UNIVERSITY DEPARTMENTS,
RAJASTHAN TECHNICAL UNIVERSITY, KOTA

Scheme of

UNDERGRADUATE DEGREE COURSE

in

Electronics Instrumentation & Control

University Departments,

Rajasthan Technical University, Kota

Effective from session: 2019 – 2020

(For students admitted in session 2018-19)

Minutes of Meeting
II Meeting (online) of Academic Council, University Departments, RTU, Kota
27 November, 2020, 3:30 pm

Ref. Number: **Date : 28-11-2020**

II Meeting of Academic Council, University Departments, RTU, KOTA was convened through online mode on 27-11-2020 at 3:30 PM using Google Meet under the Chairmanship of Prof. A.K. Mathur, Dean, Faculty Affairs. Following members were present:

1. Prof. B.P. Suneja
2. Prof. Rajiv Gupta
3. Prof. Dinesh Birla
4. Prof. S. R. Kapoor
5. Prof. V.K. Gorana
6. Prof. A.K. Chaturvedi
7. Prof. Vivek Pandey
8. Prof. K.S. Grover
9. Dr. R.K.Bayal
10. Dr S. D. Purohit
11. Dr. Sanju Tanwar
12. Shri Manoj Vaishnav
13. Shri Ashok Patni
14. Dr. Vikas Bansal (Member Secretary)

Following agendas related to academic has been discussed and resolved into the meeting:

Agenda 1: Modifications/ improvement in CBCS regulations for Undergraduate programmes

Looking towards the model curriculum provided by the AICTE and to improve the academics of University Departments, RTU, Kota in the prevailing situations, modifications may be made in the CBCS regulations. A committee was formed for modifications in CBCS regulation as decided in the meeting of Head of Departments held in the month of September 2020. The committee has recommended CBCSUG-2020 after incorporating modifications in CBCSUG-2017. CBCSUG-2020 may be affected from the students admitted in 2020-21 and onwards. Modified regulations (CBCSUG-2020) as enclose in Annexure-1 is submitted herewith for approval. These shall be affected from

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the students admitted in 2020-21 and onwards after approval. Members are requested to approve.

Resolution: The Agenda was approved by the respected members. Following modifications were suggested and approved by the respected members in proposed CBCSUG-2020 by the committee (appointed on September 05, 2020 in the meeting of Head of Departments):

i. Industrial Training (as mentioned in Section 6 and other Sections of the proposed CBCSUG-2020) has been considered as Credit courses in place of non-graded core courses. Therefore, 5 non-graded units have been changed to 5 Credits.

ii. As suggested by HVC, SODECA, which was also non-graded core course (as mentioned in Section 6 and other Sections of the proposed CBCSUG-2020), has also been converted to Credit course. Therefore, 4 non-graded units of SODECA have been changed to 4 Credits of SODECA (Anandam).

iii. Above two changes have been resulted into change in the minimum credit requirement criterion (as mentioned in Section 4 and other Sections of the proposed CBCSUG-2020) for passing the B.Tech. degree. Now, minimum credit requirement is 164 Credits along with 11 non- graded units in place of 155 Credits along with 20 non- graded units as suggested by the committee (appointed on September 05, 2020 in the meeting of Head of Departments).

iv. In ADDITION of grades S and Z (as mentioned in Section 6 and other Sections of the proposed CBCSUG-2020), two more grades V for excellent performance and G for good performance has also been.

v. As mentioned in Appendix-1 and other Sections of the proposed CBCSUG-2020, In first year scheme, Engineering Mechanics and Introduction to Electrical and Electronics Engineering has been replace by Basic Mechanical Engineering, Basic Civil Engineering and Introduction to Electrical and Electronics Engineering. Students of CS, EC, EE, EIC, IT will study Basic Mechanical Engineering and Basic Civil Engineering. Students of CE, PE, PC will study Basic Mechanical Engineering and Introduction to Electrical and Electronics Engineering. Students of AE, ME, PIE will study Basic Civil Engineering and Introduction to Electrical and Electronics Engineering.

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vi. As per the guidelines of AICTE and as suggested and approved in the UDAC meeting, Minor degree or Honours shall be added in the B. Tech. degree on completing courses of extra 20 credits in the inter-disciplinary specialization or Departmental specialization respectively. This provision has been placed in place of the option for both Minor degree and Honours (as mentioned in Section 5, Appendix-3 and other Sections of the proposed CBCSUG-2020) on clearing extra 40 credits as suggested by the committee (appointed on September 05, 2020 in the meeting of Head of Departments).

vii. Therefore, the minimum requirement for obtaining Minor degree or Honours (as mentioned in Section 5, Appendix-3 and other Sections of the proposed CBCSUG-2020) with B. Tech. Degree becomes 184 credit and 11 non-graded units.

viii. List of MOOC courses may also be prepared from the option available to the BOS other than 4 agency prescribed in the proposed CBCSUG-2020 (as mentioned in Section 5 and other Sections of the proposed CBCSUG-2020) by the committee. The list of MOOCS prepared by the BOS shall be approved by Dean UD.

ix. The provision for obtaining the grades in the MOOC COURSES as suggested by the committee and as mentioned in Section 5 and other Sections has been replaced by the following provision as suggested and approved by the Hon'ble members that In House examination / evaluation will be carried out for the MOOC COURSES as held for regular courses. The grading of the MOOC courses will be done on the basis of these examinations/evaluations. A Course Coordinator will be assigned for each MOOC COURSE.

x. Theory and Practical courses will be treated as separate courses.

xi. The provision of 'Self-study course' as mentioned at Sub. Section 4.11 of Section 4 of proposed CBCSUG-2020 has been deferred.

xii. The provision of 'Exit policy' as mentioned at Sub. Section 4.13 of Section 4 of proposed CBCSUG-2020 has been deferred till announced by AICTE and other regulating bodies.

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xiii. Minimum number of students in Departmental Elective has been replaced by 'minimum of 10 or actual number of students admitted' in place of '10' (as mentioned in Section 3.3 and other Sections of the proposed CBCSUG-2020).

Agenda 2: To approve B. Tech. Curriculum applicable for students admitted in 2017-18

In pursuance of the CBCS Regulations, the teaching schemes have been revised form 2017-18 by the concerned BOS, these are placed for kind perusal of members (Annexure 2). Members are requested to approve.

Resolution: The Agenda was approved by the respected members.

Agenda 3: To approve B. Tech. Curriculum applicable for students admitted in 2018-19

In Academic session 2018-19, a revised teaching scheme for I and II semester in line with that in RTU was adopted on recommendation of the BOS and approval of the Vice Chancellor .

In the prevailing market conditions and as per the model curriculum provided by AICTE, it has been discussed in the meeting of Head of Departments held in the month of September 2020 to **include One MOOC courses each in VII and VIII semester aggregating to 7 Credit in the scheme for the students admitted in 2018-19.** 8-10 weeks of MOOC courses shall be considered for 3 credits and 12-16 weeks for MOOC courses shall be considered for 4 credits. A list of the MOOC courses shall be submitted by the respective BOS, two months before the start of the respective semester . The students have to select the MOOC courses from the list provided by the concerned BoS. The MOOCs courses available on the following site/platform will be recognized.

Initiative	Institution Behind Platform	Website Link
NPTEL	IIT Madras	nptel.ac.in/
mooKIT	IIT Kanpur	www.mookit.co/
IITBX	IIT Bombay	iitbombayx.in/
SWAYAM	MHRD and Microsoft	Swayam.gov.in

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Only those MOOCs courses will be considered for fulfilling the requirement of the B.Tech. Degree, which have certification.

The student will inform in writing to respective Head of the Department about the MOOCs courses intended to register from the list provided by concerned BoS at the time of registration of other courses. The HOD shall verify the authenticity of the course as per points mentioned above. The student shall submit the certificate along with the credit earn to the HOD, who will ensure to submit the information about the credit and grade earn by the student during the semester (through the MOOCs courses) at the time of submission of other course grades. Before submitting the grade of MOOC course registered by the student, the HOD shall convert the grade of the MOOC course to the grading system of CBCS of University Departments. For conversion, first the grade of the course shall be converted to equivalent marks using the rules prevalent at the institute offering the MOOC course and then marks shall be converted to equivalent grade of CBCS of University Departments.

In pursuance of the CBCS Regulations, the revised teaching schemes are placed for kind perusal of members (Annexure 3). Members are requested to approve.

Resolution: The Agenda was approved by the respected members after having following modifications:

The provision for obtaining the grades in the MOOC COURSES as suggested above has been replaced by the following provision as suggested and approved by the Hon'ble members that In House examination / evaluation will be carried out for the MOOC COURSES as held for regular courses. The grading of the MOOC courses will be done on the basis of these examinations/evaluations. A Course Coordinator will be assigned for each MOOC COURSE.

Agenda 4: To approve B. Tech. Curriculum applicable for students admitted in 2019-20

In Academic session 2019-20, a revised teaching scheme for I and II semester in line with that in RTU was adopted on recommendation of the BOS.

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In the prevailing market conditions and as per the model curriculum provided by AICTE, it has been discussed in the meeting of Head of Departments held in the month of September 2020 to **include One MOOC courses each in VII and VIII semester aggregating to 7 Credit in the scheme for the students admitted in 2019-20.** 8-10 weeks of MOOC courses shall be considered for 3 credits and 12-16 weeks for MOOC courses shall be considered for 4 credits. A list of the MOOC courses shall be submitted by the respective BoS, two months before the start of the respective semester . The students have to select the MOOC courses from the list provided by the concerned BoS. The MOOCs courses available on the following site/platform will be recognized.

Initiative	Institution Behind Platform	Website Link
NPTEL	IIT Madras	nptel.ac.in/
mooKIT	IIT Kanpur	www.mookit.co/
IITBX	IIT Bombay	iitbombayx.in/
SWAYAM	MHRD and Microsoft	Swayam.gov.in

Only those MOOCs courses will be considered for fulfilling the requirement of the B.Tech. Degree, which have certification.

The student will inform in writing to respective Head of the Department about the MOOCs courses intended to register from the list provided by concerned BoS at the time of registration of other courses. The HOD shall verify the authenticity of the course as per points mentioned above. The student shall submit the certificate along with the credit earn to the HOD, who will ensure to submit the information about the credit and grade earn by the student during the semester (through the MOOCs courses) at the time of submission of other course grades. Before submitting the grade of MOOC course registered by the student, the HOD shall convert the grade of the MOOC course to the grading system of CBCS of University Departments. For conversion, first the grade of the course shall be converted to equivalent marks using the rules prevalent at the institute offering the MOOC course and then marks shall be converted to equivalent grade of CBCS of University Departments.

In pursuance of the CBCS Regulations, the teaching schemes are placed for kind perusal of members (Annexure 3). In pursuance of the CBCS Regulations, the revised teaching schemes are placed for kind perusal of members (Annexure 4). Members are requested to approve.

Resolution: The Agenda was approved by the respected members after having following modifications:

The provision for obtaining the grades in the MOOC COURSES as suggested above has been replaced by the following provision as suggested and approved by the respected members that In House examination / evaluation will be carried out for the MOOC COURSES as held for regular courses. The grading of the MOOC courses will be done on the basis of these examinations/evaluations. A Course Coordinator will be assigned for each MOOC COURSE.

Agenda 5: To approve B. Tech. Curriculum applicable from 2020-21 and onwards for first year

In pursuance of **the revised** CBCS Regulations, the teaching schemes are placed for kind perusal of members (Annexure 5). Members are requested to approve.

Resolution: The Agenda was approved by the respected members after following modifications:

In first year scheme Engineering Mechanics and Introduction to Electrical and Electronics Engineering has been replaced by Basic Mechanical Engineering, Basic Civil Engineering and Introduction to Electrical and Electronics Engineering. Students of CS, EC, EE, EIC, IT will study Basic Mechanical Engineering and Basic Civil Engineering. Students of CE, PE, PC will study Basic Mechanical Engineering and Introduction to Electrical and Electronics Engineering. Students of AE, ME, PIE will study Basic Civil Engineering and Introduction to Electrical and Electronics Engineering.

Agenda 6: To approve BOS of HEAS department.

In pursuance of CBCS Regulations, the BOS of HEAS department is placed for kind perusal of members (Annexure 6). Members are requested to approve.

Resolution: The Agenda was approved by the respected members.

Agenda 7: To approve policies and guidelines regarding academics and examination which are not in practice during pre COVID periods (Normal circumstances).

The extra ordinary situation arisen due to COVID-19, forces the administration to adopt some policies regarding academics and examination which are not in practice during pre COVID periods. Govt. of Rajasthan, Office of HVC and COE issued some guidelines for the academics and examination process. Members are requested to approve the same for University Departments, RTU, Kota.

Members are requested to approve.

Resolution: The Agenda was approved by the respected members.

Reporting Item:

There are no guidelines for preparation of grades for back /improvement examinations in the present CBCS regulations. A committee was formed and approved by HVC for addressing this issue. Following provisions were proposed by the committee and approved by HVC in 2019 (note-sheet enclosed):

a. If the back exam is conducted with main exam then the grading may be calculated with the main exam students.
b. In case the back exam is conducted separately, then the grading may be calculated along with the previous main exam. However, the grading of the students (awarded already) will remain unaffected.

Resolution: The Agenda was approved by the respected members.

The meeting ended with a vote of thanks to The Chair

Dr Vikas Bansal
Member Secretary, UDAC)

Prof Anil Mathur
Chairman, UDAC

Copy to:

1. **PS to HVC for Approval in BOM**
2. **Members of UDAC**

Dr Vikas Bansal
Member Secretary, UDAC)

Prof Anil Mathur
Chairman, UDAC

2nd Year: Electronics Instrumentation & Control
III Semester

Sr. No.	Course Code	Type of Course	Course Title	Credits	Hours/Week			Marks		
					L	T	P	IA	ETE	Total
1	3EIU1	ICC	Advanced Engineering Mathematics-I	4	3	1	0	50	100	150
2	3EIU2	DCC	Electronics Devices	4	3	1	0	50	100	150
3	3EIU3	DCC	Digital System Design	3	3	0	0	50	100	150
4	3EIU4	DCC	Signal & Systems	3	3	0	0	50	100	150
5	3EIU5	DCC	Network Theory	3	3	0	0	50	100	150
6	3EIU6	DCC/IEC	Managerial Economics and Financial Accounting	3	3	0	0	50	100	150
7	3EIU11	DCC	Electronics Devices Lab	2	0	0	3	50	25	75
8	3EIU12	DCC	Digital System Design Lab	2	0	0	3	50	25	75
9	3EIU13	DCC/IEC	Signal Processing Lab	2	0	0	3	50	25	75
10	3EIU14	DCC/IEC	Computer Programming Lab-I	2	0	0	3	50	25	75
11	3EIU20		Extra-Curricular & Discipline	1				50		50
			TOTAL	**29**	**18**	**2**	**12**	**550**	**700**	**1250**

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2nd Year: Electronics Instrumentation & Control
IV Semester

Sr. No.	Course Code	Type of Course	Course Title	Credits	Hours/Week			Marks		
					L	T	P	IA	ETE	Total
1	4EIU1	ICC	Advanced Engineering Mathematics-II	4	3	1	0	50	100	150
2	4EIU2	DCC	Analog Circuits	4	3	1	0	50	100	150
3	4EIU3	DCC	Control Systems-I	3	3	0	0	50	100	150
4	4EIU4	DCC	Electronics Measurement & Instrumentation	3	3	0	0	50	100	150
5	4EIU5	DCC	Analog and Digital Communication	3	3	0	0	50	100	150
6	4EIU6	DCC/IEC	Technical Communication	2	2	0	0	50	100	150
7	4EIU11	DCC	Control Lab	2	0	0	3	50	25	75
8	4EIU12	DCC	Electronics Measurement & Instrumentation Lab	2	0	0	3	50	25	75
9	4EIU13	DCC/IEC	Analog and Digital Communication Lab	1	0	0	2	50	25	75
10	4EIU14	DCC/IEC	Analog Circuits Lab	1	0	0	2	50	25	75
11	4EIU20		Extra-Curricular & Discipline	1				50		50
			TOTAL	**26**	**17**	**2**	**10**	**550**	**700**	**1250**

3rd Year: Electronics Instrumentation & Control
V Semester

Sr. No.	Course Code	Type of Course	Course Title	Credits	Hours/Week			Marks		
					L	T	P	IA	ETE	Total
1	5EIU1	DCC	Digital Signal Processing	4	3	1	0	50	100	150
2	5EIU2	DCC	Sensors And Transducers	4	3	1	0	50	100	150
3	5EIU3	DCC	Microcontrollers	3	3	0	0	50	100	150
4	5EIU4	DCC	Industrial Instrumentation	3	3	0	0	50	100	150
5	5EIU5.1	DEC	Biomedical Instrumentation	3	3	0	0	50	100	150
	5EIU5.2		Control System Component							
6	5EIU6.1	DEC	Probability theory & Stochastic process	2	2	0	0	50	100	150
	5EIU6.2		Embedded System Design							
7	5EIU11	DCC	Transducer Lab	2	0	0	3	50	25	75
8	5EIU12	DCC	Biomedical Instrumentation Lab	1	0	0	2	50	25	75
9	5EIU13	DCC	Microcontrollers Lab	1	0	0	2	50	25	75
10	5EIU14	DCC/IEC	Control System Simulation lab-I	1	0	0	2	50	25	75
11	5EIU20		Extra-Curricular & Discipline	1				50		50
			TOTAL	**25**	**17**	**2**	**9**	**550**	**700**	**1250**

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3rd Year: Electronics Instrumentation & Control
VI Semester

