th Edition 2023, Pearson Education Asia Pvt. Ltd., New Delhi, ISBN-10: 9789355540255, ISBN-13: 9789355540255.
9. R.C. Hibbeler, "Engineering Mechanics, Volume 2: Dynamics", 15th Edition 2023, Pearson Education Asia Pvt. Ltd., New Delhi, ISBN-10: 9789355540262, ISBN-13: 9789355540262.
10. Online courses from swayam (https://swayam.gov.in/), Stanford online (https://online.stanford.edu/) and MIT OpenCourseware (https://ocw.mit.edu/).

24-219-0206 NETWORK THEORY

L	T	P	C
3	1	0	3

Pre-requisites: Nil

Total Hours: 64

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

CO1: Analyze linear time-invariant electrical networks.

CO2: Apply time-domain, phasor, and Laplace transform methods for linear circuit analysis.

CO3: Investigate the transient response of networks under test signals.

CO4: Understand the principles of resonance, coupled circuits, and two-port networks.

Mapping of course outcomes with PO's: **Level - Low (1), medium (2) and high (3)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	3	-	-	-	-	-	-	-	-	-	1
CO2	3	3	2	-	-	-	-	-	-	-	-	1
CO3	3	3	2	2	-	-	-	-	-	-	-	1
CO4	3	3	2	2	-	-	-	-	-		-	1

Module 1 (16 Hours, End semester marks 25%)

Introduction to circuit variables and circuit elements, Kirchhoff's Laws, Independent and dependent Sources, Network topology, Network graphs, Trees, Incidence matrix, Tie-set matrix, and Cut-set matrix.

Solution methods applied to dc and phasor circuits: Mesh and node, analysis of network containing independent and dependent sources.

Module 2 (16 Hours, End semester marks 25%)

Network theorems applied to dc and phasor circuits: Thevenin's theorem, Norton's theorem, Superposition theorem, Reciprocity theorem, Millman's theorem, Maximum power transfer theorem.

Laplace transform, properties, Laplace Transforms and inverse Laplace transform of common functions, Important theorems: Time shifting theorem, Frequency shifting theorem, Time differentiation theorem, Time integration theorem, s domain differentiation theorem, s domain integration theorem, Initial value theorem, Final value theorem.

Module 3 (16 Hours, End semester marks 25%)

Partial Fraction expansions for inverse Laplace transforms, Solution of differential equations using Laplace transforms Transformation of basic signals and circuits into s-domain.

Transient analysis of RL, RC, and RLC networks with impulse, step, pulse, exponential and sinusoidal inputs, Analysis of networks with transformed impedance and dependent sources.

Module 4 (16 Hours, End semester marks 25%)

Network functions for the single port and two ports, properties of driving point and transfer functions, Poles and Zeros of network functions, Significance of Poles and Zeros, Time domain response from pole zero plot, Impulse Response Network functions in the sinusoidal steady state, Magnitude and Phase response.

Parameters of two port network: impedance, admittance, transmission and hybrid parameters, Interrelationship among parameter sets Series and parallel connections of two port networks Reciprocal and Symmetrical two port network Characteristic impedance, Image impedance and propagation constant (derivation not required)

References:

1. Ravish R., Network Analysis and Synthesis, 2/e, McGraw-Hill, 2015.
2. Valkenburg V., Network Analysis, 3/e, PHI, 2011.
3. Sudhakar A,S. P. Shyam Mohan, Circuits and Networks- Analysis and Synthesis, 5/e, McGraw-Hill, 2015.
4. Choudhary R., Networks and Systems, 2/e, New Age International, 2013.
5. Franklin F. Kuo, Network Analysis and Synthesis, 2/e, Wiley India, 2012.
6. Pandey S. K., Fundamentals of Network Analysis and Synthesis, 1/e, S. Chand, 2012.

24-219-0207 COMPUTER PROGRAMMING

L	T	P	C
1	1	1	2

Pre-requisites: Nil

Total Hours: 48

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

CO1: Solve problems efficiently by choosing loops and decision-making statements programming.

CO2: Implement different operations on arrays.

CO3: Solve problems using functions and recursion.

CO4: Design and implement C programs using the concepts of structure, pointers, and files.

Mapping of course outcomes with PO's: **Level - Low (1), medium (2) and high (3)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	2	1	-	-	-	-	-	-	2	1	-	-
CO2	1	2	-	-	-	-	-	-	1	-	-	-
CO3	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	-	3	1	-	-	-	-	-	1	3	3

Cycle I

C Programming Basics:

1. To write a program to calculate and display areas of rectangle and triangle.

Decision Making:

2. To write a program for electricity bill preparation.
3. To write a program to find the roots of a quadratic equation.
4. To write a simple menu driven calculator program using switch statement.
5. To write a program to find the sum of digits of a given number.

Cycle II

Looping:

6. To write a program to print all the prime numbers of a given range.
7. To write a program to print the sine and cosine series.
8. To write a program to print Pascal's triangle.

Arrays:

9. To write a program to print the sum and average of elements in an array.

10. To write a program to sort the given numbers using bubble sort.

11. To write a program to perform Matrix addition and matrix multiplication.

String:

12. To write a program to perform string manipulation functions like string concatenations, comparison, find the length and string copy without using library functions.

13. To write a program to arrange names in alphabetical order.

Cycle III

Functions:

14. To write a C program to calculate the mean, variance and standard deviation using functions.

15. To write a C program to perform sequential and binary search using functions.

Recursion:

16. To write a program to print the Fibonacci series using recursive function.

17. To write a program to print the factorial of the given number using recursive function.

Structure:

18. To print the mark sheet of n students using structures.

Pointers:

19. To write a program using pointers to access the elements of an array and count the number of occurrences of the given number in the array.

Files:

20. To write a program to count the number of characters and lines in a file.

References:

1. Pradip Dey and Manas Ghosh, Computer Fundamentals and Programming in C, Second Edition, Oxford University Press, (2013).
2. Smarajit Ghosh, All of C, PHI Learning Pvt. Ltd, (2009).
3. Byron Gottfried, Programming with C, 2 nd edition, Tata McGraw-Hill, (2006).
4. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Second Edition, Pearson Education, (2001).
5. Sukhendu Dey, Debobrata Dutta, Complete Knowledge in C, Narosa Publishing House, New Delhi, (2009).
6. Virtual labs (http://www.vlab.co.in/)

24-219-0208 BASIC ELECTRONICS LAB

L	T	P	C
0	0	3	1

Pre-requisites: 24-219-0103 Basic Electronics

Total Hours: 48

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

CO1: Remember how to identify different electronic components and read its specification.

CO2: Read electronic circuits drawn using IEEE standard symbols

CO3: Understand testing of various electronic components.

CO4: Properly use electronic testing and measurement instruments in the laboratories.

CO5: Understand the characteristics of electronic components such as diodes, BJTs and FETs.

Mapping of course outcomes with PO's: **Level - Low (1), medium (2) and high (3)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	-	-	2	2	-	2	-	-	-	-	-	-
CO2	-	-	-	2	-	2	-	-	-	-	-	-
CO3	3	3	-	-	-	3	-	-	-	-	-	-
CO4	-	3	3	-	-	3	-	-	-	-	-	-
CO5	-	-	2	2	-	2	-	-	-	-	-	-

List of exercises (18 hours, End semester marks 40%)

1. Familiarization/ identification of electronic components with specification: functionality, type, size/ value, colour coding, package etc. of components such as resistors, capacitors, inductors, ICs, switches, relays, crystals, displays, heat sinks etc.