Sr. No.	Course Code	Type of Course	Course Title	Credits	Hours/Week			Marks		
					L	T	P	IA	ETE	Total
1	6EIU1	DCC	Neural Networks And Fuzzy Logic Control	4	3	1	0	50	100	150
2	6EIU2	DCC	Control System II	4	3	1	0	50	100	150
3	6EIU3	DCC	Power Electronics	3	3	0	0	50	100	150
4	6EIU4	DCC	Process Control System	3	3	0	0	50	100	150
5	6EIU5.1 6EIU5.2	DEC	Optical Instrumentation Robotics	3	3	0	0	50	100	150
6	6EIU6.1 6EIU6.2	DEC	Computer Network Control System Design	2	2	0	0	50	100	150
7	6EIU11	DCC	Process Control Lab	2	0	0	3	50	25	75
8	6EIU12	DCC	Control System Simulation Lab-II	2	0	0	3	50	25	75
9	6EIU13	DCC	Electronics Instrumentation Lab	1	0	0	2	50	25	75
10	6EIU14	DCC/IEC	Power Electronics Lab	1	0	0	2	50	25	75
11	6EIU20		Extra-Curricular & Discipline	1				50		50
			TOTAL	**26**	**17**	**2**	**10**	**550**	**700**	**1250**

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4th Year: Electronics Instrumentation & Control
VII Semester

Sr. No.	Course Code	Type of Course	Course Title	Credits	Hours/Week			Marks		
					L	T	P	IA	ETE	Total
1	7EIU1	DCC	Distributed Control System	4	3	1	0	50	100	150
2	7EIU2	DCC	Digital Control	4	3	1	0	50	100	150
3	7EIU3	DCC	Digital Image And Video Processing	3	3	0	0	50	100	150
4	7EIU4	DCC	Artificial intelligence	3	3	0	0	50	100	150
5	7EIU5.1	DEC	Analytical & Environmental Instrumentation	3	3	0	0	50	100	150
	7EIU5.2		Network Control System							
6	7EIU6.1	IEC	MOOC COURSE	4						
7	7EIU11	DCC	Real Time Control Lab	2	0	0	3	50	25	75
8	7EIU12	DCC	Analytical Instrumentation Lab	1	0	0	2	50	25	75
9	7EIU13	DCC	Minor Project	1	0	0	2	50	25	75
10	7EIU14	DCC	Practical Training	4	0	0	4	150	75	225
11	7EIU20		Extra-Curricular & Discipline	1				50		50
			TOTAL	**30**	**15**	**2**	**11**	**600**	**650**	**1250**

4th Year: Electronics Instrumentation & Control
VIII Semester Option-A

Sr. No.	Course Code	Type of Course	Course Title	Credits	Hours/Week			Marks		
					L	T	P	IA	ETE	Total
1	8EIU1.1 8EIU1.2	DEC	MEMS & Nano Technology Fault Detection & Diagnosis	3	3	0	0	50	100	150
2	8EIU2.1 8EIU2.1	DEC	Wireless Sensor Networks Scientific Computing	3	3	0	0	50	100	150
3	8EIU3.1 8EIU3.2	DEC	Process Modelling & Optimization Reliability Engineering	3	3	0	0	50	100	150
4	8EIU4.1	IEC	MOOC COURSE	3						
5	8EIU13	DCC	Seminar	4	0	0	4	150	75	225
6	8EIU14	DCC	Project	12	0	0	18	350	175	525
7	8EIU20		Extra-Curricular & Discipline	1				50		50
			TOTAL	**29**	**9**	**0**	**22**	**700**	**550**	**1250**

4th Year: Electronics Instrumentation & Control
VIII Semester Option-B*

1	8EIU4.1	IEC	MOOC COURSE	3						
2	8EIU13	DCC	Seminar	4			4	150	75	225
3	8EIU14	DCC	Project Cum Internship	21			36 hours per week	500	475	975
4	8EIU20		Extra-Curricular & Discipline	1				50		50

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			TOTAL	**29**	**0**	**0**	**40**	**700**	**550**	**1250**
			Gr Total	**165**						**7500**

***Choice of option B will be given to the student having CGPA ≥ 8.0 calculated up to the VI semester B.Tech. results.**

3EIU1	ICC	Advance Engineering Mathematics-I	MM:150	3L:1T:0P	4 credits

Numerical Methods – 1: (10 lectures)
Finite differences, Relation between operators, Interpolation using Newton's forward and backward difference formulae. Gauss's forward and backward interpolation formulae. Stirling's Formulae. Interpolation with unequal intervals: Newton's divided difference and Lagrange's formulae. Numerical Differentiation, Numerical integration: Trapezoidal rule and Simpson's 1/3rd and 3/8 rules.
Numerical Methods – 2: (8 lectures)
Numerical solution of ordinary differential equations: Taylor's series, Euler and modified Euler's methods. Runge- Kutta method of fourth order for solving first and second order equations. Milne's and Adam's predicator-corrector methods. Solution of polynomial and transcendental equations-Bisection method, Newton-Raphson method and Regula-Falsi method.
Laplace Transform: (10 lectures)
Definition and existence of Laplace transform, Properties of Laplace Transform and formulae, Unit Step function, Dirac Delta function, Heaviside function, Laplace transform of periodic functions. Finding inverse Laplace transform by different methods, convolution theorem. Evaluation of integrals by Laplace transform, solving ODEs by Laplace transforms method.
Fourier Transform: (7 lectures)
Fourier Complex, Sine and Cosine transform, properties and formulae, inverse Fourier transforms, Convolution theorem, application of Fourier transforms to partial ordinary differential equation (One dimensional heat and wave equations only).
Z-Transform: (5 lectures)
Definition, properties and formulae, Convolution theorem, inverse Z-transform, application of Z-transform to difference equation.

Suggested Text/Reference Books

1. FranscisScheid, Theory and Problems of Numerical Analysis, Schaum Outline's series.
2. S. S. Sastry; Introductory Methods of Numerical Analysis; Prentice Hall India Learning Private Limited.
3. M. K. Jain, S. R. K. Iyengar and R. K. Jain; Numerical Methods for Scientific and Engineering Computation; New Age International

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Publishers.

4. Spiegel; Laplace Transforms; Schaum's outline series.
5. Erwin kreyszig, Advanced Engineering Mathematics, John Wiley & Sons.
6. R.K. Jain and S.R.K. Iyengar; Advanced Engineering Mathematics, Narosa Publications.
7. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2010.
8. Dennis G. Zill and Warren S. Wright; Advanced Engineering Mathematics; Jones & Bartlett Learning.
9. Pal and Bhunia, Engineering Mathematics, Oxford, India.
10. C.B. Gupta, Engineering Mathematics for semesters III and IV, McGraw Hill Education, India.

3EIU2	DCC	Electronic Devices	MM:150	3L:1T:0P	4 credits

Introduction to Semiconductor Physics: Introduction, Energy band gap structures of semiconductors, Classifications of semiconductors, Degenerate and non-degenerate semiconductors, Direct and indirect band gap semiconductors, Electronic properties of Silicon, Germanium, Compound Semiconductor, Gallium Arsenide, Gallium phosphide & Silicon carbide, Variation of semiconductor conductivity, resistance and bandgap with temperature and doping. Thermistors, Sensitors.
Review of Quantum Mechanics:, Electrons in periodic Lattices, E-k diagrams. Energy bands in intrinsic and extrinsic silicon; Carrier transport: diffusion current, drift current, mobility and resistivity; sheet resistance, design of resistors.
Generation and recombination of carriers; Poisson and continuity equation P-N junction characteristics, I-V characteristics, and small signal switching models; Avalanche breakdown, Zener diode, Schottky diode.
Bipolar Junction Transistor, I-V characteristics, Ebers-Moll Model, MOS capacitor, C-V characteristics, MOSFET, I-V characteristics, and small signal models of MOS transistor, LED, photodiode and solar cell.
Integrated circuit fabrication process: oxidation, diffusion, ion implantation, Photolithography, etching, chemical vapor deposition, sputtering, twin-tub CMOS process.

Text/Reference Books:

1.	G. Streetman, and S. K. Banerjee, “Solid State Electronic Devices,” 7th edition, Pearson,2014.
2.	D. Neamen , D. Biswas "Semiconductor Physics and Devices," McGraw-Hill Education
3.	S. M. Sze and K. N. Kwok, “Physics of Semiconductor Devices,” 3rd edition, John Wiley & Sons, 2006.
4.	C.T. Sah, “Fundamentals of solid state electronics,” World Scientific Publishing Co. Inc, 1991.
5.	Y. Tsividis and M. Colin, “Operation and Modeling of the MOS Transistor,” Oxford Univ.Press, 2011.

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Course Outcome:

Course Code	Course Name	Course Outcome	Details
3EIU2	Electronic Devices	CO 1	Understanding the semiconductor physics of the intrinsic, P and N materials.
		CO 2	Understanding the characteristics of current flow in a bipolar junction transistor and MOSFET.
		CO 3	Understand and utilize the mathematical models of semiconductor junctions and MOS transistors for circuits and systems.
		CO 4	Analyze the characteristics of different electronic devices such as Amplifiers, LEDs, Solar cells, etc.
		CO 5	Theoretical as well as experimental understanding of Integrated circuit fabrication.

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
3EIU2 Electronic Devices	CO 1	3	1		2	1	1						
	CO 2	3	2	1			2						
	CO 3	2	1		2		1	2					
	CO 4	3	1	1				2					
	CO 5	3	1	1	1	1							2

3: Strongly **2: Moderate** **1: Weak**

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Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Zero Lecture
Lecture 2	Introduction to Semiconductor Physics
Lecture 3	Introduction to Semiconductor Physics
Lecture 4	Introduction to Semiconductor Physics
Lecture 5	Review of Quantum Mechanics
Lecture 6	Electrons in periodic Lattices
Lecture 7	E-k diagrams
Lecture 8	Energy bands in intrinsic and extrinsic silicon
Lecture 9	Carrier transport: diffusion current, drift current, mobility and resistivity
Lecture 10	Sheet resistance and design of resistors
Lecture 11	Generation and recombination of carriers
Lecture 12	Poisson and continuity equation
Lecture 13	P-N junction characteristics and their I-V characteristics
Lecture 14	P-N junction characteristics and their I-V characteristics
Lecture 15	P-N junction small signal switching models
Lecture 16	P-N junction small signal switching models
Lecture 17	Avalanche breakdown
Lecture 18	Zener diode and Schottky diode
Lecture 19	Basics of Bipolar Junction Transistor
Lecture 20	I-V characteristics of BJT
Lecture 21	Ebers-Moll Model
Lecture 22	MOS capacitor
Lecture 23	MOS capacitor
Lecture 24	C-V characteristics
Lecture 25	Basics of MOSFET
Lecture 26	Basics of MOSFET
Lecture 27	I-V characteristics of MOSFET
Lecture 28	Small signal models of MOS transistor
Lecture 29	Small signal models of MOS transistor
Lecture 30	Light Emitting Diode
Lecture 31	Photodiode and solar cell
Lecture 32	Basics of Integrated Circuits
Lecture 33	Advancement in Integrated Circuits
Lecture 34	Oxidation, diffusion and ion implantation
Lecture 35	Photolithography and etching
Lecture 36	Chemical vapor deposition
Lecture 37	Sputtering
Lecture 38	Twin-tub CMOS process

Lecture 39	Spill over class
Lecture 40	Spill over class

Content delivery method:

1. Chalk and Duster
2. PPT
3. Hand-outs

Sample assignments:

Assignment 1	**Q1.**	Investigates the input/output characteristics of various diodes?
	Q2.	Investigate the applications of various diodes?
	Q3.	A p-type sample of silicon has a resistivity of 5 Ω-cm. In this sample, the hole mobility, μ_h, is 600 cm^2/V-s and the electron mobility, μ_e, is 1600 cm^2/V-s. Ohmic contacts are formed on the ends of the sample and a uniform electric field is imposedwhich results in a drift current density in the sample is 2 x 10^3 A/cm^2. [1]. What are the hole and electron concentrations in this sample? [2]. What are the hole and electron drift velocities under these conditions? [3]. What is the magnitude of the electric field?
Assignment 2	**Q1.**	Discuss the applications of Ebers-Moll Model.
	Q2.	Discuss different types of fabrication techniques.
	Q3.	Discuss various characteristics of CMOS transistor.

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3EIU3	DCC	Digital System Design	MM:150	3L:0T:0P	3 credits

Logic Simplification and Combinational Logic Design: Review of Boolean Algebra and De Morgan's Theorem, SOP & POS forms, Canonical forms, Karnaugh maps up to 6 variables, Binary codes, Code Conversion.
MSI devices like Comparators, Multiplexers, Encoder, Decoder, Driver & Multiplexed Display, Half and Full Adders, Subtractors, Serial and Parallel Adders, BCD Adder, Barrel shifter and ALU
Sequential Logic Design: Building blocks like S-R, JK and Master-Slave JK FF, Edge triggered FF, Ripple and Synchronous counters, Shift registers, Finite state machines, Design of Synchronous FSM, Algorithmic State Machines charts. Designing synchronous circuits like Pulse train generator, Pseudo Random Binary Sequence generator, Clock generation.
Logic Families and Semiconductor Memories: TTL NAND gate, Specifications, Noise margin, Propagation delay, fan-in, fan-out, Tristate TTL, ECL, CMOS families and their interfacing, memory elements, Concept of Programmable logic devices like FPGA. Logic implementation using programmable devices.
VLSI Design flow: Design entry: Schematic, FSM & HDL, different modeling styles in VHDL, Data types and objects, Dataflow, Behavioral and Structural Modeling, Synthesis and Simulation VHDL constructs and codes for combinational and sequential circuits.

Text/Reference Books:

1.	R.P. Jain, "Modern digital Electronics", Tata McGraw Hill, 4th edition, 2009.
2.	Douglas Perry, "VHDL", Tata McGraw Hill, 4th edition, 2002.
3.	W.H. Gothmann, "Digital Electronics- An introduction to theory and practice", PHI, 2ndedition ,2006.
4.	D.V. Hall, "Digital Circuits and Systems", Tata McGraw Hill, 1989
5.	Charles Roth, "Digital System Design using VHDL", Tata McGraw Hill 2nd edition 2012.

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Course Outcome:

Course Code	Course Name	Course Outcome	Details
3EIU3	Digital System Design	CO 1	Develop the understanding of number system and its application in digital electronics.
		CO 2	Development and analysis of K-map to solve the Boolean function to the simplest form for the implementation of compact digital circuits.
		CO 3	Design various combinational and sequential circuits using various metrics: switching speed, throughput/latency, gate count and area, energy dissipation and power.
		CO 4	Understanding Interfacing between digital circuits and analog component using Analog to Digital Converter (ADC), Digital to Analog Converter (DAC) etc.
		CO 5	Design and implement semiconductor memories, programmable logic devices (PLDs) and field programmable gate arrays (FPGA) in digital electronics.

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
3EIU3 Digital System Design	CO 1	3	2	2	1		1						
	CO 2	3	2	3	2								
	CO 3	2	2	3	1	1							
	CO 4	3	2	1	1	1							
	CO 5	2	1	3	1	1							

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3: Strongly 2: Moderate 1: Weak

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Zero Lecture
Lecture 2	Review of Boolean Algebra
Lecture 3	DeMorgan's Theorem, SOP & POS forms,
Lecture 4	Problem of SOP and POS forms of boolean functions.
Lecture 5	Simplification of karnaugh map up to 6 variables
Lecture 6	Simplification of karnaugh map up to 6 variables
Lecture 7	Simplification of karnaugh map up to 6 variables
Lecture 8	Binary codes and code conversion
Lecture 9	Binary codes and code conversion
Lecture 10	Encoder, Decoder
Lecture 11	Half and Full Adders, Subtractors, Serial and Parallel Adders
Lecture 12	BCD Adder, Barrel shifter
Lecture 13	S-R FF, edge triggered and level triggered
Lecture 14	D and J-K FF
Lecture 15	Master-Slave JK FF and T FF
Lecture 16	Ripple and Synchronous counters
Lecture 17	Other type of counters
Lecture 18	Shift registers, Finite state machines, Asynchronous FSM
Lecture 19	Design of synchronous FSM
Lecture 20	Design of synchronous FSM
Lecture 21	Design of synchronous FSM
Lecture 22	Designing synchronous circuits (pulse train generator, pseudo random binary sequence generator, clock generation)
Lecture 23	TTL NAND gate, specifications, noise margin, propagation delay, fan-in, fan-out
Lecture 24	TTL NAND gate
Lecture 25	Tristate TTL, ECL
Lecture 26	CMOS families and their interfacing
Lecture 27	CMOS families and their interfacing
Lecture 28	Read-Only Memory, Random Access Memory
Lecture 29	Programmable Logic Arrays (PLA)
Lecture 30	Programmable Array Logic (PAL),
Lecture 31	Field Programmable Gate Array (FPGA)
Lecture 32	Combinational PLD-Based State Machines,
Lecture 33	State Machines on a Chip
Lecture 34	Schematic, FSM & HDL
Lecture 35	Different modeling styles in VHDL
Lecture 36	Data types and objects, Data flow

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Lecture 37	Behavioral and Structural Modeling
Lecture 38	Behavioral and Structural Modeling
Lecture 39	Simulation VHDL constructs and codes for combinational and sequential circuits
Lecture 40	Simulation VHDL constructs and codes for combinational and sequential circuits

Content delivery method:

1. Chalk and Duster
2. PPT
3. Hand-outs

Sample Assignments:

Assignment 1	**Q1.** Using K-maps, find the minimal Boolean expression of the following SOP and POS representations. a. f (w,x,y,z)= Σ (7,13,14,15) b. f(w,x,y,z) = Σ (1,3,4,6,9,11,14,15) c. f(w,x,y,z) = Π(1,4,5,6,11,12,13,14,15) d. f(w,x,y,z) = Σ (1,3,4,5,7,8,9,11,15) e. f(w,x,y,z) = Π (0,4,5,7,8,9,13,15)
	Q2. Find the function h(a,b,c,d) such that $f = f^d$. f (a,b,c,d) = a ·b· c + (a · c + b)· d + h(a,b,c,d)
	Q3. Using K-maps of the functions f1 and f2, find the following: (provide the canonical form expression and simplify) a. T1 = f1 · f2 b. T2 = f1 + f2 c. T3 = f1 ⊕ f2 where f1(w,x,y,z) = Σ (0,2,4,9,12,15), f2(w,x,y,z) = Σ (1,2,4,5,12,13)
Assignment 2	**Q1**. Draw the state diagram of a serial adder.
	Q2. In the following circuit, given binary values were applied to the Inputs X and Y inputs of the NAND latch shown in the figure. X = 0, Y = 1; X = 0, Y = 0; X = 1, Y = 1. Find out the corresponding stable output P, Q.

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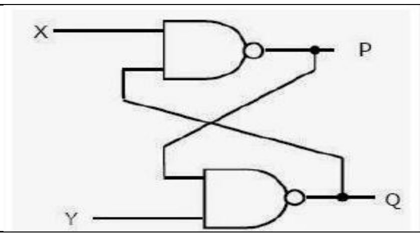
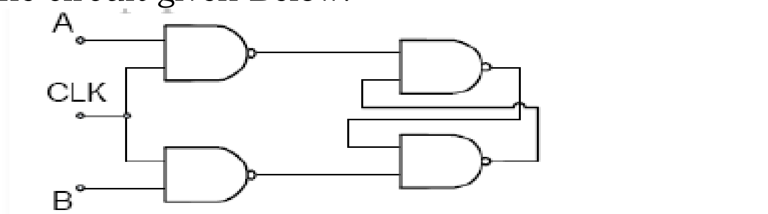
	
	Q3. When the race around condition will occur in the circuit given Below: 

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3EIU4	DCC	Signals & Systems	MM:150	3L:0T:0P	3 credits

Energy and power signals, continuous and discrete time signals, continuous and discrete amplitude signals. System properties: linearity: additivity and homogeneity, shift-invariance, causality, stability, realizability.
Linear shift-invariant (LSI) systems, impulse response and step response, convolution, input output behavior with aperiodic convergent inputs. Characterization of causality and stability of linear shift-invariant systems. System representation through differential equations and difference equations
Periodic and semi-periodic inputs to an LSI system, the notion of a frequency response and its relation to the impulse response, Fourier series representation, the Fourier Transform, convolution/multiplication and their effect in the frequency domain, magnitude and phase response, Fourier domain duality. The Discrete-Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT). Parseval's Theorem. The idea of signal space and orthogonal bases
The Laplace Transform, notion of eigen functions of LSI systems, a basis of eigen functions, region of convergence, poles and zeros of system, Laplace domain analysis, solution to differential equations and system behavior.
The z-Transform for discrete time signals and systems- eigen functions, region of convergence, z-domain analysis.
State-space analysis and multi-input, multi-output representation. The state-transition matrix and its role. The Sampling Theorem and its implications- Spectra of sampled signals. Reconstruction: ideal interpolator, zero-order hold, first-order hold, and so on. Aliasing and its effects. Relation between continuous and discrete time systems.

Text/Reference Books:

1.	A.V. Oppenheim, A.S. Willsky and I.T. Young, "Signals and Systems", Prentice Hall, 1983.
2.	R.F. Ziemer, W.H. Tranter and D.R. Fannin, "Signals and Systems - Continuous and Discrete", 4th edition, Prentice Hall, 1998.
3.	Papoulis, "Circuits and Systems: A Modern Approach", HRW, 1980.
4.	B.P. Lathi, "Signal Processing and Linear Systems", Oxford University Press, c1998.
5.	Douglas K. Lindner, "Introduction to Signals and Systems", McGraw

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	Hill International Edition: c1999.
6.	Simon Haykin, Barry van Veen, "Signals and Systems", John Wiley and Sons (Asia) Private Limited, c1998.
7	Robert A. Gabel, Richard A. Roberts, "Signals and Linear Systems", John Wiley and Sons, 1995.
8.	M. J. Roberts, "Signals and Systems - Analysis using Transform methods and MATLAB", TMH, 2003.
9.	J. Nagrath, S. N. Sharan, R. Ranjan, S. Kumar, "Signals and Systems", TMH New Delhi, 2001.
10.	Ashok Ambardar,"Analog and Digital Signal Processing", 2nd Edition, Brooks/ Cole Publishing Company (An international Thomson Publishing Company), 1999.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
3EIU4	**Signals & Systems**	**CO 1**	Analyze different types of signals and system properties
		CO 2	Represent continuous and discrete systems in time and frequency domain using different transforms
		CO 3	Investigate whether the system is stable.
		CO 4	Sampling and reconstruction of a signal.
		CO 5	Acquire an understanding of MIMO systems

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
3EIU4 Signals & Systems	**CO 1**	3	3	1	2	2			1				2
	CO 2	3	1		2	3			1				2
	CO 3	3	2	2	3								2

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

3: Strongly 2: Moderate 1: Weak

Lecture Plan:

Lecture No.	**Content to be taught**
Lecture 1	Zero Lecture
Lecture 2	Energy signals power signals
Lecture 3	Continuous and discrete time signals
Lecture 4	Continuous amplitude signals
Lecture 5	and discrete amplitude signals
Lecture 6	System properties: linearity: additivity and homogeneity
Lecture 7	shift-invariance, causality
Lecture 8	stability, realizability.
Lecture 9	Linear shift-invariant (LSI) systems
Lecture 10	impulse response
Lecture 11	Step response
Lecture 12	Convolution.
Lecture 13	Input output behavior with aperiodic convergent inputs
Lecture 14	Characterization of causality and stability of linear shift-invariant systems.
Lecture 15	System representation through differential equations and difference equations.
Lecture 16	Characterization of causality and stability of linear shift-invariant systems.
Lecture 17	System representation through differential equations and difference equations.
Lecture 18	Periodic and semi-periodic inputs to an LSI system
Lecture 19	The notion of a frequency response.
Lecture 20	Its relation to the impulse response
Lecture 21	Fourier series representation
Lecture 22	Fourier Transform
Lecture 23	Convolution/multiplication and their effect in the frequency domain
Lecture 24	Magnitude and phase response
Lecture 25	Fourier domain duality.
Lecture 26	The Discrete-Time Fourier Transform (DTFT) and Discrete Fourier Transform (DFT).
Lecture 27	Parseval's Theorem. The idea of signal space and orthogonal bases

Lecture 28	The Laplace Transform
Lecture 29	Notion of eigen functions of LSI systems
Lecture 30	A basis of eigen functions, region of convergence
Lecture 31	Poles and zeros of system, Laplace domain analysis,
Lecture 32	Solution to differential equations and system behavior.
Lecture 33	The z-Transform for discrete time signals and systems- eigen functions,
Lecture 34	Region of convergence, z-domain analysis.
Lecture 35	State-space analysis and multi-input, multi-output representation.
Lecture 36	The state-transition matrix and its role.
Lecture 37	The Sampling Theorem and its implications- Spectra of sampled signals.
Lecture 38	Reconstruction: ideal interpolator, zero-order hold, first-order hold, and so on
Lecture 39	Aliasing and its effects.
Lecture 40	Relation between continuous and discrete time systems.

Content delivery method:

1. Chalk and Duster
2. PPT
3. Animation
4. Hand-outs

Assignments:

Assignm

For each of the following signals, determine whether it is even, odd, or neither.

(a)

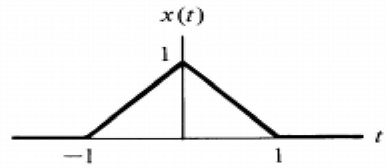

Figure P2.4-1

(b)

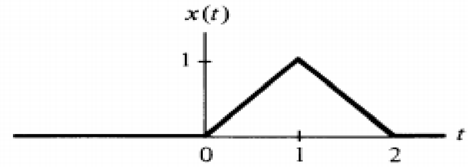

Figure P2.4-2

(c)

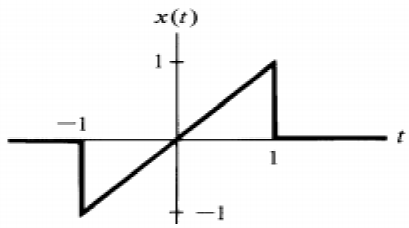

Figure P2.4-3

(d)

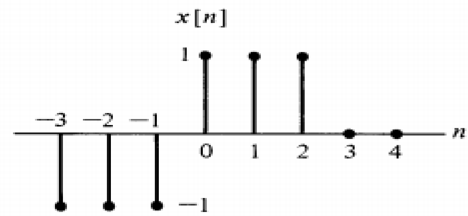

Figure P2.4-4

Q1.

Evaluate the following sums:

(a) $\sum_{n=0}^{5} 2\left(\frac{3}{a}\right)^n$

(b) $\sum_{n=2}^{6} b^n$

(c) $\sum_{n=0}^{\infty} \left(\frac{2}{3}\right)^{2n}$

Hint: Convert each sum to the form

$$C\sum_{n=0}^{N-1} \alpha^n = S_N \qquad \text{or} \qquad C\sum_{n=0}^{\infty} \alpha^n = S_\infty$$

and use the formulas

$$S_N = C\left(\frac{1-\alpha^N}{1-\alpha}\right), \qquad S_\infty = \frac{C}{1-\alpha} \qquad \text{for } |\alpha| < 1$$

Q2.

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The first-order difference equation $y[n] - ay[n-1] = x[n]$, $0 < a < 1$, describes a particular discrete-time system initially at rest.

(a) Verify that the impulse response $h[n]$ for this system is $h[n] = a^n u[n]$.

(b) Is the system

(i) memoryless?

(ii) causal?

(iii) stable?

Clearly state your reasoning.

(c) Is this system stable if $|a| > 1$?

Q3.

Assignm

Consider a discrete-time system with impulse response

$$h[n] = (\tfrac{1}{2})^n u[n]$$

Determine the response to each of the following inputs:

(a) $x[n] = (-1)^n = e^{j\pi n}$ for all n

(b) $x[n] = e^{j(\pi n/4)}$ for all n

(c) $x[n] = \cos\left(\frac{\pi n}{4} + \frac{\pi}{8}\right)$ for all n

Q1.

Consider two specific periodic sequences $\tilde{x}[n]$ and $\tilde{y}[n]$. $\tilde{x}[n]$ has period N and $\tilde{y}[n]$ has period M. The sequence $\tilde{w}[n]$ is defined as $\tilde{w}[n] = \tilde{x}[n] + \tilde{y}[n]$.

(a) Show that $\tilde{w}[n]$ is periodic with period MN.

(b) Since $\tilde{x}[n]$ has period N, its discrete Fourier series coefficients a_k also have period N. Similarly, since $\tilde{y}[n]$ has period M, its discrete Fourier series coefficients b_k also have period M. The discrete Fourier series coefficients of $\tilde{w}[n]$, c_k, have period MN. Determine c_k in terms of a_k and b_k.

Q2.

The sequence $x[n] = (-1)^n$ is obtained by sampling the continuous-time sinusoidal signal $x(t) = \cos \omega_0 t$ at 1-ms intervals, i.e.,

$$\cos(\omega_0 nT) = (-1)^n, \qquad T = 10^{-3}\text{ s}$$

Determine three *distinct* possible values of ω_0.

Q3.

3EIU5	DCC	Network Theory	MM:150	3L:0T:0P	3 credits

Node and Mesh Analysis, matrix approach of network containing voltage and current sources, and reactances, source transformation and duality.
Network theorems: Superposition, reciprocity, Thevenin's, Norton's, Maximum power Transfer, compensation and Tallegen's theorem as applied to AC. circuits.
Trigonometric and exponential Fourier series: Discrete spectra and symmetry of waveform, steady state response of a network to non-sinusoidal periodic inputs, power factor, effective values, Fourier transform and continuous spectra, three phase unbalanced circuit and power calculation.
Laplace transforms and properties: Partial fractions, singularity functions, waveform synthesis, analysis of RC, RL, and RLC networks with and without initial conditions with Laplace transforms evaluation of initial conditions..
Transient behavior, concept of complex frequency, Driving points and transfer functions poles and zeros of immittance function, their properties, sinusoidal response from pole-zero locations, convolution theorem and Two four port network and interconnections, Behaviors of series and parallel resonant circuits, Introduction to band pass, low pass, high pass and band reject filters.

Text/Reference Books:

	Van, Valkenburg.; "Network analysis" ; Prentice hall of India, 2000
	Sudhakar, A., Shyammohan, S. P.; "Circuits and Network"; Tata McGraw-Hill New Delhi, 1994
	A William Hayt, "Engineering Circuit Analysis" 8th Edition, McGraw-Hill Education

Course Outcome:

Course Code	Course Name	Course Outcome	Details
3EIU5	Network Theory	CO 1	Apply the basic circuital law and simplify the network using network theorems
		CO 2	Appreciate the frequency domain techniques in different applications.
		CO 3	Apply Laplace Transform for steady state and transient analysis

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		CO 4	Evaluate transient response and two-port network parameters
		CO 5	Analyze the series resonant and parallel resonant circuit and design filters

CO-PO Mapping:

Subject	**Course Outcomes**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
3EIU5 Network Theory	**CO 1**	3	2		3	2							
	CO 2	3	3	1	2	2							1
	CO 3	3	2	2		2							1
	CO 4	2	3	2	2	1							
	CO 5	2	3	3	2	1							

3: Strongly 2: Moderate 1: Weak

Lecture Plan:

Lecture No.	**Content to be taught**
Lecture 1	Overview of Network Theory and its significance
Lecture 2	Node and Mesh Analysis
Lecture 3	matrix approach of network containing voltage and current sources and reactances
Lecture 4	source transformation and duality
Lecture 5	Network theorems: Superposition and reciprocity
Lecture 6	Thevenin’s and Norton’s theorem
Lecture 7	Maximum power Transfer theorem
Lecture 8	compensation and Tallegen's theorem as applied to AC. Circuits
Lecture 9	Trigonometric and exponential Fourier series
Lecture 10	Fourier series: Discrete spectra and symmetry of waveform
Lecture 11	Steady state response of a network to non-sinusoidal periodic inputs
Lecture 12	power factor and effective values
Lecture 13	Fourier transform and continuous spectra
Lecture 14	three phase unbalanced circuit and power calculation
Lecture 15	three phase unbalanced circuit and power calculation
Lecture 16	Laplace transforms

Lecture 17	Laplace transforms
Lecture 18	Laplace transforms properties: Partial fractions
Lecture 19	singularity functions and waveform synthesis
Lecture 20	analysis of RC networks
Lecture 21	analysis of RL networks
Lecture 22	analysis of RLC networks
Lecture 23	Analysis of networks with and without initial conditions
Lecture 24	Analysis of networks with and without initial conditions
Lecture 25	Analysis of networks with and without initial conditions with lapalace transforms evaluation
Lecture 26	Analysis of networks with and without initial conditions with lapalace transforms evaluation of initial condition
Lecture 27	Transient behavior
Lecture 28	concept of complex frequency
Lecture 29	Driving points and transfer functions poles and zeros of immittance function
Lecture 30	Driving points and transfer functions poles and zeros of immittance function: their properties
Lecture 31	sinusoidal response from pole-zero locations
Lecture 32	sinusoidal response from pole-zero locations
Lecture 33	convolution theorem
Lecture 34	sinusoidal response from pole-zero locations
Lecture 35	Two four port network and interconnections
Lecture 36	Two four port network and interconnections
Lecture 37	Behaviors of series and parallel resonant circuits
Lecture 38	Introduction to band pass and low pass
Lecture 39	Introduction to high pass and reject filters
Lecture 40	Spill over class

Content delivery method:

1. Chalk and Duster
2. PPT
3. Hand-outs

Sample assignments:

Assignment 1	**Q1.**	Elaborate the significance of source transformation with relevant example
	Q2.	State and prove time differentiation theorem in Laplace Transform

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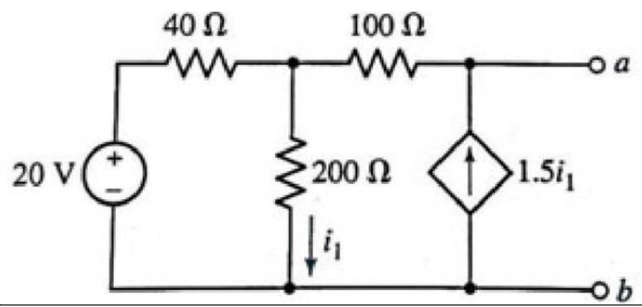
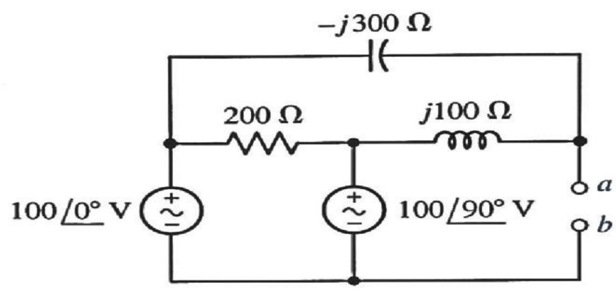
	Q3. Find the Thevenin equivalent of the network shown in figure. What power would be delivered to a load of 100 ohms at *a* and *b*? 
Assignment 2	**Q4.** Calculate Thevenin equivalent circuit with respect to terminals *a* and *b* 
	Q5. Derive transient current and voltage responses of sinusoidal driven RL and RC circuits.
	Q6. Specify the restrictions on pole and zero locations for transfer functions and driving-point functions.