2. Understanding IEEE symbols for electronic components in drawings.

3. Familiarization of electronic test and measurement instruments such as multi-meter, function generator, power supply, oscilloscope etc.

4. Testing of electronic components such as resistor, capacitor, diode, transistor, UJT and FET

5. Soldering practice: assemble a full wave rectifier using transformer, diodes, capacitor, and Zener diode on a general-purpose PCB.

List of experiments (30 hours, End semester marks 60%)

1. Characteristics of diode

2. Characteristics of Zener diode

3. Transistor characteristics in CB configuration

4. Transistor characteristics in CE configuration

5. Bias and bias stabilization

6. FET characteristics

7. Design of FET amplifiers – frequency response

References:

1. The faculty in charge will provide lab manual

2. Virtual labs (http://www.vlab.co.in/)

COCHIN UNIVERSITY OF SCIENCE AND TECHNOLOGY

COCHIN – 682 022

CURRICULUM AND SYLLABUS

of

M.TECH. DEGREE PROGRAMME IN INSTRUMENTATION TECHNOLOGY

offered by

Department of Instrumentation

Cochin University of Science And Technology

(With effect from 2024 Admission)

CURRICULUM FOR M.TECH. IN INSTRUMENTATION TECHNOLOGY

SEMESTER I

Sl. No.	Course code	Name of the course	Core/ Elective	Credits	Hours per week			Marks
					L	T	P	
1	24-473-0101	Soft Computing Techniques in Instrumentation	C	3	3	1	-	100
2	24-473-0102	Data Acquisition and Hardware Interfaces	C	3	3	1	-	100
3	24-473-0103	Optimal and Robust Control	C	4	4	1	-	100
4	24-473-0104	Sensor Technology Lab	C	1	-	-	3	50
5	24-473-0105	Control system and Computing Lab	C	1	-	-	3	50
6		Elective - I	E	3	3	1	-	100
7		Elective - II	E	3	3	1	-	100
Total				18				600

List of Electives

1. 24-473-0106 Advanced Digital Signal Processing
2. 24-473-0107 Process Dynamics and Control
3. 24-473-0108 Advanced Analytical Instruments
4. 24-473-0109 Optimisation Techniques
5. 24-473-0110 Robotics and Automation
6. 24-473-0111 Non Linear Control Systems
7. 24-473-0112 Advanced Biomedical Instruments
8. 24-473-0113 Adaptive Control Theory

CURRICULUM FOR M.TECH. IN INSTRUMENTATION TECHNOLOGY

SEMESTER I

Sl. No.	Course code	Name of the course	Core/ Elective	Credits	Hours per week			Marks
					L	T	P	
1	24-473-0201	Advanced Multi-sensor Data Fusion	C	3	3	1	-	100
2	24-473-0202	Wireless Sensor Networks	C	3	3	1		100
3	24-473-0203	Seminar	C	1	-	-	3	50
4	24-473-0204	Soft computing Lab	C	1	-	-	3	50
5	24-473-0205	Advanced Process control Lab	C	1	-	-	3	50
6		Elective - III	E	3	3	1	0	100
7		Elective - IV	E	3	3	1	0	100
8		Elective V	E	3	3	1	0	100
Total				18				

List of Electives

1. 24-473-0206 Digital Image Processing
2. 24-473-0207 Mechatronics
3. 24-473-0208 MEMS and Microsystems
5. 24-473-0209 Optoelectronics and Instrumentation
6. 24-473-0210 Non Destructive Testing and Analysis.
7. 24-473-0211 Navigation Guidance and Control
8. 24-473-0212 Embedded System Design
9. 24-473-0213 Remote Sensing and Geographical Information Systems
10. 24-473-0214 Internet of Things.
11. 24-473- 0215 Fractional Order System and Control

CURRICULUM FOR M.TECH. IN INSTRUMENTATION TECHNOLOGY

SEMESTER III

Sl. No.	Course code	Name of the course	Core/Elective	Credits	Marks
1	24-473-0301	Open Elective- I*	E	3	100
2	24-473-0302	Project Progress Evaluation	C	15	400
Total				18	500

CURRICULUM FOR M.TECH. IN INSTRUMENTATION TECHNOLOGY

SEMESTER IV

Sl. No.	Course code	Name of the course	Core/Elective	Credits	Marks
1	24-473-0401	Open Elective - II*	E	3	100
2	24-473-0402	Project Dissertation Evaluation	C	15	400
Total				18	500

***** The students shall select these courses from the list of courses available from approved national agencies such as SWAYAM, subject to the approval of the department council. The students are responsible to pay the course fee, if any, attend these online courses, pass the exam and produce the certificate. The percentage of marks/credit will be given according to the marks obtained in the above examination.

Total credits for the course = 18+18+18+18 = 72

Program Outcomes (POs)

POs are statements that describe what students are expected to know and be able to do upon graduating from the program. These relate to the skills, knowledge, analytical ability, attitude and behaviour that students acquire through the program.

The POs essentially indicate what the students can do from subject-wise knowledge acquired by them during the program. As such, POs define the professional profile of a graduate of PG Engineering Program.

NBA has defined the following three POs for a graduate of PG Engineering Program:

i) PO1: An ability to independently carry out research /investigation and development work to solve practical problems.

ii) PO2: An ability to write and present a substantial technical report/document.

iii) PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

24-473-0101 SOFT COMPUTING TECHNIQUES IN INSTRUMENTATION

L	T	P	C
3	1	0	3

Pre-requisites: Nil

Total Hours: 64

Course Objectives:

To provide the student with the basic understanding of neural networks and fuzzy logic fundamentals, Program the related algorithms and design the required and related systems.

To understand the fundamental theory and concepts of neural networks, several neural network paradigms and its applications.

To understand the basics of an evolutionary computing paradigm known as genetic algorithms and its application to engineering optimization problems

Course Outcomes

After the completion of the course, the student will be able to –

CO 1. Define basic concepts of neural networks and fuzzy systems.

CO 2. Develop and train different supervised and unsupervised learning.

CO 3. Classify various nature inspired algorithms according to their application aspect.

CO 4. Analyze and compare the efficiency of various hybrid systems.

CO 5. Design a soft computing model for solving real world problems.

CO-PO Mapping

PO	**CO 1**	**CO 2**	**CO 3**	**CO 4**	**CO 5**
PO 1	2	1	3	2	3
PO 2	2	2	2	1	3
PO 3	3	3	3	3	3

MODULE I

Introduction to Soft Computing: Soft Computing v/s Hard Computing, Human brain and the biological neuron, Artificial Neurons, Neural Networks and architectures, feed forward and feedback architectures, Terminologies of ANNs McCulloch-Pitts Neurons, Linear Separability, Learning Rules, Hebb Network, Supervised Learning Networks: Introduction, Perceptron Networks, LMS, Back Propagation Networks, Fast variants of Back propagation.

MODULE II

Support vector machines, RBFNNs, learning in RBFNNs, Image classification application, PNNs, Associative learning, associative memory, Hopfield memory, Simulated annealing and the Boltzmann Machine, BAM, ART principles, Self-Organizing Maps.