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3EIU6	DCC/IEC	Managerial Economics And Financial Accounting	MM:150	3L:0T:0P	3 credit

SN	Contents	Hours
1	**Basic economic concepts-** Meaning, nature and scope of economics, deductive vs inductive methods, static and dynamics, Economic problems: scarcity and choice, circular flow of economic activity, national income-concepts and measurement.	4
2	**Demand and Supply analysis-Demand-** types of demand, determinants of demand, demand function, elasticity of demand, demand forecasting–purpose, determinants and methods, Supply-determinants of supply, supply function, elasticity of supply.	5
3	**Production and Cost analysis-Theory of production-** production function, law of variable proportions, laws of returns to scale, production optimization, least cost combination of inputs, isoquants. Cost concepts-explicit and implicit cost, fixed and variable cost, opportunity cost, sunk costs, cost function, cost curves, cost and output decisions, cost estimation.	5
4	**Market structure and pricing theory-**Perfect competition, Monopoly, Monopolistic competition, Oligopoly.	4
5	**Financial statement analysis-**Balance sheet and related concepts, profit and loss statement and related concepts, financial ratio analysis, cash-flow analysis, funds-flow analysis, comparative financial statement, analysis and interpretation of financial statements, capital budgeting techniques.	8
	Total	**26**

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3EIU11	**DCC**	**Electronics Devices Lab**	**MM:75**	**0L:0T:3P**	**2 credit**

List of Experiments

Sr. No.	Name of Experiment
1.	**Study the following devices:** (a) Analog& digital multimeters (b) Function/ Signal generators (c) Regulated d. c. power supplies (constant voltage and constant current operations) (d) Study of analog and digital CRO, measurement of time period, amplitude, frequency & phase angle using Lissajous figures.
2.	Plot V-I characteristic of P-N junction diode & calculate cut-in voltage, reverse Saturation current and static & dynamic resistances.
3.	Plot the output waveform of half wave rectifier and effect of filters on waveform. Also calculate its ripple factor.
4.	Study bridge rectifier and measure the effect of filter network on D.C. voltage output & ripple factor.
5.	Plot and verify output waveforms of different clipper and clamper.
6.	Plot V-I characteristic of Zener diode
7.	Study of Zener diode as voltage regulator. Observe the effect of load changes and determine load limits of the voltage regulator
8.	Plot input-output characteristics of BJT in CB, CC and CE configurations. Find their h-parameters.
9.	Study of different biasing circuits of BJT amplifier and calculate its Q-point.
10.	Plot frequency response of two stage RC coupled amplifier & calculate its bandwidth .
11.	Plot input-output characteristics of field effect transistor and measure I_{dss} and V_p.
12.	Plot frequency response curve for FET amplifier and calculate its gain bandwidth product.

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Course Outcome:

Course Code	Course Name	Course Outcome	Details
3EIU11	Electronic Devices Lab	**CO 1**	Understand the characteristics of different Electronic Devices.
		CO 2	Verify the rectifier circuits using diodes and implement them using hardware.
		CO 3	Design various amplifiers like CE, CC, common source amplifiers and implement them using hardware and also observe their frequency responses
		CO 4	Understand the construction, operation and characteristics of JFET and MOSFET, which can be used in the design of amplifiers.
		CO 5	Understand the need and requirements to obtain frequency response from a transistor so that Design of RF amplifiers and other high frequency amplifiers is feasible

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
3EIU11Electronic Devices Lab	**CO 1**	3	2	3	2	1							1
	CO 2	2	3	1	3	3							2
	CO 3	2	1	2	3	3							
	CO 4	3	2	3	2	2							1
	CO 5	3	2	1	2	2							

3: Strongly **2: Moderate** **1: Weak**

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3EIU12	DCC	Digital System Design Lab	MM:75	0L:0T:3P	2 credit

List of Experiments

S. No.	Name of Experiment
Part A: Combinational Circuits	
1.	To verify the truth tables of logic gates: AND, OR, NOR, NAND, NOR, Ex-OR and Ex-NOR
2.	To verify the truth table of OR, AND, NOR, Ex-OR, Ex-NOR logic gates realized using NAND & NOR gates.
3.	To realize an SOP and POS expression.
4.	To realize Half adder/ Subtractor & Full Adder/ Subtractor using NAND & NOR gates and to verify their truth tables
5.	To realize a 4-bit ripple adder/ Subtractor using basic Half adder/ Subtractor & basic Full Adder/ Subtractor.
6.	To design 4-to-1 multiplexer using basic gates and verify the truth table. Also verify the truth table of 8-to-1 multiplexer using IC
7.	To design 1-to-4 demultiplexer using basic gates and verify the truth table. Also to construct 1-to-8 demultiplexer using blocks of 1-to-4 demultiplexer
8.	To design 2x4 decoder using basic gates and verify the truth table. Also verify the truth table of 3x8 decoder using IC
9.	Design & Realize a combinational circuit that will accept a 2421 BCD code and drive a TIL -312 seven-segment display
Part B: Sequential Circuits	
10.	Using basic logic gates, realize the R-S, J-K and D-flip flops with and without clock signal and verify their truth table.
11.	Construct a divide by 2, 4 & 8 asynchronous counter. Construct a 4-bit binary counter and ring counter for a particular output pattern using D flip flop.
12.	Design and construct unidirectional shift register and verify the
13.	Design and construct BCD ripple counter and verify the function.
14.	Design and construct a 4 Bit Ring counter and verify the function
15.	Perform input/output operations on parallel in/Parallel out and Serial in/Serial out registers using clock. Also exercise loading only one of multiple values into the register using multiplexer.

Note: Minimum 6 experiments to be conducted from **Part-A**& 4 experiments to be conducted from **Part-B.**

Course Outcome:

Course Code	Course Name	Course Outcome	Details
3EIU12	Digital System Design Lab	CO 1	
		CO 2	To minimize the complexity of digital logic circuits.
		CO 3	To design and analyse combinational logic circuits.
		CO 4	To design and analyse sequential logic circuits.
		CO 5	Able to implement applications of combinational & sequential logic circuits.

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
3EIU12 Digital System Design Lab	CO 1	3	3	1									1
	CO 2	3	3	2	1	1							1
	CO 3	3	3	3	2	3	1						2
	CO 4	3	3	3	2	3	1						2
	CO 5	3	3	3	3	3	3						3

3: Strongly **2: Moderate** **1: Weak**

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3EIU13	DCC/IEC	Signal Processing Lab	MM:75	0L:0T:3P	2 credit

List of Experiments

Sr. No.	Name of Experiment (Simulate using MATLAB environment)
1.	Generation of continuous and discrete elementary signals (periodic and non periodic)using mathematical expression.
2.	Generation of Continuous and Discrete Unit Step Signal.
3.	Generation of Exponential and Ramp signals in Continuous & Discrete domain.
4.	Continuous and discrete time Convolution (using basic definition).
5.	Adding and subtracting two given signals. (Continuous as well as Discrete signals)
6.	To generate uniform random numbers between (0, 1).
7.	To generate a random binary wave.
8.	To generate and verify random sequences with arbitrary distributions, means and variances for following: (a) Rayleigh distribution (b) Normal distributions: N(0,1). (c) Gaussion distributions: N (m, x)
9.	To plot the probability density functions. Find mean and variance for the above distributions

Course Outcome:

Course Code	Course Name	Course Outcome	Details
3EIU13	Signal Processing Lab	CO 1	Able to generate different Continuous and Discrete time signals.
		CO 2	Understand the basics of signals and different operations on signals.
		CO 3	Develop simple algorithms for signal processing and test them using MATLAB
		CO 4	Able to generate the random signals having different distributions, mean and variance.
		CO 5	Design and conduct experiments, interpret and analyse data and report results.

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CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
3EIU13 Signal Processing Lab	CO 1	2		1		2							
	CO 2	3		1									
	CO 3	1	2	3	1	3							
	CO 4	2	1	1		2							
	CO 5	1	1	2	2	2							

3: Strongly 2: Moderate 1: Weak

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3EIU14	**DCC/IEC**	**Computer Programming Lab-I**	**MM:75**	**0L:0T:3P**	**2 credit**

1.	Write a simple C program on a 32 bit compiler to understand the concept of array storage, size of a word. The program shall be written illustrating the concept of row major and column major storage. Find the address of element and verify it with the theoretical value. Program may be written for arrays upto 4-dimensions.
2.	Simulate a stack, queue, circular queue and dequeue using a one dimensional array as storage element. The program should implement the basic addition, deletion and traversal operations.
3.	Represent a 2-variable polynomial using array. Use this representation to implement addition of polynomials.
4.	Represent a sparse matrix using array. Implement addition and transposition operations using the representation.
5.	Implement singly, doubly and circularly connected linked lists illustrating operations like addition at different locations, deletion from specified locations and traversal.
6.	Repeat exercises 2, 3 & 4 with linked structures.
7.	Implementation of binary tree with operations like addition, deletion, traversal.
8.	Depth first and breadth first traversal of graphs represented using adjacency matrix and list.
9.	Implementation of binary search in arrays and on linked Binary Search Tree.
10.	Implementation of insertion, quick, heap, topological and bubble sorting algorithms.

3EIU20		**DECA**	**MM:50**	**0L:0T:0 P**	**1 credit**

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4EIU1	ICC	Advance Engineering Mathematics-II	MM:150	3L:1T:0P	4 credit

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Complex Variable – Differentiation:** Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate; elementary analytic functions (exponential, trigonometric, logarithm) and their properties; Conformal mappings, Mobius transformations and their properties.	7
3	**Complex Variable - Integration:** Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy Integral formula (without proof), Liouville's theorem and Maximum-Modulus theorem (without proof); Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof).	8
4	**Applications of complex integration by residues:** Evaluation of definite integral involving sine and cosine. Evaluation of certain improper integrals.	4
5	**Special Functions:** Legendre's function, Rodrigues formula, generating function, Simple recurrence relations, orthogonal property. Bessel's functions of first and second kind, generating function, simple recurrence relations, orthogonal property.	10
6	**Linear Algebra:** Vector Spaces, subspaces, Linear independence, basis and dimension, Inner product spaces, Orthogonality, Gram Schmidt orthogonalization, characteristic polynomial, minimal polynomial, positive definite matrices and canonical forms, QR decomposition.	10
	Total	**40**

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4EIU2	DCC	Analog Circuits	MM:150	3L:1T:0P	4 credit

Diode Circuits, Amplifier models: Voltage amplifier, current amplifier, trans-conductance amplifier and trans-resistance amplifier. Biasing schemes for BJT and FET amplifiers, bias stability, various configurations (such as CE/CS, CB/CG, CC/CD) and their features, small signal analysis, low frequency transistor models, estimation of voltage gain, input resistance, output resistance etc., design procedure for particular specifications, low frequency analysis of multistage amplifiers.
High frequency transistor models, frequency response of single stage and multistage amplifiers, cascode amplifier. Various classes of operation (Class A, B, AB, C etc.), their power efficiency and linearity issues. Feedback topologies: Voltage series, current series, voltage shunt, current shunt, effect of feedback on gain, bandwidth etc., calculation with practical circuits, concept of stability, gain margin and phase margin.
Oscillators: Review of the basic concept, Barkhausen criterion, RC oscillators (phase shift, Wien bridge etc.), LC oscillators (Hartley, Colpitt, Clapp etc.), non-sinusoidal oscillators. Current mirror: Basic topology and its variants, V-I characteristics, output resistance and minimum sustainable voltage (VON), maximum usable load. Differential amplifier: Basic structure and principle of operation, calculation of differential gain, common mode gain, CMRR and ICMR. OP-AMP design: design of differential amplifier for a given specification, design of gain stages and output stages, compensation.
OP-AMP applications: review of inverting and non-inverting amplifiers, integrator and differentiator, summing amplifier, precision rectifier, Schmitt trigger and its applications. Active filters: Low pass, high pass, band pass and band stop, design guidelines.
Digital-to-analog converters (DAC): Weighted resistor, R-2R ladder, resistor string etc. Analog to digital converters (ADC): Single slope, dual slope, successive approximation, flash etc. Switched capacitor circuits: Basic concept, practical configurations, application in amplifier, integrator, ADC etc.

Text/Reference Books:

1.	J.V. Wait, L.P. Huelsman and GA Korn, Introduction to Operational Amplifier theory and applications, McGraw Hill, 1992.
2.	J. Millman and A. Grabel, Microelectronics, 2nd edition, McGraw Hill, 1988.
3.	P. Horowitz and W. Hill, The Art of Electronics, 2nd edition, Cambridge University Press, 1989.
4.	A.S. Sedra and K.C. Smith, Microelectronic Circuits, Saunder's College11 Publishing, Edition IV.
5.	Paul R. Gray and Robert G.Meyer, Analysis and Design of Analog

	Integrated Circuits, John Wiley, 3rdEdition.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
4EIU2	Analog Circuits	CO 1	Understand the characteristics of diodes and transistors
		CO 2	Design and analyze various rectifier and amplifier circuits
		CO 3	Design sinusoidal and non-sinusoidal oscillators
		CO 4	Understand the functioning of OP-AMP and design OP-AMP based circuits
		CO 5	Understanding the designing of ADCs and DACs

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
4EIU2 Analog Circuits	CO 1	3		1	1	2							
	CO 2	1	1	2		1							
	CO 3	3	1		1								
	CO 4	2				2							
	CO 5	2	3		2								

3: Strongly 2: Moderate 1: Weak

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Zero Lecture
Lecture 2	Diode Circuits and Amplifier models

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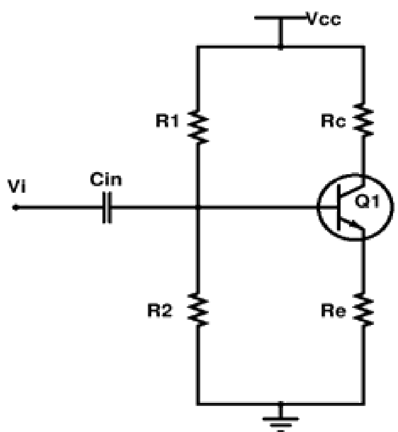
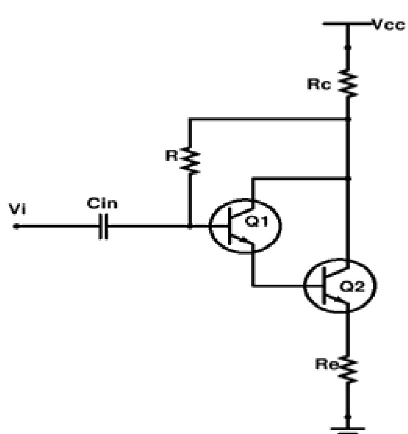
Lecture 3	Voltage amplifier, current amplifier, trans-conductance amplifier and trans-resistance amplifier
Lecture 4	Biasing schemes for BJT and FET amplifiers
Lecture 5	Bias stability in various configurations such as CE/CS, CB/CG, CC/CD
Lecture 6	Small signal analysis of BJT and FET
Lecture 7	low frequency transistor models
Lecture 8	Estimation of voltage gain, input resistance, output resistance etc.
Lecture 9	Design procedure for particular specifications, low frequency analysis of multistage amplifiers.
Lecture 10	High frequency transistor models
Lecture 11	frequency response of single stage and multistage amplifiers
Lecture 12	Cascode Amplifier
Lecture 13	Various classes of operation (Class A, B, AB, C etc.), their power efficiency and linearity issues
Lecture 14	Feedback topologies: Voltage series, current series, voltage shunt, current shunt
Lecture 15	Effect of feedback on gain, bandwidth etc.,
Lecture 16	Calculation with practical circuits
Lecture 17	Concept of stability, gain margin and phase margin.
Lecture 18	Basics of oscillator
Lecture 19	Barkhausen criterion, RC oscillators (phase shift, Wien bridge etc.)
Lecture 20	LC oscillators (Hartley, Colpitt, Clapp etc.)
Lecture 21	Non-sinusoidal oscillators. Current mirror: Basic topology and its variants,
Lecture 22	V-I characteristics, output resistance and minimum sustainable voltage (VON), maximum usable load.
Lecture 23	Differential amplifier: Basic structure and principle of operation, calculation of differential gain, common mode gain, CMRR and ICMR.
Lecture 24	OP-AMP design: design of differential amplifier for a given specification
Lecture 25	Design of gain stages and output stages, compensation
Lecture 26	OP-AMP applications: review of inverting and non-inverting amplifiers
Lecture 27	Integrator and differentiator, summing amplifier
Lecture 28	Precision rectifier, Schmitt trigger and its applications
Lecture 29	Active filters: Low pass, high pass
Lecture 30	Band pass and band stop Filters
Lecture 31	Filter Design guidelines
Lecture 32	Digital-to-analog converters (DAC): Weighted resistor, R-2R ladder, resistor string etc
Lecture 33	Analog to digital converters (ADC): Single slope, dual slope
Lecture 34	successive approximation, flash TYPE ADC

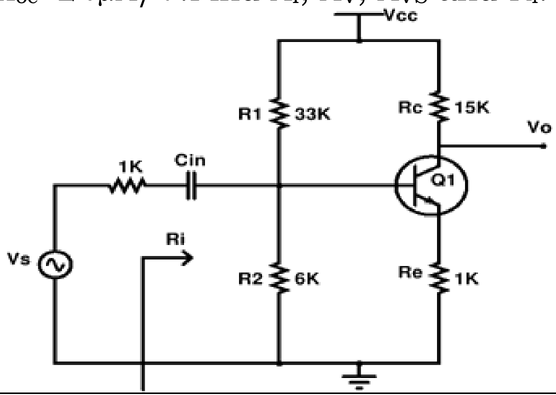
Lecture 35	Switched capacitor circuits: Basic concept
Lecture 36	Switched capacitor circuits: practical configurations
Lecture 37	Switched capacitor circuits: applications
Lecture 38	Spill over classes
Lecture 39	Spill over classes
Lecture 40	Spill over classes

Content delivery method:

1. Chalk and Duster
2. PPT
3. Hand-outs

Sample assignments:

Assignment 1	**Q1.** Assume that a silicon transistor with β =50, $V_{BEactive}$=0.7 V, V_{CC} =15V and R_C=10K is used in the Fig.1.It is desired to establish a Q-point at V_{CE}=7.5 V and I_C=5mA and stability factor $S \leq 5$.Find Re,$R_1$and R_2. 
	Q2. In the Darlington stage shown in Fig.2 , V_{CC}=15V , β_1=50, β_2=75,V_{BE}=0.7,R_C=750 Ω and R_E=100 Ω. If at the quiescent point V_{CE2}=6V determine the value of R. 