Statistical pattern recognition perspective of ANNs: Bayes theorem, implementing classification decisions with the Bayes theorem, interpreting neuron signals as probabilities,

MODULE III

Fuzzy Sets, Fuzzy Membership Functions, Operations on Fuzzy Sets, Fuzzy Relations, Fuzzy rules, Fuzzy Reasoning, Defuzzification: Lambda-Cuts for Fuzzy sets (Alpha Cuts), Lambda-Cuts for Fuzzy Relations. Fuzzy Inference System: Introduction, Mamdani Fuzzy Model, Takagi-Sugeno Fuzzy Model.

Neural Networks and Fuzzy logic, Fuzzy neurons, Fuzzy perceptron, Fuzzy classification networks using Backpropagation, Fuzzy ART, Adaptive Neuro fuzzy inference system (ANFIS)

MODULE IV

Evolutionary Algorithm, Traditional optimization and Search Techniques, Basic Terminologies in GA, Operators in Genetic Algorithm, Stopping Condition for Genetic Algorithm Flow, Classification of Genetic Algorithm, Comparison with Evolutionary algorithm, Application of Genetic algorithm.

Swarm Intelligent Systems: Ant Colony Systems (ACO): Biological concept, artificial systems, Applications, Particle Swarm Intelligent Systems – PCO method, Applications.

MODULE V

Differential Evolution (DE) Algorithm, Artificial Bee Colony (ABC) Algorithm, Cuckoo Search (CS), Firefly Algorithm (FA), Immune Algorithm (IA), Grey Wolf Optimization (GWO), Spider Monkey Optimization.

Application of Soft Computing Techniques, Image Fusion, Traveling SalesMan Problem, Flexible Robots, GA Based internet search techniques.

REFERENCES

1. Principles of Soft Computing, S. N. Sivanandam and S. N. Deepa , Wiley Neural Networks (2018)
2. Fuzzy Logic and Genetic Algorithms: Synthesis and Applications- S. Rajasekaran &G.A. Vijayalakshmi Pai, PHI. (2017)
3. Introduction to Soft Computing Neuro-Fuzzy and Genetic Algorithms, Samir Roy and Udit Chakraborty, Pearson. (2013)
4. Neural Networks and Learning Machines-Simon Haykin PHI. (2022)
5. Fuzzy Logic and Engineering Application, Tomthy Ross, TMH. (2011)
6. Evolutionary Optimization Algorithms, D. Simon Wiley. (2013),
7. Fundamentals of Natural Computing: Basic Concepts, Algorithms, and Applications, L.N. de Castro, CRC Press. (2012)

8. Nature-inspired Computing Design, Development, and Applications, Leandro Nunes De Castro Medical Information Science Reference (2012)

9. Neural Networks, A Class room approach, Satish Kumar, Tata McGraw Hill, (2017)

10. Artificial Intelligence and Intelligent Systems, N.P Padhy, Oxford University Press, (2005).

24-473-0102 DATA ACQUISITION AND HARDWARE INTERFACES

L	T	P	C
3	1	0	3

Pre-requisites: Nil
Total Hours: 64

Course Outcomes: After completion of this course, the student will be able to

CO1: Understand the basics of various bus topology and computer interfacing.

CO2: Comprehensively analyze signal conditioning, signal conversion, data acquisition, and signal processing.

CO3: Utilize A/D and D/A converter in various applications.

CO4: Acquainted with various data acquisition methods and Interface Standards and PC buses.

CO5: Integrate and program various distributed and stand-alone Loggers.

Mapping of course outcomes with program outcomes

	CO 1	CO 2	CO 3	CO4	CO5
PO1	2	1	-	2	3
PO2	1	2	-	1	1
PO3	3	3	-	3	2

Module 1

Fundamentals of Data Acquisition: Transducers and sensors - Field wiring and communications cabling - Signal conditioning - Data acquisition hardware - Data acquisition software - Host computer - Essentials of computer interfacing –Configuration and structure – interface systems - Interface bus.

Data acquisition and control system configuration: Computer plug-in I/O - Distributed I/O - Stand-alone or distributed loggers/controllers - IEEE 488 (GPIB) remote programmable instruments.

Design of Signal Conditioning Circuit: Signal amplifiers, Analog filters, Digital and pulse train conditioning, Two-wire transmitter, and Distributed I/O - High-speed digital transmitter, Noise reduction and isolation.

Module 2

Plug-in data acquisition boards:

A/D boards: Multiplexers, Input signal amplifier, Channel-gain arrays, Sample and hold circuits, A/D converters, Memory (FIFO) buffer, Timing circuitry, and Expansion bus interface.

Single vs. Differential signals - Resolution, dynamic range, and accuracy of A/D boards - Sampling techniques - Speed vs throughput.

D/A boards: Digital to analog converters, Parameters of D/A converters, Functional characteristics of D/A boards, Memory (FIFO) buffer, Timing circuitry, Output amplifier buffer, and Expansion bus interface.

Digital I/O boards - Interfacing digital inputs/outputs - Counter/timer I/O boards.

Module 3

Interface Standards and PC Buses: Transmission modes – simplex and duplex - RS-232-C interface standard: Electrical signal characteristics, Interface mechanical characteristics, Functional description of the interchange circuits, The sequence of operation of the EIA-232 interface, Examples of RS-232 interfaces, and Main features of the RS-232 Interface Standard. RS422 - RS485 - 20 mA current loop – Comparison between RS-232, RS422, and RS485 - GPIB. USB: USB overall structure, the physical layer, the data link layer, and the application layer. Firewire; Backplane buses - PCI, PCI-Express, PXI, PXI – Express, VME, VXI; Ethernet – TCP/IP protocols.

Module 4

Distributed and Stand-alone Loggers: Introduction **-** Methods of operation: Programming and logging data using PCMCIA cards, stand-alone operation, direct and remote connection to host PC – power management circuitry. - Stand-alone logger/controller hardware - Communications hardware interface - Stand-alone logger/controller firmware - Stand-alone logger/controller software design - Host software - Stand-alone logger/controllers vs internal systems.

IEEE 488 Standard: Introduction - Electrical and mechanical characteristics - Physical connection configurations - Device types - Bus structure - GPIB handshaking - Device communication - IEEE 488.2 - Standard commands for programmable instruments (SCPI).

Module 5

Ethernet and LAN Systems: Ethernet and field buses for data acquisition - Physical layer - Medium access control - MAC frame format - Difference between 802.3 and Ethernet - Reducing collisions - Ethernet design rules - Fieldbuses.

Virtual Instrumentation: Virtual instrument and traditional instrument - Hardware and software for virtual instrumentation - Virtual instrumentation for test, control, and design - Graphical system design - Graphical, and textual programming - DAQ hardware configuration - DAQ hardware - Analog I/O, Counters, Digital I/O - DAQ Software Architecture - DAQ assistant - Selecting and configuring a data acquisition device - components of a computer-based measurement system.

References:

1. Ramon Pallas-Areny and John G Webster, Sensors and Signal Conditioning, 2012, 2nd ed., Wiley India Pvt. Ltd.
2. John Park and Steve Mackay, Practical Data Acquisition for Instrumentation and Control, 2011, 1st ed., Newness publishers, Oxford, UK.
3. Maurizio Di Paolo Emilio, Data Acquisition systems- from Fundamentals to Applied Design, 2013, 1st ed., Springer, New York.
4. Robert H King, Introduction to Data Acquisition with LabVIEW, 2012, 2nd ed., McGraw Hill, New York.
5. Jerome, PHI Virtual Instrumentation using LabVIEW, Jovitha, ISBN 978-81-203-40305, 2010.
6. Gary Johnson - Labview Graphical Programming, Second edition, McGraw Hill. 1997.

24-473-0103 OPTIMAL AND ROBUST CONTROL

L	T	P	C
4	1	0	4

Pre-requisites: Nil

Total Hours: 64

Course Outcomes:

After completion of this course, the student will be able to

CO1: Apply the various concepts in the mathematical area of 'calculus of variation' for solving optimal control problems.

CO2: Develop methods of problem formulation pertaining to optimal control and design of optimal controllers

CO3: Analyze robustness of systems and develop skills useful in controlling systems when accurate mathematical models are unavailable

CO4: Design and synthesis robust controllers for practical systems

Mapping of course outcomes with program outcomes

	CO1	CO2	CO3	CO4
PO 1	3	3	3	3
PO 2	1	1	1	1
PO 3	3	3	3	3

MODULE 1:

Calculus of variations: Examples of variational problems, Basic calculus of variations problem, Weak and strong extrema, Variable end point problems, Hamiltonian formalism and mechanics: Hamilton's canonical equations.

From Calculus of variations to Optimal control :Necessary conditions for strong extrema, Calculus of variations versus optimal control, optimal control problem formulation and assumptions, Variational approach to the fixed time, free end point problem. The Pontryagin's Minimum principle: Statement of Minimum principle for basic fixed endpoint and variable end point control problems, Proof of the minimum principle, Properties of the Hamiltonian, Time optimal control problems. Minimum energy problems.

MODULE 2:

Linear Quadratic Regulator: Finite horizon LQR problem-Candidate optimal feedback law, Ricatti differential equations (RDE), Global existence of solution for the RDE. Infinite horizon LQR problem-Existence and properties of the limit, solution, closed loop stability.LQR using output feedback: Output feedback LQR design equations, Closed loop stability, Solution of design equations. Numerical solution of Riccatti Equations-Linear Quadratic tracking control: Tracking a reference input with compensators of known structure, Tracking by regulator redesign, Command generator tracker, Explicit model following design. Linear Quadratic Guassian controller (LQG) and Kalman-Bucy Filter: LQG control equations, estimator in feedback loop,

steady state filter gain, constraints and minimizing control, state estimation using Kalman-Bucy Filter, constraints and optimal control.

MODULE 3:

Robust Control - Control system representations, System stabilities, Co-prime factorization and stabilizing controllers, Signals and system norms, Modeling of uncertain systems - Unstructured Uncertainties-Additive, multiplicative and other forms. Parametric uncertainty, Interval Systems, Structured uncertainties

MODULE 4:

Linear fractional transformation Robust design specifications: Small gain theorem and robust stabilization, Performance considerations, Structured singular values. Design - Mixed sensitivity optimization, 2-Degree of freedom design, Sub-optimal solutions, H2 /H∞ Systems.

MODULE 5:

Loop-shaping design procedures: Robust stabilization against Normalized co-prime factor perturbation, Loop shaping design procedures, μ - Analysis and Synthesis - Consideration of robust performance, μ-synthesis: D – K iteration method, Schur Compliment & Linear Matrix Inequalities: Some standard LMI problems – eigen - value problems, generalized eigen - value problems; Algorithms to solve LMI problems – Ellipsoid algorithm, interior point methods

REFERENCES:

1. D. W.Gu, P. Hr.Petkov and M.M.Konstantinov, 'Robust Control design with MATLAB', Springer, 2005.
2. Alok Sinha, 'Linear Systems-Optimal and Robust Controls', CRC Press, 2007.
3. S. Skogestad and Ian Postlethwaite, 'Multivariable feedback control', John Wiley & Sons, Ltd, 2005.
4. G.E. Dullerud, F. Paganini, 'A course in Robust control theory-A convex approach', Springer, 2000.
5. Kemin Zhou with J.C. Doyle and K. Glover, 'Robust and Optimal Control,' Prentice Hall, 1996.
6. Kemin Zhou, John Comstock Doyle, Keith Glover, 'Robust and optimal control,' PrenticeHall,1996.
7. Kemin Zhou, John Comstock Doyle, Essentials of robust control, Prentice Hall, 1998.
8. Stephen Boyd, Laurent El Ghaoul, Eric Feron, 'Linear Matrix Inequalities in System and ControlTheory', SIAM, 1994.

24-473-0104 SENSOR TECHNOLOGY LAB

L	T	P	C
0	0	3	1

Pre-requisites: Nil

Total Hours: 64

Course Outcomes:

After completion of this course, the student will be able to

CO1: Obtain response characteristics of various sensors and transducers.

CO2: Evaluate the performance of various sensors.

CO3: Design and implement programs in LabView.

CO4: Acquire sensor data with LabView software using different interfacing hardware.

Mapping of course outcomes with program outcomes

	CO1	**CO2**	**CO3**	**CO4**
PO1	2	1	-	2
PO2	1	2	-	1
PO3	3	3	-	3

List of Experiments:

1. Familiarization of LabVIEW.
2. Creating Virtual Instrumentation for simple applications.
3. Programming exercises for loops, clusters, charts and graphs.
4. Programming exercises on arrays and clusters.
5. Programming exercises on SubVI.
6. Programming exercises on case and sequence structures, file Input / Output.
7. Developing voltmeter using DAQ cards.
8. Developing signal generators using DAQ cards.
9. Response characteristics of thermistor.
10. Current measurement using Hall effect transducer.
11. Controller using optical transducer (LDR).
12. Response characteristics and coefficients of RTD.
13. Phase detection electronics circuit for capacitive transducer with 7556 dual timer.
14. Active bridge circuit, active low and high pass filter.

Also, it is expected that the students must learn to use the latest equipment and software so that the industry gets trained engineers.

24-473-0105 CONTROL SYSTEM AND COMPUTING LAB

L	T	P	C
0	0	3	1

Pre-requisites: Nil

Total Hours: 64

Course Outcomes:

After completion of this course, the student will be able to

CO1: Use the software MATLAB and MATLAB Control System Toolbox.

CO2: Represent physical systems as transfer functions and derive open loop and closed loop transfer functions.

CO3: Compare first order and second order systems and its performance.

CO4: Design control components like PID controller, compensator etc.

Mapping of course outcomes with program outcomes

	CO1	CO2	CO3	CO4
PO1	3	3	1	2
PO2	2	2	1	2
PO3	2	3	2	3

List of experiments: (8 -10 experiments to be done)

1. Familiarization with MATLAB and MATLAB Control System Toolbox.
2. Transfer functions
3. Time domain analysis and steady state errors
4. Proportional Integral Derivative Control
5. Stability analysis using Bode plots and Nyquist plots
6. State Space analysis - Controllability, Observability and system gain
7. Pole placement and Root locus
8. Compensation design using Lag, Lead compensators
9. Compensators using Lead – Lag approaches
10. Models of Practical systems like electric Power System
11. Familiarization of digital Control System Analysis
12. Analysis of stability in the digital domain.