	Q3. For the amplifier shown in Fig.3 using a transistor whose parameters are $h_{ie}=1100, h_{re}=2.5\times10^{-4}, h_{fe}=50, h_{oe}=24\mu A/V$. Find A_I, A_V, A_{VS} and R_i. 
Assignment 2	**Q1.** Discuss the applications of operational amplifier.
	Q2. Discuss different types of filters.
	Q3. Discuss Dual counter type DAC and its applications

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4EIU3	DCC	Control Systems-I	MM:150	3L:0T:0P	3 credit

Systems and their representation: Terminology and basic structure of control system, Open loop and Closed loop systems, servomechanism, regulatory system, analogous systems, electrical analogy of physical systems, Physical Systems and their models, transfer function, Block diagram representation of physical systems, Block diagram algebra, Signal Flow graph and Mason's formula.
Time response: Types of test inputs, Response of first and second order system, Time domain specifications, Error coefficients, generalized error series. Concepts of stability: Characteristic equation, location of roots in s-plane for stability, asymptotic stability and relative stability, Routh-Hurwitz stability criterion.
Control system components: Potentiometers, synchros, Armature & Field controlled DC servomotors, AC servomotors, stepper motor and ac tacho generator.
Root Loci: Effect of pole zero addition, desired closed loop pole location, Root locus plot, Properties of Root loci and applications, Stability range from the loci. Determination of roots of the closed loop system, transient response and stability from root locus**.**
Frequency response: Frequency-domain techniques – Nyquist and Bode plots, Frequency response for systems with transportation lag, Frequency-domain specifications. Nyquist stability criterion, Bode plots- gain margin and phase margin.
Elementary ideas of compensating networks: Lag, Lead and Lag lead networks. Brief idea of proportional, derivative and integral controller.

Text/Reference Books:

6.1	Modern control Engineering, Ogata, Pearson.(2009)
6.2	Control system, M.Gopal, TMH (2011)
6.3	Control Systems: Principles & Design, M. Gopal, TMH 2002
6.4	Automatic Control System,B. C. Kuo,Wiley 2009
6.5	Singh & Janardhanan - Modern control engineering, Cengage learning 2010
6.6	Control Systems,Srivastava,TMH 2009
6.7	Systems and Control - Stanislawhizak, Oxford 2002
6.8	Control System Engineering,S. K. Bhattacharya,Pearson 2009
6.9	Control Systems: Theory And Applications,Ghosh,Pearson 2004
6.10	Manik – Control systems, Cengage learning 2012

Course Outcome:

Course Code	Course Name	Course Outcome	Details
4EIU3	Control Systems - I	CO 1	Study of basic structure of control system
		CO 2	Characterize a system mathematically and find its steady state behaviour
		CO 3	Analyze stability of a system using different tests
		CO 4	Design various controllers
		CO 5	Description of Control system components

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
4EIU3 Control Systems - I	CO 1	3	2	2	2	2			1				1
	CO 2	3	2	2	3	1							
	CO 3	2	2	3	3	2							
	CO 4	3	3	2	3	2			1				2
	CO 5	3	3	3	2	3			1				2

3: Strongly **2: Moderate** **1: Weak**

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Zero Lecture
Lecture 2	Terminology and basic structure of control system
Lecture 3	Open loop and Closed loop systems
Lecture 4	servomechanism, regulatory system
Lecture 5	analogous systems, electrical analogy of physical systems
Lecture 6	Physical Systems and their models, transfer function
Lecture 7	Block diagram representation of physical systems
Lecture 8	Block diagram algebra
Lecture 9	Signal Flow graph and Mason's formula.
Lecture 10	Types of test inputs
Lecture 11	Response of first and second order system
Lecture 12	Time domain specifications

Lecture 13	Error coefficients, generalized error series
Lecture 14	Concepts of stability: Characteristic equation
Lecture 15	location of roots in s-plane for stability
Lecture 16	asymptotic stability and relative stability
Lecture 17	Routh-Hurwitz stability criterion.
Lecture 18	Potentiometers
Lecture 19	Synchros
Lecture 20	Armature & Field controlled DC servomotors
Lecture 21	AC servomotors
Lecture 22	stepper motor
Lecture 23	ac tacho generator
Lecture 24	Effect of pole zero addition
Lecture 25	desired closed loop pole location
Lecture 26	Root locus plot
Lecture 27	Root locus plot
Lecture 28	Properties of Root loci and applications
Lecture 29	Stability range from the loci
Lecture 30	Determination of roots of the closed loop system
Lecture 31	transient response and stability from root locus
Lecture 32	Frequency-domain techniques – Nyquist and Bode plots
Lecture 33	Frequency response for systems with transportation lag
Lecture 34	Frequency-domain specifications
Lecture 35	Nyquist stability criterion
Lecture 36	Bode plots- gain margin
Lecture 37	Bode plots- phase margin
Lecture 38	Lag, Lead and Lag lead networks
Lecture 39	Brief idea of proportional controller
Lecture 40	Brief idea derivative and integral controller

Content delivery method:

1. Chalk and Duster
2. PPT
3. Animation
4. Hand-outs

Assignments:

Assignment 1	**Q1.** Find is the convolution of e^{-t} with sin(t) applying the convolution theorem.
	Q2. Find the transfer function Y (s) R(s) for the system with the following block diagram:

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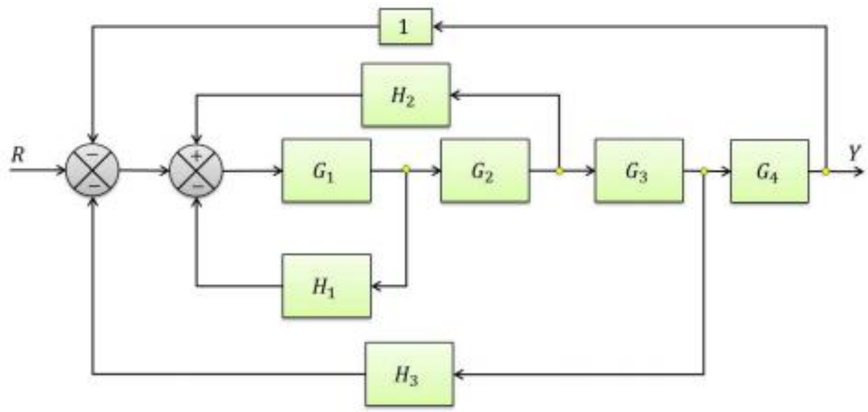

Q3. The forward transfer function of a unity feedback system is G(s) = K(s 2 + 1) (s + 1)(s + 2) The system is stable for

(a) K < −1
(b) K > −1
(c) K < −2
(d) K > −2

Q1. The root locus having the open loop transfer function G(s)H(s) = K s(s + 4)(s 2 + 4s + 5) has

(a) 3 breakaway point
(b) 3 breakin point
(c) 2 breakin point and 1 breakaway point
(d) 2 breakaway point and 1 breakin point

Q2. The phase margin of a system with open loop transfer function G(s)H(s) = 1 − s (s + 1)(s + 3), is

(a) 68.3 ^{o}
(b) 90^{o}
(c) 0^{o}
(d) ∞

Q3. Given the plant transfer function of a servomechanism to be G(s) = 10 s(s+2)(s+8) Design a lead-lag compensator Gc(s) in unity feedback configuration to meet the following specification for step response:

(a) Mp = 16.3%
(b) The rise time tr = 0.6046 sec
(c) The steady state error to a unit ramp input must be equal 0.0125.
What is the real part of the dominant poles of the compensated system?

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4EIU4	DCC	**Electronics Measurement & Instrumentation**	MM:150	3L:0T:0P	3 credit

THEORY OF ERRORS - Accuracy & precision, Repeatability, Limits of errors, Systematic & random errors, Modeling of errors, Probable error & standard deviation, Gaussian error analysis, Combination of errors.
ELECTRONIC INSTRUMENTS - Electronic Voltmeter, Electronic Multimeters, Digital Voltmeter, and Component Measuring Instruments: Q meter, Vector Impedance meter, RF Power & Voltage Measurements, Introduction to shielding & grounding.
OSCILLOSCOPES – CRT Construction, Basic CRO circuits, CRO Probes, Techniques of Measurement of frequency, Phase Angle and Time Delay, Multibeam, multi trace, storage & sampling Oscilloscopes.
SIGNAL GENERATION AND SIGNAL ANALYSIS - Sine wave generators, Frequency synthesized signal generators, Sweep frequency generators. Signal Analysis - Measurement Technique, Wave Analyzers, and Frequency - selective wave analyser, Heterodyne wave analyser, Harmonic distortion analyser, and Spectrum analyser.
TRANSDUCERS - Classification, Selection Criteria, Characteristics, Construction, Working Principles and Application of following Transducers:- RTD, Thermocouples, Thermistors, LVDT, Strain Gauges, Bourdon Tubes, Seismic Accelerometers, Tachogenerators, Load Cell, Piezoelectric Transducers, Ultrasonic Flow Meters.

Text/Reference Books:

1.	Electronic Instrument and Measurment, Bell, Oxford . 2007
2.	Electronic Measurements & Instrumentation, Bernard Oliver, TMH. 1971
3.	Electronic Instrumentation, H S Kalsi, TMH 2012
4.	Instrumentation Measurement & Analysis, B.C.Nakra,K.K. Chaudhry, TMH 2004
5.	Electronic Measurements and Instrumentation, Gupta &Soni, Genius pub. 2014.
6.	Electronic Measurements & Instrumentation, Bernard Oliver, John Cage, TMH 1971
7.	Electronic Measurements and Instrumentation, Lal Kishore, Pearson 2010

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8.	Elements of Electronic Instrumentation And Measurement, Carr, Pearson 1996
9.	Instrumentation for Engineering Measurements, 2ed, Dally, Wiley 1993
10.	Introduction To Measurements and Instrumetation, Arun K. Ghosh, PHI 2012

4EIU5	DCC	Analog and Digital Communication	MM:150	3L:0T:0P	3 credit

Review of signals and systems, Frequency domain representation of signals, Principles of Amplitude Modulation Systems- DSB, SSB and VSB modulations. Angle Modulation, Representation of FM and PM signals, Spectral characteristics of angle modulated signals.
Review of probability and random process. Gaussian and white noise characteristics, Noise in amplitude modulation systems, Noise in Frequency modulation systems. Pre-emphasis and Deemphasis, Threshold effect in angle modulation.
Pulse modulation. Sampling process. Pulse Amplitude and Pulse code modulation (PCM), Differential pulse code modulation. Delta modulation, Noise considerations in PCM, Time Division multiplexing, Digital Multiplexers.
Elements of Detection Theory, Optimum detection of signals in noise, Coherent communication with waveforms- Probability of Error evaluations. Baseband Pulse Transmission- Inter symbol Interference and Nyquist criterion. Pass band Digital Modulation schemes- Phase Shift Keying, Frequency Shift Keying, Quadrature Amplitude Modulation, Continuous Phase Modulation and Minimum Shift Keying.
Digital Modulation tradeoffs. Optimum demodulation of digital signals over band-limited channels- Maximum likelihood sequence detection (Viterbi receiver). Equalization Techniques. Synchronization and Carrier Recovery for Digital modulation.

Text/Reference Books:

1.	Haykin S., "Communications Systems", John Wiley and Sons, 2001.
2.	Taub H. and Schilling D.L., "Principles of Communication Systems", Tata McGraw Hill, 2001.
3.	Proakis J. G. and Salehi M., "Communication Systems Engineering", Pearson Education, 2002.
4.	Wozencraft J. M. and Jacobs I. M., ``Principles of Communication Engineering'',John Wiley, 1965.
5.	Barry J. R., Lee E. A. and Messerschmitt D. G., ``Digital Communication'', Kluwer Academic Publishers, 2004.
6.	Proakis J.G., ``Digital Communications'', 4th Edition, McGraw Hill, 2000.

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Course Outcome:

Course Code	Course Name	Course Outcome	Details
4EIU5	Analog and Digital Communication	CO 1	Analyze and compare different analog modulation schemes for their efficiency and bandwidth
		CO 2	Analyze the behavior of a communication system in presence of noise
		CO 3	Investigate pulsed modulation system and analyze their system performance
		CO 4	Analyze different digital modulation schemes and can compute the bit error performance
		CO 5	Design a communication system comprised of both analog and digital modulation techniques

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
4EIU5 Analog & Digital Communication	CO 1	3	3		3		1				1		
	CO 2	3	2		3		1						
	CO 3	3	2		3		2						
	CO 4	3	3		3		2				1		
	CO 5	3	2	3	3		3			2	2		

3: Strongly **2: Moderate** **1: Weak**

Content delivery method:

1. Chalk and Duster
2. PPT

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Introduction to the COURSE
Lecture 2	Review of signals and systems, Frequency domain representation of signals
Lecture 3	Principles of Amplitude Modulation Systems- DSB, SSB and VSB modulations
Lecture 4	Principles of Amplitude Modulation Systems- DSB, SSB and VSB modulations
Lecture 5	Principles of Amplitude Modulation Systems- DSB, SSB and VSB modulations
Lecture 6	Angle Modulation, Representation of FM and PM signals
Lecture 7	Angle Modulation, Representation of FM and PM signals
Lecture 8	Spectral characteristics of angle modulated signals.
Lecture 9	Review of probability and random process
Lecture 10	Review of probability and random process
Lecture 11	Noise in amplitude modulation systems
Lecture 12	Noise in amplitude modulation systems
Lecture 13	Noise in Frequency modulation systems
Lecture 14	Pre-emphasis and Deemphasis
Lecture 15	Threshold effect in angle modulation
Lecture 16	Pulse modulation. Sampling
Lecture 17	Pulse Amplitude and Pulse code modulation (PCM)
Lecture 18	Pulse Amplitude and Pulse code modulation (PCM)
Lecture 19	Differential pulse code modulation
Lecture 20	Delta modulation
Lecture 21	Noise considerations in PCM
Lecture 22	Time Division multiplexing, Digital Multiplexers
Lecture 23	Elements of Detection Theory
Lecture 24	Optimum detection of signals in noise
Lecture 25	Coherent communication with waveforms- Probability of Error evaluations
Lecture 26	Coherent communication with waveforms- Probability of Error evaluations
Lecture 27	BasebandPulse Transmission- Inter symbol Interference and Nyquist criterion
Lecture 28	BasebandPulse Transmission- Inter symbol Interference and Nyquist criterion
Lecture 29	Pass band Digital Modulation schemes
Lecture 30	Phase Shift Keying
Lecture 31	Frequency Shift Keying
Lecture 32	Quadrature Amplitude Modulation
Lecture 33	Continuous Phase Modulation and Minimum Shift Keying.

Lecture 34	Digital Modulation tradeoffs
Lecture 35	Optimum demodulation of digital signals over band-limited channels
Lecture 36	Optimum demodulation of digital signals over band-limited channels
Lecture 37	Maximum likelihood sequence detection (Viterbi receiver)
Lecture 38	Equalization Techniques
Lecture 39	Synchronization and Carrier Recovery for Digital modulation
Lecture 40	Synchronization and Carrier Recovery for Digital modulation

Assignments:

Assignment 1	**Q1.** Design Modulator and Demodulator of SSB-SC Modulation based on its mathematical expression.
	Q2. Derive the figure of merit in a) FM Receiver b) PM Receiver
	Q3. A Carrier signal c(t) = 20 cos $(2\pi 10^6 t)$ is modulated by a message signal having three frequencies 5 KHz, 10 KHz & 20 KHz. The corresponding modulation indexes are 0.4, 0.5 & 0.6. Sketch the spectrum. Calculate bandwidth, power and efficiency.
Assignment 2	**Q1.** Derive the expression for probability of error in ASK, FSK and PSK systems and compare them.
	Q2. With block diagrams explain about DPCM & DM. also compare them.
	Q3. A message signal m(t) = 4 cos $(2\pi 10^3 t)$ is sampled at nyquist rate and transmitted through a channel using 3-bit PCM system. i. Calculate all the parameters of the PCM. ii. If the sampled values are 3.8, 2.1, 0.5, -1.7, -3.2 & -4 then determine the quantizer output, encoder output and quantization error per each sample. iii. Sketch the transfer characteristics of the quantizer.

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4EIU6	DCC/IEC	Technical Communication	MM:150	2L:0T:0P	2 credit

SN		Hours
1	**Introduction to Technical Communication-** Definition of technical communication, Aspects of technical communication, forms of technical communication, importance of technical communication, technical communication skills (Listening, speaking, writing, reading writing), linguistic ability, style in technical communication.	4
2	**Comprehension of Technical Materials/Texts and Information Design & development**- Reading of technical texts, Reading and comprehending instructions and technical manuals, Interpreting and summarizing technical texts, Note-making. Introduction of different kinds of technical documents, Information collection, factors affecting information and document design, Strategies for organization, Information design and writing for print and online media.	6
3	**Technical Writing, Grammar and Editing-**Technical writing process, forms of technical discourse, Writing, drafts and revising, Basics of grammar, common error in writing and speaking, Study of advanced grammar, Editing strategies to achieve appropriate technical style, Introduction to advanced technical communication. Planning, drafting and writing Official Notes, Letters, E-mail, Resume, Job Application, Minutes of Meetings.	8
4	**Advanced Technical Writing-**Technical Reports, types of technical reports, Characteristics and formats and structure of technical reports. Technical Project Proposals, types of technical proposals, Characteristics and formats and structure of technical proposals. Technical Articles, types of technical articles, Writing strategies, structure and formats of technical articles.	8
	Total	**26**

Suggested Text/Reference Books

1. "Technical Communication", 2018, Rajesh K. Lidiya, Oxford University Press, India.
2. Communication Skills, Pushplata& Sanjay Kumar, Oxford University Press, India.
3. The Written Word, Vandana Singh, Oxford University Press, India.
4. Current English Grammar and Usage with Composition, R. P.