Text Book

1. D. Frederick and J. Chow, Feedback control problems using MATLAB, Brooks/Cole Thomson Learning, 2000

References

1. MATLAB documentation.
2. Control System ToolBox documentation
3. Ogata Modern Control Engineering, Tata McGraw Hill, 1998

FIRST SEMESTER ELECTIVES

21-473-0112 ADVANCED BIOMEDICAL INSTRUMENTS

L	T	P	C
3	1	0	3

Pre-requisites: Nil
Total Hours: 64

Course Outcome:
On completion of the course the student will be able to:

- **CO1:** Explain the sources of bioelectric potentials and theory behind biopotential electrodes.
- **CO2:** Describe various medical devices, imaging technologies, and diagnostic techniques used in modern biomedical applications.
- **CO3:** Explain fundamental principles, technology, operation modes, and applications of ultrasonic imaging systems in medical diagnosis and therapy.
- **CO4:** Identify lasers in various medical procedures, including surgery and diagnostics, as well as the advantages and applications of laser technology in healthcare.
- **CO5:** Employ instrumentation in medical thermography, quantitative analysis techniques, as well as computer applications in medicine, including ECG analysis, catheterization laboratories, and patient monitoring systems.

Mapping of course outcomes with program outcomes

	PO 1	**PO 2**	**PO 3**
CO1	1	-	3
CO2	-	-	3
CO3	2	2	3
CO4	2	2	3
CO5	1	-	3

MODULE 1

Development of Biomedical Instrumentation, biometrics, Man-instrument system-components-block diagram, Problems encountered in biomedical measurements. Sources of bioelectric potentials - resting and action potentials -propagation of action potentials bioelectric potentials - examples (ECG, EEG, EMG, ERG, EOG, EGG, etc.) Biopotential electrodes–theory-microelectrodes- skin surface electrodes- needle electrodes - transducers for biomedical applications.

MODULE 2

Heart-Iung machine -Artificial heart valves -Pacemakers and Defibrillators - Anaesthesia machine. Blood cell counter -digital thermometer -Audiometer - Electron Microscope - Ventilator biomaterials.

X- ray machine -Radiography, fluoroscopy -image intensifiers -Conventional X-ray Imaging - Angiography -Computed tomography -linear tomography -tomography scanner- applications. Magnetic Resonance Imaging systems -Basic NMR components.

MODULE 3

Ultrasonic imaging systems -Physics of ultrasonic waves, medical ultrasound. construction of an ultrasonic transducer. different modes of operations of ultrasound -A scan, B scan - Echocardiography (M mode), Real time ultrasonic imaging system, Computer controlled ultrasonic imaging - Applications.

MODULE 4

Laser application in machine -Laser- Pulsed Ruby Laser, Nd- AG laser, Argon Laser, CO_2 laser, Helium-neon laser -applications -Advantages of laser surgery -Laser based Doppler blood flow meter- Endoscope -Cardio scope -Laproscope -Endoscopic laser coagulator cryogenic surgery.

MODULE 5

Medical thermography -Physics of theromography -Themographic equipment - Quantitative medical thermography -Infrared and Microwave Thermography- Medical applications of thermography. Computer applications in Medicine - Computer aided ECG analysis- Computerized Catheterisation Laboratory -Computerised patient monitoring system.

Text Books

1. Leslie Cromwel -Biomedical instrumentation and measurements -Prentice Hall.
2. L.A. Geddes and L.E. Baker -Principles of Applied biomedical instrumentation -John Wiley and sons.

References

1. B. Jacobson and J.G. Webster -Medicine and Clinical Engineering -Prentice Hall of. India
2. Macka Sturat Biomedical telemetering- John Wiley.
3. R.S. Khandpur -Handbook of biomedical engineering -Tata McGraw Hill.

24-473-0113 ADAPTIVE CONTROL THEORY

L	T	P	C
3	1	0	3

Pre-requisites: Nil

Total Hours: 64

Course Outcomes:

After completion of this course, the student will be able to

CO1: Integrate the concepts of norms and spaces to be applied in adaptive control theory

CO2: Apply identification techniques for design of adaptive controller

CO3: Explain direct and indirect adaptive control techniques

CO4: Describe advanced adaptive control methods along with case studies and computer simulations

Mapping of course outcomes with program outcomes

	CO1	CO2	CO3	CO4
PO 1	3	3	-	-
PO 2	-	-	-	3
PO 3	3	3	2	3

Module 1: Preliminaries

Norms and Lp spaces-positive definite matrices-input –output stability-Lp stability-small gain theorem-Positive real functions and stability-Analysis of Dynamical Systems, Analysis of Solutions to Differential Equations, Equilibria and Stability. Invariant Sets. Lyapunov Stability Theory and Performance Analysis., Nonautonomous Systems., LaSalle Extensions, Barbalat Lemma.

Module 2: Adaptive Control Basics

Basic approaches to adaptive control -Applications of adaptive control. Introduction to types of Adaptive Control-Model Reference-Variable Structure-Sliding Mode- Neuro-Fuzzy-Learning Control-Intelligent Control using schematic diagrams and literature survey.

Module 3: Identification

Identification problem- Identification of linear time-invariant systems. Adaptive observers. Sufficient richness condition for parameter convergence. Equation error and output error methods. Gradient and least squares algorithms: Linear error equation. Gradient and normalized gradient algorithms. Least-squares algorithms (batch, recursive, recursive with forgetting factor). Convergence properties. Identification for Control.

Frequency-domain analysis and averaging approximations: Averaging of signals. Averaging theory for one-time scale and two-time scale systems. Applications to adaptive systems.

Module 4: Model Reference Adaptive Control

Indirect adaptive control: Pole placement adaptive control. Model reference adaptive control. Predictive control. Singularity regions and methods to avoid them. Direct adaptive control: Filtered linear error equation. Gradient and pseudo-gradient algorithms. Strictly positive real transfer functions and Kalman-Yacubovitch-Popov lemma. Lyapunov redesign. Passivity theory. Direct model reference adaptive control. One case study of MRAC and computer based design.

Module 5: Methods in Adaptive Control

Adaptive Backstepping, Adaptive Output Feedback Control, Adaptive Neuro Control, Examples of Adaptive Control. One case study and computer simulation.

References:

1. K.J. Astrom and B. Wittenmark, 'Adaptive Control', Addison-Wesley, 2nd edition, 1995.
2. P.A. Ioannou& J. Sun, 'Robust Adaptive Control', Prentice Hall, Upper Saddle River, NJ, 1996.
3. I.D. Landau, R. Lozano, and M. M'Saad, 'Adaptive Control', Springer Verlag, London, 1998.
4. K.S. Narendra and A.M. Annaswamy, 'Stable Adaptive Systems', Prentice-Hall, 1989.
5. S. Sastry and M. Bodson, 'Adaptive Control: Stability, Convergence, and Robustness', Prentice-Hall,1989.
6. https://onlinecourses.nptel.ac.in/noc22_me129/preview

24-473-0201 ADVANCED MULTISENSOR DATA FUSION

L	T	P	C
3	1	0	3

Pre-requisites: Nil

Total Hours: 64

Course Outcomes:

At the end of this course, students will demonstrate the ability to:

CO1: Understand the fundamental principles of sensor data fusion, including the concept of multiple sensors, fusion applications, and the inference hierarchy.
CO2: Analyze and implement algorithms for multi-sensor data fusion, including data association, feature extraction, and identity declaration.
CO3: Gain knowledge and skills in estimation methods such as Kalman filtering, decision-level identity fusion, and Bayesian inference for effective data fusion.
CO4: Acquire expertise in pixel and feature-level image fusion techniques, including image registration, segmentation, target tracking, and performance evaluation metrics.
CO5: Demonstrate the ability to implement and optimize data fusion systems, including decentralized estimation, sensor fusion algorithms, and high-performance data structures, to meet specified dependability and scalability requirements.