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Sinha, Oxford University Press, India.
5. Rodriques M. V., ‘Effective Business Communication’, Concept Publishing Company, New Delhi, 1992 reprint (2000).
6. Bansal, R K and Harrison J B, ‘Spoken English’ Orient Longman, Hyderabad.
7. Binod Mishra &Sangeeta Sharma, ‘Communication Skills for Engineers and Scientists, PHI Learning Private Ltd, New Delhi, 2011.
8. Gartside L. ‘Modern Business Correspondence, Pitman Publishing, London.

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4EIU11	**DCC**	**Control Lab**	**MM:75**	**0L:0T:3P**	**2 credit**

List of Experiments

Sr. No.	**Name of Experiment**
1.	To design I order system on R-C circuit and observe its response with the following inputs and trace the curve. (a) Step (b) Ramp (c) Impulse.
2.	To design II order electrical network and study its transient response for step input and following cases:- (a) Under damped System (b) Over damped System (c) Critically damped System.
3.	To Study the frequency response of following compensating networks, plot the graph and find out corner frequencies:- (a) Lag Network (b) Lead Network (c) Lag-lead Network.
4.	To perform experiment on stepper motor (finding step angle and frequency response etc.)
5.	To perform experiment on Potentiometer error detector.
6.	To perform experiments on Position control system using dc servomotor.
7.	a) To draw the error Vs angle characteristics of Synchro transmitter. b) To draw the characteristics of Synchro transmitter and control transformer.
8.	To perform experiments on relay control system.
9.	a) To find Transfer Function of a.c. servo motor. b) To draw Torque Speed Characteristics of a.c. servo motor.
10.	a) To find Transfer Function of d.c. servo motor. b) To draw Torque Speed Characteristics of armature controlled d.c. servo motor.

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11.	To identify a system T.F. using its frequency response.
12.	To perform experiments on magnetic levitation systems.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
4EIU11	**Control Lab**	**CO 1**	**Describe** State space model of a system (K2)
		CO 2	**Define** stability, controllability and observability (K1)
		CO 3	**Analyze**Analysis of Linear State Equations System modes and modal decomposition (K4)
		CO 4	**Solve** Solution of state equations, Pole placement by state feedback, Ackermann's Formula. (K3)
		CO 5	**Explain** Pole placement by state feedback, (K2)

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
4EIU11 Control Lab	**CO 1**	3	3	2	1	3							
	CO 2	3	2	2	2	3							
	CO 3	3	2	2	1	3							
	CO 4	3	2	2	2	3							
	CO 5	3	2	2	1	3							

3: Strongly **2: Moderate** **1: Weak**

Content delivery method:

1. Chalk, Board and Duster
2. PPT
3. Animation
4. Hand-outs

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4EIU12	**DCC**	**Electronic Measurement and Instrumentation Lab**	**MM:75**	**0L:0T:3P**	**2 credit**

List of Experiments

Sr. No.	**Name of Experiment**
1.	Measure earth resistance using fall of potential method.
2.	Plot V-I characteristics & measure open circuit voltage & short circuit current of a solar panel.
3.	Measure unknown inductance capacitance resistance using following bridges (a) Anderson Bridge (b) Maxwell Bridge
4.	To measure unknown frequency & capacitance using Wein's bridge.
5.	Measurement of the distance with the help of ultrasonic transmitter & receiver.
6.	Measurement of displacement with the help of LVDT.
7.	Draw the characteristics of the following temperature transducers (a) RTD (Pt-100) (b) Thermistors.
8.	Draw the characteristics between temperature & voltage of a K type thermocouple
9.	Calibrate an ammeter using D.C. slide wire potentiometer
10.	Measurement of strain/force with the help of strain gauge load cell.
11.	Study the working of Q-meter and measure Q of coils.

12.	Calibrate a single-phase energy meter (Analog and Digital) by phantom loading at different power factor by: (i) Phase shifting transformer (ii) Auto transformer.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
4EIU12	Electronic Measurement and Instrumentation Lab	CO 1	Understanding of the fundamentals of Electronic Instrumentation. Explain and identify measuring instruments.
		CO 2	Able to measure resistance, inductance and capacitance by various methods.
		CO 3	Design an instrumentation system that meets desired specifications and requirements.
		CO 4	Design and conduct experiments, interpret and analyze data, and report results.
		CO 5	Explain the principle of electrical transducers. Confidence to apply instrumentation solutions for given industrial applications.

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO 12
Measurement and Instrumentation	CO 1	3	2	1	2	2							
	CO 2	2	3	1	2	3							
	CO 3	1	3	2	3	2							
	CO 4	1	2	3	2	3							
	CO 5	1	2	3	3	3							

3: Strongly **2: Moderate** **1: Weak**

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4EIU13	DCC/IEC	Analog and Digital Communication Lab	MM:75	0L:0T:2P	1 credit

List of Experiments

Sr. No.	Name of Experiment
1.	Observe the Amplitude modulated wave form & measure modulation index and demodulation of AM signal.
2.	Harmonic analysis of Amplitude Modulated wave form.
3.	Generation & Demodulation of DSB – SC signal.
4.	Modulate a sinusoidal signal with high frequency carrier to obtain FM signal and demodulation of the FM signal.
5.	Verification of Sampling Theorem.
6.	To study & observe the operation of a super heterodyne receiver.
7.	PAM, PWM & PPM: Modulation and demodulation.
8.	To observe the transmission of four signals over a single channel using TDM-PAM method.
9.	To study the PCM modulation & demodulation and study the effect of channel like attenuation, noise in between modulator & demodulator through the experimental setup.
10.	To study the 4 channel PCM multiplexing & de-multiplexing in telephony system.
11.	To study the Delta & Adaptive delta modulation & demodulation and also study the effect of channel like attenuation, noise in between modulator & demodulator through the experimental setup.
12.	To perform the experiment of generation and study the various data formatting schemes (Unipolar, Bipolar, Manchester, AMI etc.)
13.	To perform the experiment of generation and detection of ASK, FSK, BPSK, DBPSK signals with variable length data pattern.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
4EIU13	Analog and Digital Communication Lab	CO 1	Understand different analog modulation schemes and evaluate modulation index
		CO 2	Able to understand the principle of superhetrodyne receiver
		CO 3	Develop time division multiplexing concepts in real time applications
		CO 4	Develop and able to comprehend different data formatting schemes
		CO 5	Comprehend and analyze the concepts of different digital modulation techniques in communication.

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
4EIU13Analog and Digital Communication Lab	CO 1	3	2		1								
	CO 2	3	2	1									
	CO 3	3	3	2	2	1							
	CO 4	3	3	2	2	1							
	CO 5	3	3	2	2	1							

3: Strongly **2: Moderate** **1: Weak**

4EIU14	**DCC/IEC**	**Analog Circuits Lab**	**MM:75**	**0L:0T:2P**	**1 credit**

List of Experiments

Sr. No.	**Name of Experiment**
1.	Study and implementation of Voltage Series and Current Series Negative Feedback Amplifier.
2.	Study and implementation of Voltage Shunt and Current Shunt Negative Feedback Amplifier.
3.	Plot frequency response of BJT amplifier with and without feedback in the emitter circuit and calculate bandwidth, gain bandwidth product with and without negative feedback.
4.	Study and implementation of series and shunt voltage regulators and calculate line regulation and ripple factor.
5.	Plot and study the characteristics of small signal amplifier using FET.
6.	Study and implementation of push pull amplifier. Measure variation of output power & distortion with load and calculate the efficiency.
7.	Study and implementation of Wein bridge oscillator and observe the effect of variation in oscillator frequency.
8.	Study and implementation of transistor phase shift oscillator and observe the effect of variation in R & C on oscillator frequency and compare with theoretical value.
9.	Study and implementation of the following oscillators and observe the effect of variation of capacitance on oscillator frequency: (a) Hartley (b) Colpitts.
10.	Study and implementation of the Inverting And Non-Inverting Operational Amplifier.
11.	Study and implementation of Summing, Scaling And Averaging of Operational Amplifier
12.	Implementation of active filters using OPAMP.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
4EIU14	Analog Circuits Lab	CO 1	Discuss and observe the operation of a bipolar junction transistor and field-effect transistor in different region of operations.
		CO 2	Analyze and design of transistor Amplifier and Oscillators. Importance of negative feedback.
		CO 3	Analyze the frequency response of amplifiers and operational amplifier circuits. Develop an intuition for analog circuit behavior in both linear and nonlinear operation.
		CO 4	Design op-amps for specific gain, speed, or switching performance. Compensate operational amplifiers for stability.
		CO 5	Design and conduct experiments, interpret and analyze data, and report results.

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
4EIU14 Analog Circuits Lab	CO 1	3	2	1	2	2							
	CO 2	2	3	1	2	3							
	CO 3	1	3	2	3	2							
	CO 4	1	2	3	2	3							
	CO 5	1	2	3	3	3							

3: Strongly **2: Moderate** **1: Weak**

4EIU20		DECA	MM:50	0L:0T:0P	1 credit

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5EIU1	DCC	Digital Signal Processing	MM:150	3L:1T:0P	4 credit

Discrete time signals: Sequences; representation of signals on orthogonal basis; Sampling and reconstruction of signals; Discrete systems attributes, Z-Transform, Analysis of LSI systems, frequency Analysis, Inverse Systems, Discrete Fourier Transform (DFT), Fast Fourier Transform Algorithm, Implementation of Discrete Time Systems
Design of FIR Digital filters: Window method, Park-McClellan's method. Design of IIR Digital Filters: Butterworth, Chebyshev and Elliptic Approximations; Lowpass, Bandpass, Bandstop and High pass filters.
Effect of finite register length in FIR filter design. Parametric and non-parametric spectral estimation. Introduction to mult-irate signal processing. Application of DSP.

Text/Reference Books:

1.	S.K. Mitra, Digital Signal Processing: A computer based approach. TMH
2.	A.V. Oppenheim and Schafer, Discrete Time Signal Processing, Prentice Hall, 1989.
3.	John G. Proakis and D.G. Manolakis, Digital Signal Processing: Principles, Algorithms And Applications, Prentice Hall, 1997
4.	L.R. Rabiner and B. Gold, Theory and Application of Digital Signal Processing, Prentice Hall, 1992.
5.	J.R. Johnson, Introduction to Digital Signal Processing, Prentice Hall, 1992.
6.	D.J. De Fatta, J. G. Lucas and W. S. Hodgkiss, Digital Signal Processing, John Wiley& Sons, 1988.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
5EIU1	Digital Signals Processing	CO 1	Represent signals mathematically in continuous and discrete time and frequency domain
		CO 2	Get the response of an LSI system to different signals
		CO 3	Design of different types of digital filters for various applications
		CO 4	Estimation of spectral parameters
		CO 5	Application of Digital Signal Processing

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CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
5EIU1Digital Signals Processing	CO 1	3	3	3	2	1							1
	CO 2	3	2	2	2	1							
	CO 3	2	3	3	2	3	2	1					
	CO 4	3	3	2	3	3							
	CO 5	2	2	2	2	2	2	2	3	1			2

3: Strongly 2: Moderate 1: Weak

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Zero Lecture
Lecture 2	Sequences; representation of signals on orthogonal basis
Lecture 3	Sequences; representation of signals on orthogonal basis
Lecture 4	Sequences; representation of signals on orthogonal basis
Lecture 5	Sampling and reconstruction of signals;
Lecture 6	Sampling and reconstruction of signals;
Lecture 7	Sampling and reconstruction of signals;
Lecture 8	Discrete systems attributes
Lecture 9	Discrete systems attributes
Lecture 10	Z-Transform
Lecture 11	Z-Transform
Lecture 12	Z-Transform
Lecture 13	Z-Transform
Lecture 14	Analysis of LSI systems
Lecture 15	Analysis of LSI systems
Lecture 16	frequency Analysis
Lecture 17	frequency Analysis
Lecture 18	Inverse Systems
Lecture 19	Inverse Systems
Lecture 20	Discrete Fourier Transform (DFT
Lecture 21	Fast Fourier Transform Algorithm
Lecture 22	Fast Fourier Transform Algorithm
Lecture 23	Implementation of Discrete Time Systems
Lecture 24	Design of FIR Digital filters

Lecture 25	Window method
Lecture 26	Park-McClellan's method
Lecture 27	Design of IIR Digital Filters
Lecture 28	Butterworth, Chebyshev filter
Lecture 29	Elliptic Approximations; Lowpass, Bandpass, Bandstop and High pass filters.
Lecture 30	Elliptic Approximations; Lowpass, Bandpass, Bandstop and High pass filters.
Lecture 31	Elliptic Approximations; Lowpass, Bandpass, Bandstop and High pass filters.
Lecture 32	Effect of finite register length in FIR filter design
Lecture 33	Effect of finite register length in FIR filter design
Lecture 34	Parametric and non-parametric spectral estimation
Lecture 35	Parametric and non-parametric spectral estimation
Lecture 36	Introduction to mult-irate signal processing.
Lecture 37	Introduction to mult-irate signal processing.
Lecture 38	Application of DSP
Lecture 39	Application of DSP
Lecture 40	Spill-over Classes

Content delivery method:

1. Chalk and Duster
2. PPT
3. Animation
4. Hand-outs

Assignments:

Assignment 1	**Q1.** Find a function f(t) = a + bt that is perpendicular to another function g(t) = 1 − t in the interval [0, 1].
	Q2. Comment on the linearity, time-invariant and invertibility property of Up-sampler and Down-sampler
	Q3. Why is a filter with a zerophase response necessarily causal?
Assignment 2	**Q1.** Prove that if the length of wavelet filter is L then the support of scaling function φ(t)is L − 1?
	Q2. What is the effect of cascading a (1- z^{-1}) term in the high pass analysis filter?

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	Q3. Interpret the following equation in the wake of perfect reconstruction: $\tau_0(Z) = 1\ 2\ \{H_1(-Z)\ H_0(Z) + (-H_0(-Z))\ H_1(Z)\}$

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5EIU2	**DCC**	**Sensors And Transducers**	**MM:150**	**3L:1T:0P**	**4 credit**

Introduction: Concepts and terminology of measurement system, transducer, sensor, Role of transducers - selection criteria, range and span, classification of transducers, applications of transducers, static and dynamic characteristics, sources of errors and their statistical analysis, standards and calibration.
Displacement Measurement: Fundamental Standards, Calibration, Resistive Potentiometer, Resistance Strain Gages, Differential Transformers, Induction Potentiometer, Variable Inductance and Variable Reluctance Pickup, Eddy current Non-contact type Transducer, Capacitance Pickup, Piezoelectric Transducers, Digital Displacement transducers: translation and rotary encoders, Ultrasonic transducers.
Velocity Measurement: Calibration, Velocity by electrical differentiation of displacement voltage signals, Average velocity from measurement of Δx and Δt, Mechanical fly ball angular velocity sensor, Mechanical revolution counters and timers, Magnetic and photoelectric pulse counting methods, Stroboscopic Methods, Translation velocity transducers : moving coil and moving magnet pickups, DC Tachometer generator for rotary velocity measurement, AC Tachometer generator for rotary velocity measurement, Eddy current drag-up tachometer.
Force and torque measurement: Basic methods of force measurement, elastic force traducers, strain gauge, load cells, shear web, piezoelectric force transducers, vibrating wire force transducers, Strain gauge torque meter, Inductive torque meter, Magneto-strictive transducers, torsion bar dynamometer, etc. Dynamometer (servo control and absorption) instantaneous power measurement and alternator power measurement.
Strain Measurement: Potentiometers, metal and semiconductor strain gauges and their signal conditioning circuits, Electrical strain gauges Wire & foil type materials, Adhesives, Protective coatings, Bonding, Temp. Compensation, Calibration, Applications Rosette gauges.

Text/Reference Books:

1.	B. C. Nakra and K. K. Choudhari, “Instrumentation Measurements and Analysis”, Tata McGraw Hill Education, Second ed., 2004.
2.	Doebelin E.O, “Measurement Systems - Application and Design”, 4th Edition, McGraw-Hill, New York (2003).
3.	A. K. Sawhney, “Electrical & Electronic Instruments & Measurement”, Dhanpat Rai and Sons, Eleventh ed., 2000.
4.	Electronic Measurements & Instrumentation, Oliver & Cage, TMH.1971

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5.	Instruments Transducers, Neubert, Oxford.1963.
6.	Elements of Electronic Instrumentation & Measurements, Joseph J. Carr, Pearson.2002
7.	Fundamentals of Instrumentation and Measurements, Dominique Placko, Wiley.2013
8.	Instrumentation Devices & Systems. Rangan, Sarma & Mani, MVGraw Hill.1983

Course Outcome:

Course Code	Course Name	Course Outcome	Details
5EIU2	Sensors And Transducers	CO 1	familiar with the basics of measurement system and its input, output configuration.
		CO 2	familiar with both static and dynamic characteristics of measurement system.
		CO 3	familiar with the principle and working of various sensors and transducers.
		CO 4	able to design signal conditioning circuit for various transducers.
		CO 5	able to identify or choose a transducer for a specific measurement application.