CO-PO Mapping

PO	**CO 1**	**CO 2**	**CO 3**	**CO 4**	**CO 5**
PO 1	2	3	2	3	3
PO 2	2	1	2	2	3
PO 3	3	3	3	3	3

MODULE 1

Introduction, Sensors and sensor data, Use of multiple sensors, Fusion applications. The inference hierarchy: output data. Data fusion model. Architectural concepts and issues. Benefits of data fusion, Mathematical tools used: Algorithms, co-ordinate transformations, rigid body motion. Dependability and Markov chains, Meta – heuristics.

MODULE 2

Algorithms for Data Fusion, Taxonomy of algorithms for multi-sensor data fusion. Data association. Identity declaration. Concept of Data Association/ Correlation Problem, Process Model for Correlation, Hypothesis Generation, Hypothesis Evaluation, Hypothesis Selection Techniques

Feature Extraction - examples of image features and signal data features for identity declaration, features available from different sources, Parametric templates, Cluster analysis techniques,, Physical models for identity declaration, Knowledge- based methods and Hybrid techniques for identity declaration, Identity Declaration and Pattern Recognition.

MODULE 3

Estimation, Kalman filtering, practical aspects of Kalman filtering, extended Kalman filters. Decision level identify fusion. Knowledge based approaches. Classical inference, Bayesian inference,

Heuristic methods for identity fusion, Implementation and trade-offs involved in the utilization of different techniques to perform identity fusion

MODULE 4

Pixel and Feature-Level Image Fusion, Concepts and Algorithms. Image Registration. Area-Based Matching. Feature-Based Methods. Transform Model. Resampling and Transformation, Segmentation, Centroid Detection, and Target Tracking with Image Data, Image Noise, Metrics for Performance Evaluation. Pixel-Level Fusion Algorithms. Principal Component Analysis Method, Spatial Frequency, Performance Evaluation, Wavelet Transform, Feature-Level Fusion Methods, Fusion of Appearance and Depth Information, Stereo Face Recognition System, Feature-Level Fusion, Match Score Generation, Illustrative Examples.

MODULE 5

Data information filter, extended information filter. Decentralized and scalable decentralized estimation. Sensor fusion and approximate agreement. Optimal sensor fusion using range trees recursively. Distributed dynamic sensor fusion.

High Performance Data Structures- Tessellated, trees, graphs and function. Representing ranges and uncertainty in data structures. Designing optimal sensor systems within dependability bounds. Implementing a data fusion system.

REFERENCES

1. David L. Hall, Mathematical techniques in Multi-sensor data fusion, Artech House, Boston. (2004)
2. Jitendra R Raol, Data Fusion Mathematics: Theory and Practice, CRC Press, (2016).
3. Liping Yan, Lu Jiang, Yuanqing Xia, Multisensor Fusion Estimation Theory and Application, Springer Nature Singapore (2020)
4. Arthur Gelb, Applied Optimal Estimation, M.I.T. Press. (1998)
5. James V. Candy, Signal Processing: The Model Based Approach, McGraw –Hill Book Company (1986)
6. David L. Hall, Sonya A.H. McMullen, Mathematical Techniques in Multisensor Data Fusion, Second Edition, Artech House, Boston, (2004).
7. R. Brooks and S.S. Iyengar, Multisensor Fusion: Fundamentals and Applications with Software, Prentice Hall Inc., New Jersey, (1998).

8. Thor I. Fossen, Kristin Y. Pettersen, Henk Nijmeijer: Sensing and Control for Autonomous Vehicles: Applications to Land, Water and Air Vehicles, Springer, The Netherlands, (2017).
9. Tom Denton : Automated Driving And Driver Assistance Systems, IMI, NY, (2020).

24-473-0202 WIRELESS SENSOR NETWORKS

L	T	P	C
3	1	0	3

Pre-requisites: Nil

Total Hours: 64

Course Outcomes:

After completion of this course, the student will be able to

CO1: Explain the Fundamental Concepts and applications of wireless sensor networks.

CO2: Explain the architectures, functions, and performance of wireless sensor network systems and platforms.

CO3: Explain various network-level protocols for MAC, routing, time synchronization, aggregation, consensus, and distributed tracking and design issues.

CO4: Explain the various levels of information processing in wireless sensor networks.

CO5: Explain the hardware and software platforms used in the design of WSN.

Mapping of course outcomes with program outcomes

	CO1	CO2	CO3	CO4	CO5
PO1	3	3	3	3	3
PO2	3	3	3	3	3
PO3	3	3	3	3	3

Module 1

Introduction: Introduction and overview of Wireless Sensor Networks (WSN), Commercial and Scientific Applications of WSN, Category of Applications of WSN, Challenges for WSN, Enabling Technologies for WSN.

Module 2

WSN Architecture: Single node Architecture: Hardware Components, Energy Consumption of Sensor nodes, Operating Systems and Execution Environments, Examples of Sensor Nodes, Network Architecture: WSN Scenarios, Optimization Goals and figures of Merits, Design principles for WSNs, Service Interfaces for WSNs, and Gateway Concepts.

Module 3

WSN Protocols: Physical Layer: Wireless Channel and Communication Fundamentals,

Physical Layer & Transceiver Design Considerations in WSN, MAC Protocols: Fundamentals, MAC Protocols for WSNs, IEEE802.15.4 MAC Protocol, Routing Protocols: Gossip and agent based unicast protocols, Energy Efficient Unicast, Broadcast and Multicast, Geographic Routing, Transport Control Protocols: Traditional Protocols, Design Issues, Examples of Transport Protocols.

Module 4

Information Processing: Sensor Tasking and Control: Information-Based Sensor Tasking, Joint Routing Information Aggregation, Sensor Network Databases: Challenges, Query Interfaces, In-Network Aggregation, Data Centric Storage, Data Indices and Range queries, Distributed Hierarchical Aggregation, Temporal Data.

Module 5

Applications and Design of WSN: Target detection and tracking, Habitat monitoring, Environmental disaster monitoring, Practical implementation issues, IEEE 802.15.4 low rate WPAN, Sensor Network Platforms and tools-Sensor node hardware, Node-level software platforms, node –level simulators.

References:

1.	Kazem Sohraby, Daniel Minoli, Taieb Znati, “Wireless Sensor Networks: Technology, Protocols, and Applications”, John wiley & Sons.
2.	Holger Karl, Andreas Willig, “Protocols and architectures for wireless sensor networks”, John wiley & Sons.
3.	Feng Zhao and Leonidas J. Guibas, “Wireless Sensor Networks: An Information Processing Approach”, Elsevier, 2004.
4.	Holger Karl and Andreas Willig, “Protocols and Architectures for Wireless Sensor Networks”, John Wiley, 2007.
5.	Ivan Stojmenovic, “Handbook of Sensor Networks: Algorithms and Architectures”, Wiley, 2005.
6.	Kazem Sohraby, Daniel Minoli and Taieb Znati, “Wireless Sensor Networks: Technology, Protocols and Applications”, John Wiley, 2007.
7.	Bhaskar Krishnamachari, “Networking Wireless Sensors”, Cambridge University Press, 2011.