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
5EIU2 Sensors And Transducers	CO 1	2		1									
	CO 2	2	1	2									
	CO 3	3	1	1									
	CO 4	1	3	2									
	CO 5	2											

3: Strongly **2: Moderate** **1: Weak**

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Concepts and terminology of measurement system
Lecture 2	transducer, sensor
Lecture 3	Role of transducers - selection criteria, range and span
Lecture 4	classification of transducers, applications of transducers
Lecture 5	static and dynamic characteristics
Lecture 6	sources of errors and their statistical analysis
Lecture 7	standards and calibration
Lecture 8	Displacement Measurement:Fundamental Standards, Calibration
Lecture 9	Resistive Potentiometer, Resistance Strain Gages
Lecture 10	Differential Transformers, Induction Potentiometer
Lecture 11	Variable Inductance and Variable Reluctance Pickup
Lecture 12	Eddy current Non-contact type Transducer
Lecture 13	Capacitance Pickup, Piezoelectric Transducers
Lecture 14	Digital Displacement transducers: translation and rotary encoders
Lecture 15	Ultrasonic transducers
Lecture 16	Velocity Measurement: Calibration
Lecture 17	Velocity by electrical differentiation of displacement voltage signals
Lecture 18	Average velocity from measurement of Δx and Δt, Mechanical fly ball angular velocity sensor
Lecture 19	Mechanical revolution counters and timers, Magnetic and photoelectric pulse counting methods
Lecture 20	Stroboscopic Methods, Translation velocity transducers : moving coil and moving magnet pickups
Lecture 21	DC Tachometer generator for rotary velocity measurement
Lecture 22	AC Tachometer generator for rotary velocity measurement
Lecture 23	Eddy current drag-up tachometer.
Lecture 24	Force and torque measurement: Basic methods of force measurement
Lecture 25	elastic force traducers, strain gauge
Lecture 26	load cells, shear web
Lecture 27	piezoelectric force transducers
Lecture 28	vibrating wire force transducers, Strain gauge torque meter
Lecture 29	Inductive torque meter, Magneto-strictive transducers
Lecture 30	torsion bar dynamometer, etc
Lecture 31	Dynamometer (servo control and absorption) instantaneous power measurement and alternator power measurement
Lecture 32	Strain Measurement: Potentiometers
Lecture 33	metal and semiconductor strain gauges and their signal conditioning circuits

Lecture 34	metal and semiconductor strain gauges and their signal conditioning circuits
Lecture 35	Electrical strain gauges Wire & foil type materials
Lecture 36	Electrical strain gauges Wire & foil type materials
Lecture 37	Adhesives, Protective coatings
Lecture 38	Bonding, Temp. Compensation
Lecture 39	Calibration
Lecture 40	Applications Rosette gauges.

Content delivery method:

1. Chalk, Board and Duster
2. PPT
3. Animation
4. Hand-outs

5EIU3	DCC	Microcontrollers	MM:150	3L:0T:0P	3 credit

Overview of microcomputer systems and their building blocks, memory interfacing, concepts of interrupts and Direct Memory Access, instruction sets of microprocessors (with examples of 8085 and 8086);
Interfacing with peripherals - timer, serial I/O, parallel I/O, A/D and D/A converters; Arithmetic Coprocessors; System level interfacing design;
Concepts of virtual memory, Cache memory, Advanced coprocessor Architectures- 286, 486, Pentium; Microcontrollers: 8051 systems,
Introduction to RISC processors; ARM microcontrollers interface designs.

Text/Reference Books:

1.	R. S. Gaonkar, Microprocessor Architecture: Programming and Applications with the 8085/8080A, Penram International Publishing, 1996
2.	D A Patterson and J H Hennessy, "Computer Organization and Design The hardware and software interface. Morgan Kaufman Publishers.
3.	Douglas Hall, Microprocessors Interfacing, Tata McGraw Hill, 1991.
4.	Kenneth J. Ayala, The 8051 Microcontroller, Penram International Publishing, 1996.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
5EIU3	Microcontrollers	CO 1	Develop assembly language programming skills.
		CO 2	Able to build interfacing of peripherals like, I/O, A/D, D/A, timer etc.
		CO 3	Develop systems using different microcontrollers.
		CO 4	Explain the concept of memory organization.

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		CO 5	Understand RSIC processors and design ARM microcontroller based systems.

CO-PO Mapping:

Subject	**Course Outcomes**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
5EIU3 Microcontrollers	**CO 1**			3	1								
	CO 2			3		1							
	CO 3	1	2	3									
	CO 4	3	2	1									
	CO 5			3	2	1							

3: Strongly　　2: Moderate　　1: Weak

Lecture Plan:

Lecture No.	**Content to be taught**
Lecture 1	Zero Lecture
Lecture 2	Overview of microcomputer systems and their building blocks
Lecture 3	Overview of microcomputer systems and their building blocks
Lecture 4	Memory interfacing
Lecture 5	Memory interfacing
Lecture 6	Concepts of interrupts
Lecture 7	Direct Memory Access
Lecture 8	Direct Memory Access
Lecture 9	Instruction sets of microprocessors (with examples of 8085 and 8086)
Lecture 10	Instruction sets of microprocessors (with examples of 8085 and 8086)
Lecture 11	Instruction sets of microprocessors (with examples of 8085 and 8086)
Lecture 12	Instruction sets of microprocessors (with examples of 8085 and 8086)
Lecture 13	Interfacing with peripherals
Lecture 14	Timer
Lecture 15	Serial I/O

Lecture 16	Parallel I/O
Lecture 17	A/D and D/A converters;
Lecture 18	A/D and D/A converters
Lecture 19	Arithmetic Coprocessors
Lecture 20	System level interfacing design
Lecture 21	Concepts of virtual memory, Cache memory
Lecture 22	Concepts of virtual memory, Cache memory
Lecture 23	Advanced coprocessor Architectures- 286, 486, Pentium
Lecture 24	Advanced coprocessor Architectures- 286, 486, Pentium
Lecture 25	Advanced coprocessor Architectures- 286, 486, Pentium
Lecture 26	Microcontrollers: 8051 systems,
Lecture 27	Microcontrollers: 8051 systems,
Lecture 28	Microcontrollers: 8051 systems,
Lecture 29	Microcontrollers: 8051 systems,
Lecture 30	Microcontrollers: 8051 systems,
Lecture 31	Introduction to RISC processors
Lecture 32	Introduction to RISC processors
Lecture 33	Introduction to RISC processors
Lecture 34	ARM microcontrollers interface designs
Lecture 35	ARM microcontrollers interface designs
Lecture 36	ARM microcontrollers interface designs
Lecture 37	ARM microcontrollers interface designs
Lecture 38	ARM microcontrollers interface designs
Lecture 39	Spill Over Classes
Lecture 40	Spill Over Classes

Content delivery method:

1. Chalk and Duster
2. PPT
3. Hand-outs

Assignments:

Assignment 1	**Q1.** Compare between microprocessor & microcontroller based on no. of instructions used, registers, memory and applications.
	Q2. Interface external program memory with 8051 & explain how the data is transfer.
	Q3. List the I/O ports of microcontroller 8051. Explain their alternative function?
Assignment 2	**Q1.** Explain RISC and CISC?
	Q2. Without using MUL instruction, perform multiplication operation on any two operands, with both of them being:

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	a. Positive numbers b. One positive and other negative number c. Both negative numbers Verify the values computed.
	Q3. Can you brief up the evolution of ARM architecture?

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5EIU4	DCC	Industrial Instrumentation	MM:150	3L:0T:0P	3 credit

TEMPERATURE MEASUREMENTS - Thermocouples, Resistance Temperature detectors: 2-wire, 3-wire systems, Thermistors, Radiation and optical pyrometers, Infrared pyrometers, Calibration of temperature sensors.
PRESSURE MEASUREMENTS - Electric pressure transducers: LVDT, strain guage, Capacitive pressure transducers, Piezo electric pressure transducers, Potentiometric pressure transducer, Low pressure measurement: McLeod gauge, Thermal conductivity: Thermocouple type, Differential pressure transmitters, Calibration of pressure gauge: Dead weight tester.
FLOW MEASUREMENTS - Orifice, Venturi, Flow nozzles and pitot tubes, Rotameters, Vortex flowmeters, Electromagnetic flow meters, Ultrasonic flow meter, thermal flow meter, Mass flow type meters, Shunt flow meters.
LEVEL MEASUREMENTS - Float gauge, Bubbler (Purge) system, Hydrostatic pressure type in open vessels and closed vessels, Differential pressure method, Electrical conductivity method, Capacitance type, Radioactive type, Ultrasonic type.
DENSITY MEASUREMENTS - Ultrasonic densitometer, radiation densitometer, Impulse wheel methods.
RECORDER- Operating mechanism, Chart drive mechanism, Strip chart recorders, Circular chart recorders, X-Y type recorders, Magnetic tape recorders.

Text/Reference Books:

1.	Industrial Instrumentation ,S K Singh, New Age 2003.
2.	Transducer and Instrumentation DVS Murty PHI Publication 2004.
3.	Electronic Measurements & Instrumentation, Oliver & Cage, TMH 1971.
4.	Instruments Transducers, Neubert, Oxford 1986.
5.	Elements of Electronic Instrumentation & Measurements, Joseph J. Carr, Pearson 2002.
6.	Fundamentals of Instrumentation and Measurements, Dominique Placko, Wiley 2013.
7.	Instrumentation Devices & Systems. Rangan, Sarma & Mani, MVGraw Hill 1997.
8.	Industrial Instrumentation ,Krishnaswamy .K,New Age 2005.

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Course Outcome:

Course Code	Course Name	Course Outcome	Details
5EIU4	Industrial Instrumentation	CO 1	**Distinguish** between the various types of measurement parameters that are available.(K4)
		CO 2	To **identify** the various measurement techquines and select the best suitable one.(K2)
		CO 3	**Explain** the basic idea of different measurement process used.(K5)
		CO 4	**Analysis** of temperature , pressure , flow , density and level measurement can be done .(K1)
		CO 5	Build **ability** to troubleshoot different measurement related issues.(K3)

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
5EIU4 Industrial Instrumentation	CO 1	3	1	2	2	2							
	CO 2	2	2		1	3							
	CO 3	2	3	2	2	2							
	CO 4	2	1	2	3								
	CO 5	1	2	1	3	1							

3: Strongly **2: Moderate** **1: Weak**

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Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Thermocouples,
Lecture 2	Resistance Temperature detectors: 2-wire
Lecture 3	Resistance Temperature detectors: 3-wire systems
Lecture 4	Thermistors,
Lecture 5	Radiation
Lecture 6	optical pyrometers
Lecture 7	Infrared pyrometers,
Lecture 8	Calibration of temperature sensors.
Lecture 9	Electric pressure transducers: LVDT, strain guage,
Lecture 10	Capacitive pressure transducers,
Lecture 11	Piezo electric pressure transducers, Potentiometric pressure transducer,
Lecture 12	Low pressure measurement: McLeod gauge,
Lecture 13	Thermal conductivity
Lecture 14	Thermocouple type
Lecture 15	Differential pressure transmitters
Lecture 16	Differential pressure transmitters
Lecture 17	Calibration of pressure gauge: Dead weight tester
Lecture 18	Orifice, Venturi,
Lecture 19	Flow nozzles and pitot tubes
Lecture 20	Rotameters, Vortex flowmeters,
Lecture 21	Electromagnetic flow meters,
Lecture 22	Ultrasonic flow meter,
Lecture 23	thermal flow meter,
Lecture 24	Mass flow type meters,
Lecture 25	Shunt flow meters.
Lecture 26	Float gauge,
Lecture 27	Bubbler (Purge) system,
Lecture 28	Hydrostatic pressure type in open vessels and closed vessels,
Lecture 29	Hydrostatic pressure type in open vessels and closed vessels,

Lecture 30	Differential pressure method,
Lecture 31	Electrical conductivity method,
Lecture 32	Capacitance type, Radioactive type,
Lecture 33	Ultrasonic type.
Lecture 34	Ultrasonic densitometer,
Lecture 35	radiation densitometer,
Lecture 36	Impulse wheel methods.
Lecture 37	Operating mechanism, Chart drive mechanism
Lecture 38	Strip chart recorders, Circular chart recorders,
Lecture 39	X-Y type recorders,
Lecture 40	Magnetic tape recorders.

Content delivery method:

1. Chalk and Duster
2. PPT
3. Hand-outs

5EIU5.1	DEC	Biomedical Instrumentation	MM:150	3L:0T:0P	3 credit

TRANSDUCERS AND ELECTRODES- Principles and classification of transducers for Bio-medical applications, Electrode theory, different types of electrodes, Selection criteria for transducers and electrodes.
BIOPOTENTIALS- Electrical activity of excitable cells, ENG, EMG, ECG, ERG, ECG. Neuron potential.
CARDIOVASCULAR SYSTEM MEASUREMENTS- Measurement of blood pressure, blood flow, cardiac output, cardiac rate, heart sounds, Electrocardiograph, phonocardiograph, Plethysmograph, Echocardiograph.
INSTRUMENTATION FOR CLINICAL LABORATORY Measurement of pH value of blood, ESR measurement, hemoglobin measurement, O2 and CO2 concentration in blood, GSR measurement. Spectrophotomentry, chromatography, Hematology,
MEDICAL IMAGING: Diagnostic X-rays, CAT, MRI, thermography, ultrasonography, medical use of isotopes, endoscopy.
PATIENT CARE, BIOTELEMETRY AND SAFETY MEASURES Elements of Intensive care monitoring basic hospital systems and components, physiological effects of electric current shock hazards from electrical equipment, safety measures, Standards & practices. Biomedical Telemetry: Introduction, block diagram and description of single channel/multi channel telemetry systems.
THERAPEUTIC AND PROSTHETIC DEVICES - Introduction to cardiac pacemakers, defibrillators, ventilators, muscle stimulators, diathermy, heart lung machine, Hemodialysis, Applications of Laser. **APPLICATIONS OF BIOPOTENTIALS**: Electrocardiographic diagnostic criteria for Identification of cardiac disorders, Electrocardiographic pattern of ischemia, Atrial abnormalities, Ventricular enlargement, Abnormal ECG patterns, Clinical applications of EEG, EMG, ERG **COMPUTER APPLICATIONS**: data acquisition and processing, remote data recording and management. Real time computer applications

Text/Reference Books:

S.N	Name of books \author\publication	Year
1	L. Cromwell, F. J. Weibell, and L. A. Pfeiffer, Biomedical Instrumentation and Measurements, Pearson Education	1990
2	J. J. Carr and J. M. Brown, Introduction to Biomedical Equipment Technology, 4th ed., Pearson Education,	2001
3	Biomedical Instrumentation Systems ,Chatterjee, Cengage learning Pub.	2011
4	Aston, "Principles of Biomedical Instrumentation and measurements", McGraw Hill publishing Company.	1990
5	L.A. Geddes and L.E. Baker, Principles of Applied Biomedical Instrumentation , John Wiley & Sons,	1989
6	Richard Aston, Principles of Biomedical Instrumentation and Measurement , Merrill Publishing	1990
7	Jacobson B. and Webster J.G., Medical Clinical Engineers , Prentice Hall Inc.	1979

Course Outcome:

Course Code	Course Name	Course Outcome	Details
5EIU5.1	Biomedical Instrumentation	CO1	To develop the basic idea of human body systems and basic functions.(K6)
		CO2	Learn different types of sensors and electrodes that may be used for the betterment of human body system.(K1)
		CO3	To develop the understanding of different types of biomedical instruments used for human body .(K3)
		CO4	To apply the use biomedical instrument in day to day life. (K2)
		CO5	To analysis the multiple application of biomedical instrument devices.(K4)

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CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
5EIU5.1 Biomedical Instrumentation	CO1	2											
	CO2	2											
	CO3	1											
	CO4	3											
	CO5	1											

3: Strongly **2: Moderate** **1: Weak**

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Zero Lecture
Lecture 2	Brief description of neural, muscular, cardiovascular and respiratory systems;
Lecture 3	Brief description cardiovascular and respiratory systems
Lecture 4	their electrical, mechanical and chemical activities.
Lecture 5	Principles and classification of transducers for Bio-medical applications,
Lecture 6	Electrode theory, different types of electrodes,
Lecture 7	Selection criteria for transducers and electrodes.
Lecture 8	Electrical activity of excitable cells, ENG, EMG
Lecture 9	ECG, ERG, ECG. Neuron potential.
Lecture 10	Measurement of blood pressure, blood flow,
Lecture 11	cardiac output, cardiac rate, heart sounds,
Lecture 12	Electrocardiograph,
Lecture 13	phonocardiograph, Plethysmograph,
Lecture 14	Echocardiograph.
Lecture 15	ESR measurement, hemoglobin measurement,
Lecture 16	O2 and CO2 concentration in blood,
Lecture 17	GSR measurement, Hematology,
Lecture 18	Spectrophotomentry, chromatography,
Lecture 19	Diagnostic X-rays, CAT, MRI,

Lecture 20	thermography,
Lecture 21	ultrasonography,
Lecture 22	medical use of isotopes, endoscopy.
Lecture 23	Elements of Intensive care monitoring basic hospital systems and components
Lecture 24	Elements of Intensive care monitoring basic hospital systems and components
Lecture 25	physiological effects of electric current shock hazards from electrical equipment,
Lecture 26	safety measures, Standards & practices.
Lecture 27	Biomedical Telemetry: Introduction
Lecture 28	block diagram and description of single channel/multi channel telemetry systems
Lecture 29	block diagram and description of single channel/multi channel telemetry systems
Lecture 30	Introduction to cardiac pacemakers,
Lecture 31	defibrillators, ventilators,
Lecture 32	muscle stimulators, diathermy,
Lecture 33	Heart lung machine, Hemodialysis,
Lecture 34	Electrocardiographic diagnostic criteria for Identification of cardiac disorders,
Lecture 35	Electrocardiographic pattern of ischemia,
Lecture 36	Atrial abnormalities, Ventricular enlargement
Lecture 37	Abnormal ECG patterns, Clinical applications of EEG, EMG, ERG
Lecture 38	data acquisition and processing,
Lecture 39	remote data recording and management.
Lecture 40	Real time computer applications

Content delivery method:

1. Chalk and Duster
2. PPT
3. Animation
4. Hand-outs

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5EIU5.2	DEC	Control System Component	MM:150	3L:0T:0P	3 credit

Motors: Types, working principle, characteristic, and mathematical model of following: Motors AC/DC motors, stepper, servo, linear, Synchronous, Generators, and Alternator.
Types, working principle, characteristics, and symbolic representation of following: Switches: Toggle, Slide, DIP, Rotary, Thumbwheel, Selector, Limit, Proximity, Combinational switches, zero speed, belt sway, pull cord. Relays: Electromechanical, Solid state relays, relay packages Contactors: Comparison between relay & contactor, contactor size and ratings Timers: On Delay, Off delay and Retentive.
Sequencing & Interlocking for motors: Concept of sequencing & Interlocking, Standard symbols used for Electrical Wiring Diagram, Electrical Wiring diagrams for Starting, Stopping, Emergency shutdown, (Direct on line, star delta, soft starter) Protection devices for motors: Short circuit protection, Over load Protection, Over/ under voltage protection, Phase reversal Protection, high temperature and high current Protection, over speed, Reversing direction of rotation, Braking, Starting with variable speeds, Jogging/Inching Motor Control Center: Concept and wiring diagrams.
Pneumatic components: Pneumatic Power Supply and its components: Pneumatic relay (Bleed & Non bleed, Reverse & direct), Single acting & Double acting cylinder, Special cylinders: Cushion, Double rod, Tandem, Multiple position, Rotary Filter Regulator Lubricator (FRL), Pneumatic valves (direction controlled valves, flow control etc), Special types of valves like relief valve, pressure reducing etc. Hydraulic components: Hydraulic supply, Hydraulic pumps, Actuator (cylinder & motor), Hydraulic valves.