24-473-0203 SEMINAR

L	T	P	C
0	0	3	1

Pre-requisites: Nil

Total Hours: 64

Course Outcomes:

After completion of this course, the student will be able to

CO1: Carry out a literature survey on new research areas.

CO2: Organize and illustrate technical documentation with sufficient literal standards.

CO3: Abide by professional ethics while reporting findings and stating claims.

CO4: Demonstrate communication skills through the oral presentation using modern presentation tools.

Mapping of course outcomes with program outcomes

	CO1	**CO2**	**CO3**	**CO4**
PO1	2	1	-	2
PO2	1	2	-	1
PO3	3	3	-	3

All the students of II semester will be required to deliver a seminar, on the topic relevant to recent trends in "Control and Instrumentation Systems" using power point presentation.Topics are selected in consultation with their supervisors. Presentation will be of 20 minutes duration followed by a question answer session before a duly constituted evaluation committee of Faculty Members of the department. A report of the seminar in the form of hard copy must also be submitted in the office after approval by the committee.

24-473-0204 SOFT COMPUTING LAB

Course Outcomes:

At the end of this course, students will demonstrate the ability to:

CO1: Illustrate soft computing techniques like neural networks and fuzzy logic and their roles in building intelligent systems.

CO2: Illustrate and implement the various learning rules

CO3: Comprehend the fuzzy logic and the concept of fuzziness involved in various systems and fuzzy set theory.

CO4: Understand the concepts of fuzzy sets, knowledge representation using fuzzy rules, approximate reasoning, fuzzy inference systems, and fuzzy logic

CO5: Design and Implement real-life examples using fuzzy logic and genetic algorithms

CO – PO Mapping

PO	CO 1	CO 2	CO 3	CO 4	CO 5
PO 1	1	1	1	2	3
PO 2	2	2	2	3	2
PO 3	3	3	3	3	3

List of Experiments:

The following experiments are to be demonstrated using any of the software tools like MATLAB, Python etc.

1. Write a program to implement the Perceptron Training Algorithm.
2. Write a program to Implement Hebb's Rule
3. Write a program to Implement Delta Rule
4. Write a program to implement the Back-propagation algorithm
5. Write a program to implement a Hopfield Net
6. Write a program to implement a BAM
7. Write a program to Implement PCA
8. Write a program to Implement SVM
9. Write a program for pattern classification/pattern recognition
10. Write a program to study Fuzzy vs. crisp Logic.
11. Write a program to study and implement fuzzy set operations.

12. Write a program to illustrate the various fuzzy operations
13. Write a program to study and implement fuzzy relational operations.
14. Write a program to design and implement a fuzzy temperature controller.
15. Write a program to design and implement a Fuzzy Traffic light controller.
16. Write a program to study and implement the concept of Fuzzy C – means Clustering.
17. Write a program to implement Genetic Algorithms
18. Write a program to solve TSP (Travelling Salesman Problem) using a genetic algorithm.

24-473-0205 ADVANCED PROCESS CONTROL LAB

L	T	P	C
0	0	3	1

Pre-requisites: Nil

Total Hours: 64

Course Outcomes:

After completion of this course, the student will be able to

CO1: Design and simulate PID controller for various processes.
CO2: Acquire and process data using different data acquisition systems
CO3: Tune the controllers with different methods
CO4: Analyse and implement various advanced control loops
CO5: Analyse the stability of process control systems.
CO6: Implement signal conditioning circuits.

Mapping of course outcomes with program outcomes

	CO1	CO2	CO3	CO4	CO5	CO6
PO1	3	3	3	3	3	2
PO2	3	2	2	3	3	1
PO3	-	-	-	-	-	-

8 -10 Experiments from Both Cycles (4-5 from each)

Cycle - I

1. Design and simulation of PID controller for Temperature process station.

2. To acquire and display a continuously changing physical variable in the system using Lab View/Matlab/ Custom software.

3. Program to implement online data processing and data logging.

4. Experimentation of a Multi process Trainer.

5. To implement discrete control strategy using both analog and digital Siemens PLC.

6. To study on the interface of PLC with PC for data acquisition applications.

7. To develop stand alone executable signal conditioning files as library files in LabView/Matlab.

8. Experimentation of Control loops for Inverted Pendulum.

9. Implementation of Digital PID Controller.

10. Signal Conditioning Circuit for Temperature Measurement.

11. System Identification by the Method of Approximation.

12. Controller tuning by Frequency domain analysis.

Cycle - II:

1. To analyse the stability of a level control system with time delay in frequency domain analysis.

2. To auto tune a PID controller using a relay switch method for process control systems

3. To study the phenomenon of the reset windup and to compensate it with anti reset Windup technique for a first order process.

4. To analyse the stability of the discrete control system and to compare it with the continuous control system using IMC.

5. To study the robustness of the simple first order time delay process with frequency response analysis.

6. Design and simulation of split range controller.

7. Computer calibration of temperature and pressure measuring instruments

8. Design and simulation of cascade controller.

9. Experimental Study of DCS and SCADA in a process control system.

10. To study the action of ON/OFF, P, PI, PID control for pressure process station.

11. Stability analysis of process control systems.

12. Study of performance and automation of a flexible manufacturing trainer.

Text Books

1. Curtis D. Johnson –Microprocessors in Process Control, PHI. 1993 Reference

2. George Stephanooulos Chemical Process Control. 2005

3. Coughner Process Analysis & Control, Tata Mcgraw Hill. – 1991

SECOND SEMESTER ELECTIVES

21-473-0209 OPTOELECTRONICS AND INSTRUMENTATION

L	T	P	C
3	1	0	3

Pre-requisites: Nil
Total Hours: 64

Course Outcome:
After the completion of the course the student will be able to

- **CO1:** Describe the principle and operation of interferometers, and various modulation techniques used in optical systems.
- **CO2:** Outline the basic theory of lasers, including their principles of operation, and their properties.
- **CO3:** Explain the operation of different classes of lasers, their operation principles, and their wide-ranging applications in various fields including industrial, biomedical, and environmental sciences.
- **CO4:** Give an account of fibre optics and various fibre optic components, measurement techniques, and associated equipment such as OTDRs, couplers, splicers, and connectors.
- **CO5:** Illustrate various sensor applications of optical fibers, including their principles, applications, and associated technologies such as fiber Bragg gratings and photonic band gap materials.

Mapping of course outcomes with program outcomes

	PO 1	**PO 2**	**PO 3**
CO1	2	2	3
CO2	2	-	3
CO3	3	2	3
CO4	1	3	3
CO5	1	-	3

MODULE 1

Interferometers – Faby-Perot, Michelson interferometer, Interference filters, optical spectrum analyzer, modulation of light, electro-optic effect, magneto-optic effect and acousto-optic effect

MODULE 2

Lasers- Principle of operation, Einstein relations, population inversion, optical feedback, resonant cavity, laser modes, Q-switching, mode locking, 3 and 4 level systems, properties of lasers.

MODULE 3

Classes of lasers- Solid state, gas lasers, dye lasers and semiconductor lasers, operation and working, lasers applications, holography, industrial biomedical, pollution monitoring

MODULE 4

Optical fiber- Light guidance through fibers, step index fiber, graded index fiber, multi-mode, single mode, numerical aperture, dispersion, losses in fiber, measurement fiber characteristics, OTDR, couplers, splicers, connectors.

MODULE 5

Optical fiber communication system, components, modulation, demodulation, fiber optic sensors, pressure, temperature displacement acceleration strain, fiber bragg grating, photonic band gap materials.

Text Books

1. J. Wilson and J.F Hawkes, Optoelectronics-An introduction, Pentice Hall
2. K. Tyagarajan and A.K.Ghatak, Lasers- Theory and Applications, Springer

24-473- 0215 FRACTIONAL ORDER SYSTEM AND CONTROL

L	T	P	C
3	1	0	3

Pre-requisites: Nil
Total Hours: 64

Course Outcomes:
After completion of this course, the student will be able to

CO1: Understand the fundamentals of fractional-order systems, including the advantages of fractional-order control compared to its integer order counterpart, definitions, properties, and models of fractional-order systems, as well as stability analysis.

CO2: Gain proficiency in state-space representation and analysis techniques for continuous-time LTI commensurate-order systems, including solving state equations, and assessing controllability and observability.

CO3: Develop a deep understanding of fractional-order control theory, including the need for fractional-order control, the design of generalized fractional-order control actions, and the tuning of fractional-order proportional integral derivative (PID) controllers for various plant models.

CO4: Learn the principles of robust control, including the problem statement, H(n) norm, H∞ norm, frequency domain formulation, state-space formulation, robust stabilization, and H2 optimal control.

CO5: Explore non-integer-order robust control techniques, such as CRONE controllers and their different generations, including their definitions, characteristics, and applications in control systems.

Mapping of course outcomes with program outcomes

	CO1	**CO2**	**CO3**	**CO4**	**CO5**
PO 1	3	2	3	2	1
PO 2	3	2	3	2	1
PO 3	3	2	3	2	1

Module 1

Fundamentals of Fractional-order Systems: Advantage of fractional-order system/control over its integer order counterpart, Fractional-order Operators: Definitions and Properties, Fractional-order Differential Equations, Fractional-order Systems-Models and Representations, Stability, Bode's Ideal Loop Transfer Function as Reference System

Module 2

State-space Representation and Analysis: Continuous-time LTI State-space Models, Solution of the State Equation of Continuous LTI Commensurate-order Systems, Controllability of Continuous LTI Commensurate-order, Observability of Continuous LTI Commensurate-order Systems

Module 3

Fundamentals of Fractional-order Control: Need for Fractional-order Control, Generalized Fractional-order Control Actions, Generalized PID Controller, Fractional-order Proportional Integral Controller Tuning for First-order Plus Delay Time Plants, Fractional-order Proportional Derivative Controller Tuning for Motion Systems, Fractional-order Proportional Integral Derivative Controllers.

Module 4

Robust Control: Definition and problem statement, the H(n) norm, H∞ norm, frequency domain formulation, state space formulation robust stabilization H2 optimal control, H∞ control.
Non-integer-order Robust Control: CRONE, First Generation CRONE Controller, Second Generation CRONE Controller, Third Generation CRONE Controller.

Module 5

Implementations of Fractional-order Controllers: Methods and Tools- Continuous-time Implementations of Fractional-order Operators, Frequency Response Fitting of Fractional-order Controllers, Continuous-time Approximation, Time moments of a transfer function, Markov parameters of a transfer function, approximate generalized time Moments (AGTM) & approximate generalized Markov parameters (AGMP), AGTM and AGTM based approximation of fractional-order system.
Numerical Issues and MATLAB Implementations for Fractional-order Control Systems:
Computations in Fractional Calculus, Fractional-order Transfer Functions, Optimum Controller Design for Fractional-order Systems.
Real Applications: Systems Identification, Position Control of a Single-link Flexible Robot

References:

1. C. A. Monje, Y. Chen, B. M. Vinagre, D. Xue, and V. Feliu-Battle, Fractional-order systems and controls : fundamentals and applications. London: Springer-Verlag London Limited, 2010. (Modules I-V)
2. Astrom .K, Adaptive Control, Second Edition, Pearson Education Asia Pte Ltd. (Module IV).
3. Bultheel, A., & Van Barel, M. (1997). Linear Algebra, Rational Approximation and Orthogonal Polynomials (Vol. 6). North-Holland, Elsevier Science; Amsterdam. (Module V).
4. J. Pal, “An algorithmic method for the simplification of linear dynamic scalar systems,” Int. J. Control, vol. 43, no. 1, pp. 257–269, Jan. 1986. (Module V).
5. J. Pal, B. Sarvesh, and M. K. Ghosh, “A new method for model order reduction,” IETE J. Res., vol. 41, no. 5–6, pp. 305–311, Sep. 1995. (Module V).
6. Shantanu Das, Functional Fractional Calculus. Berlin, Germany: Springer, 2011. (Module I, II).

24-473-0301 PROJECT PROGRESS EVALUATION

Course Outcome:

At the end of this course, students will demonstrate the ability to:

CO1: Demonstrate aptitude for research and independent learning.

CO2: Demonstrate the ability to carry out a literature survey and select unresolved problems in the domain of the selected project topic.

CO3: Gain the expertise to use new tools and techniques for design and development.

CO4: Develop the ability to write a good technical report, make an oral presentation of the work, and publish the work in reputed conferences/journals.

CO – PO Mapping

PO	CO 1	CO 2	CO 3	CO 4
PO 1	3	3	2	1
PO 2	1	1	1	3
PO 3	2	3	3	2

The Project is aimed at training the students to analyze any problem in the field of Instrumentation systems independently. The project may be analytical, computational or experimental or a combination of them based on the latest developments in the relevant areas. It should consist of objectives of study, scope of work, critical literature review and preliminary work done pertaining to the seminar undertaken in Semester II.

During the project period, every student has to present the progress of their work before the duly constituted committee of internal teachers of the department. The assessment by the committee members is a part of the term Evaluation. A report of the project in the form of a hard copy must be submitted to the office before the final evaluation at the end of the semester

24-473-0401 PROJECT DISSERTATION EVALUATION

Course Outcome:

At the end of this course, students will demonstrate the ability to:

CO1: Demonstrate aptitude for research and independent learning.

CO2: Demonstrate the ability to carry out literature survey and select unresolved problems in the domain of the selected project topic.

CO3: Gain the expertise to use new tools and techniques for the design and development.

CO4: Develop the ability to write good technical report, to make oral presentation of the work, and to publish the work in reputed conferences/journals.

PO	CO 1	CO 2	CO 3	CO 4
PO1	3	3	2	1
PO2	1	1	1	3
PO3	2	3	3	2

The dissertation is a continuation of the project work done by the student during Semester III. The dissertation report is expected to show clarity of thought and expression, critical appreciation of the existing literature and analytical computation and experimental aptitude of the students as applicable. During the dissertation period, every student has to present the progress of their work before the duly constituted committee of Faculty Members of the department. The assessment by the committee members is a part of the term Evaluation. A report of the dissertation in the form of a hard copy must be submitted in the office at least two weeks before the final viva voce is conducted by the evaluation committee.