Text/Reference Books:

1.	B. L. Theraja, “A text book of Electrical Technology”, S. Chand & Company Ltd., IE - 09005 Control System Components Vol II First ed. 1959.
2.	S. R. Majumdhar, “Pneumatic Systems”, Tata McGraw-Hill Publisher, 2009.
3.	Meixner H and Sauer E, “Intro to Electro-Pneumatics”, Festo didactic,

	First ed. 1989.
4.	Hasebrink J P and Kobler R, "Fundamentals of Pneumatic Control Engineering", FestoDidactic: Esslinger(W Germany),1989.
5.	Petruzella, "Industrial Electronics", McGraw-Hill International First ed., 1996.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
5EIU5.2	Control System Components	CO 1	**Ability** to understand different types motors , actuators , relays and switches.(K3)
		CO 2	**Explain** the basic concept of semiconductor devices, stepper motor and DC motor.(K1)
		CO 3	**Ability** to deal with sequencing and interlocking of motors.(K4)
		CO 4	**Learn** about pneumatic components and its applications.(K5)
		CO 5	**Apply** the concept on various engineering projects.(K2)

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
5EIU5.2 Control System Components	CO 1	2	1	2	3	1							
	CO 2	2	3	2	1	1							
	CO 3	1	3	2	1	3							
	CO 4	1	2	3	2	2							
	CO 5	1	3	2	3	1							

3: Strong **2: Moderate** **1: Weak**

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Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Types , working principle
Lecture 2	character tics and mathematical model of following motors AC/DC motors
Lecture 3	character tics and mathematical model of following motors AC/DC motors
Lecture 4	stepper , servo , linear
Lecture 5	stepper , servo , linear
Lecture 6	synchronous ,generator and alternator
Lecture 7	Switchs , toggle , slides , DIP switch
Lecture 8	Rotary switch,
Lecture 9	Thumbwheel switch
Lecture 10	selector switch , Limit switch
Lecture 11	proximity , combinational switches,
Lecture 12	zero speed ,belt sway , pull cords,
Lecture 13	Relays , electrochemical
Lecture 14	solid state relays, relay package
Lecture 15	contactors , comparsion between relay and contractors , contractor size and
Lecture 16	ratings timers : on delay , off delay and retentive.
Lecture 17	Concept of sequencing and interlocking ,
Lecture 18	standard symobls used for electrical wiring diagram ,
Lecture 19	electrical wiring diagram for starting
Lecture 20	stopping, , emergency shutdown
Lecture 21	protection devices ,
Lecture 22	over under voltage protection
Lecture 23	phase reversal protection ,
Lecture 24	high temperature and high current protection ,
Lecture 25	over speed , reversing direction of rotation ,breaking ,
Lecture 26	starting with variable speeds ,

Lecture 27	jogging inching motors control center ,
Lecture 28	concept and wiring diagram
Lecture 29	pneumatic power supply and its components,
Lecture 30	pneumatic relays (bleed and non bleed, reverse and direct)
Lecture 31	pneumatic relays (bleed and non bleed, reverse and direct)
Lecture 32	single acting and double acting cylinders ,
Lecture 33	special cylinders (cushion , double rod , tandem, multiple position, rotary),
Lecture 34	special cylinders (cushion , double rod , tandem, multiple position, rotary),
Lecture 35	filter regulator lubricator,
Lecture 36	pneumatic valves (direction controlled valves , flow control etc.)
Lecture 37	pneumatic valves (direction controlled valves , flow control etc.)
Lecture 38	special type of valves , relief valve , pressure reducing valve
Lecture 39	hydraulic component : hydraulic supply hydraulic pumps
Lecture 40	actuator , hydraulic valves.

Content delivery method:

1. Chalk and Duster
2. PPT
3. Animation
4. Hand-outs

5EIU6.1	DEC	Probability Theory and Stochastic Processes	MM:150	2L:0T:0P	2 credit

Sets and set operations; Probability space; Conditional probability and Bayes theorem; Combinatorial probability and sampling models.
Discrete random variables, probability mass function, probability distribution function, example random variables and distributions; Continuous random variables, probability density function, probability distribution function, example distributions;
Joint distributions, functions of one and two random variables, moments of random variables; Conditional distribution, densities and moments; Characteristic functions of a random variable; Markov, Chebyshev and Chernoff bounds;
Random sequences and modes of convergence (everywhere, almost everywhere, probability, distribution and mean square); Limit theorems; Strong and weak laws of large numbers, central limit theorem.
Random process. Stationary processes .Mean and covariance functions. Ergodicity. Transmission of random process through LTI.Power spectral density.

Text/Reference Books:

1.	H. Stark and J. Woods, ``Probability and Random Processes with Applications to Signal Processing,'' Third Edition, Pearson Education
2.	A.Papoulis and S. UnnikrishnanPillai, ``Probability, Random Variables and Stochastic Processes,'' Fourth Edition, McGraw Hill.
3.	K. L. Chung, Introduction to Probability Theory with Stochastic Processes, Springer International
4.	P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Probability, UBS Publishers,
5.	P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Stochastic Processes, UBS Publishers
6.	S. Ross, Introduction to Stochastic Models, Harcourt Asia, Academic Press.

5EIU6.2	DEC	Embedded System Design	MM:150	2L:0T:0P	2 credit

Embedded system architecture and classifications, challenges, choice and selection of microcontrollers for embedded systems design. ARM Processor – Evolution, Architecture versions, Processor Families, Instruction Set – ARM state and Thumb state instructions, Software development tools.
TIVA ARM Cortex Architecture, Programming: Internal blocks – Processor core features, system peripherals, Memory map, bus system, debug support, User Peripherals, Serial Interfaces, Programming the peripherals using C – examples. Case studies of hardware design and software development.
OS Concepts and types, tasks & task states, process, threads, inter process communication, task synchronization, semaphores, role of OS in real time systems, scheduling, resource allocation, interrupt handling, other issues of RTOS. Examples of RTOS. Working with TI-RTOS with TIVA ARM Cortex embedded controllers

Text/Reference Books:

1.	Johnathon M Valvano, Embedded Systems: Introduction to ARM Cortex M Microcontrollers, 5th Edition, 2017
2.	Johnathon M. Valvano, Real Time Operating Systems for ARM Cortex M Microcontrollers, 4th Edition, 2017
3.	Joseph Yiu, The Definitive Guide to ARM Cortex M3 and ARM Cortex M4 Processors, 1st Edition, 2014

Course Outcome:

Course Code	Course Name	Course Outcome	Details
5EIU6.2	Embedded System Design	CO 1	To introduce the basic concepts of Embedded Systems
		CO 2	To expose to the design principles of advanced level ARM processors.
		CO 3	design embedded system for simple applications
		CO 4	write application programs in embedded C and test the programs using CCS.
		CO 5	develop application programs for execution under TI-RTOS environment.

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CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
5EIU6.2 Embedded System Design	CO 1	2		2									
	CO 2	2	3										
	CO 3	2		2		1							
	CO 4	2	2										
	CO 5	2			1	1							

3: Strongly 2: Moderate 1: Weak

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Zero Lecture: Overview of subject
Lecture 2	Embedded system architecture and classifications
Lecture 3	Embedded system architecture and classifications
Lecture 4	challenges, choice and selection of microcontrollers for embedded systems design.
Lecture 5	challenges, choice and selection of microcontrollers for embedded systems design.
Lecture 6	ARM Processor – Evolution
Lecture 7	Architecture versions
Lecture 8	Processor Families
Lecture 9	Instruction Set – ARM state and Thumb state instructions
Lecture 10	Instruction Set – ARM state and Thumb state instructions
Lecture 11	Instruction Set – ARM state and Thumb state instructions
Lecture 12	Software development tools
Lecture 13	TIVA ARM Cortex Architecture
Lecture 14	Programming: Internal blocks – Processor core features
Lecture 15	Programming: Internal blocks – Processor core features
Lecture 16	system peripherals
Lecture 17	Memory map
Lecture 18	bus system,
Lecture 19	debug support
Lecture 20	User Peripherals

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Lecture 21	Serial Interfaces
Lecture 22	Programming the peripherals using C – examples
Lecture 23	Programming the peripherals using C – examples
Lecture 24	Programming the peripherals using C – examples
Lecture 25	Case studies of hardware design and software development.
Lecture 26	Case studies of hardware design and software development.
Lecture 27	OS Concepts and types
Lecture 28	OS Concepts and types
Lecture 29	tasks & task states
Lecture 30	Process
Lecture 31	Threads
Lecture 32	inter process communication
Lecture 33	task synchronization
Lecture 34	Semaphores
Lecture 35	role of OS in real time systems
Lecture 36	Scheduling
Lecture 37	resource allocation, interrupt handling
Lecture 38	other issues of RTOS. Examples of RTOS
Lecture 39	Working with TI-RTOS with TIVA ARM Cortex embedded controllers
Lecture 40	Working with TI-RTOS with TIVA ARM Cortex embedded controllers

Content delivery method:

1. Chalk, Board and Duster
2. PPT
3. Animation
4. Hand-outs

5EIU11	DCC	Transducer Lab	MM:75	0L:0T:3P	2 credit

List of Experiments

Sr. No.	Name of Experiment
1.	To draw the characteristics of following temperature transducers: - (a)PT 100 (b) Thermistor (c) K Type Thermocouple
2.	To perform experiment on ultrasonic depth meter.
3.	Water level measurement kit: a) To draw I/P vs O/P characteristics. b) Study of water level indication. c) To plot the curve between error and different measured water level.
4.	Load Cell Kit: a) To perform experiment and plot curve between load and strain. b) To study about excitation. c) To plot error curve at different loads.
5.	To study Piezo electric vibration pickup.
6.	LVDT Kit: a) To study excitation and balancing network. b) To study phase difference. c) To plot curve between displacement and output voltage.
7.	Torque measurement Kit: a) To study about unbalanced strain. b) To plot the curve between torque vss train.
8.	To draw characteristics of LDR.
9.	To draw Characteristics of Hall effect sensor.
10.	Design of Opto-coupler using photoelectric transducers.
11.	To study various pressure sensors like Bourdon tube, Diaphragms, Pressure switches, Bellows etc.

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Course Outcome:

Course Code	Course Name	Course Outcome	Details
5EIU11	Transducer Lab	CO 1	**Describe** the characteristics of temperature transducers(K2)
		CO 2	**Design** of Opto-coupler using photoelectric transducers (K5)
		CO 3	**Analyze** characteristics of LDR, Hall effect sensor (K4)
		CO 4	**Experiment** and plot curve between load and strain (K3)
		CO 5	**Explain** various pressure sensors like Bourdon tube, Diaphragms, Pressure switches, Bellows etc. (K2)

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
5EIU11 Transducer Lab	CO 1	2	1		1	2							
	CO 2	1	1		2								
	CO 3	1	1	1	2								
	CO 4	1	1		2								
	CO5	1	1										

3: Strong **2: Moderate** **1: Weak**

Content delivery method:

1Chalk, Board and Duster

2PPT

3Animation

4Hand-outs

5EIU12	**DCC**	**Biomedical Instrumentation Lab**	**MM:75**	**0L:0T:2P**	**1 credit**

List of Experiments

Sr. No.	**Name of Experiment**
1.	Measurement of optical power attenuation and numerical aperture in a plastic optical fiber.
2.	Study and measurement of losses in optical fiber.
3.	Measurements of various amplitudes and time intervals between each segment of ECG, Measurement of R-R interval and calculation of Heart Rate.
4.	Determination of Heart Axis by measuring QRS amplitude in the different leads (Lead I, Lead II and Lead III) and Plotting Einthoven Triangle.
5.	Measurement of Heart rate variability (HRV) and analysis using time and frequency based approach.
6.	Recording of blood pressure using sphygmomanometer & stethoscope and relate with heart rate.
7.	Recording of the EMG Signal for different stress on the muscle.
8.	To find out various lung capacity measurements using pneumotachograph.
9.	Study of EEG Signal, to measure the amplitude, frequency & nature of EEG.
10.	Design of an instrumentation amplifier for amplification of the low level ECG signals for gain 1000 and CMRR >100 dB and flat frequency response from 4 to 40 Hz.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
5EIU12	Biomedical Inst. Lab	CO 1	**Identify** practical aspects of measurement and instrumentation (K1).
		CO 2	**Recognize** the limitations of physiological measurements (K2).
		CO 3	**Experiment** and test with biomedical instrumentation equipment (K4).
		CO 4	**Deduce** measurements and interpret data from physiological systems(K4).
		CO 5	**Develop**, discuss and apply electrical engineering concepts and principles to a range of problems and medical applications (K3).

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
5EIU12 Biomedical Inst. Lab	CO 1	3	1										
	CO 2	1	3										
	CO 3	1	2	1	3	2							
	CO 4	2	1	1	1	3							
	CO 5	2	2	3	2								

3: Strongly **2: Moderate** **1: Weak**

Content delivery method:

1. Chalk, Board and Duster
2. PPT
3. Animation
4. Hand-outs

5EIU13	DCC	Microcontrollers Lab	MM:75	0L:0T:2P	1 Credit

List of Experiments

Sr. No.	Name of Experiment
Following exercises has to be Performed on 8085	
1.	Write a program for 1.1 Multiplication of two 8 bit numbers 1.2 Division of two 8 bit numbers
2.	Write a program to arrange a set of data in Ascending and Descending order.
3.	Write a program to find Factorial of a given number.
4.	Write a program to generate a Software Delay. 4.1 Using a Register 4.2 Using a Register Pair
8085 Interfacing Programs	
5.	5.1 Write a program to Interface ADC with 8085.
	5.2 Write a program to interface Temperature measurement module with 8085.
6.	Write a program to interface Keyboard with 8085.
7.	Write a program to interface DC Motor and stepper motor with 8085.
Following exercises has to be Performed on 8051	
8.	Write a program to convert a given Hex number to Decimal.
9.	Write a program to find numbers of even numbers and odd numbers among 10 Numbers.
10.	Write a program to find Largest and Smallest Numbers among 10 Numbers.
11.	11.1 To study how to generate delay with timer and loop.
	11.2 Write a program to generate a signal on output pin using timer.
8051 Interfacing Programs	
12	12.1 Write a program to interface Seven Segment Display with 8051.
	12.2 Write a program to interface LCD with 8051.

13	Write a program for Traffic light Control using 8051.
14	Write a program for Elevator Control using 8051.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
5EIU13	**Microcontrollers Lab**	**CO 1**	Develop skills related to assembly level programming of microprocessors and microcontroller.
		CO 2	Interpret the basic knowledge of microprocessor and microcontroller interfacing, delay generation, waveform generation and Interrupts.
		CO 3	Interfacing the external devices to the microcontroller and microprocessor to solve real time problems.
		CO 4	Illustrate functions of various general purpose interfacing devices.
		CO 5	Develop a simple microcontroller and microprocessor based systems

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
5EIU13 Microcontrollers Lab	**CO 1**	2	1	2	1	3							
	CO 2	3	2	1	2	1							
	CO 3	1	1	3	1	3							
	CO 4	2	2	1									
	CO 5	1	1	3	2	2		2					

3: Strongly **2: Moderate** **1: Weak**

5EIU14	DCC/IEC	**Control System Simulation Lab-I**	**MM:75**	**0L:0T:2P**	**1 Credit**

1.	Introduction to `Matlab'. Computing control software, defining systems in TF, ZPK form.
2.	Use of for, while loops in Matlab programming.
3.	(a). Plot step response a given TF and system in state-space. Take different valves of damping ratio and natural undamped frequency and observe the difference. (b). Plot ramp and impulse response for the same.
4.	For a given 2nd order system write a program to obtain time response specifications maximum overshoot, peak time, settling time etc.
5.	Write a program to check for the stability of a given closed loop system by (a) Finding close loop poles (b) using Routh's stability criterion.
6.	Sketch the root locus for a given system and determine the system gain. Also simulate the same using MATLAB.
7.	Sketch the Bode plot (actual and asymptotic) for a given system and analyses the stability. Also simulate the same using MATLAB and find the values of GM and PM for different values of gain.
8.	Design of lead controller to satisfy given specifications using bode plot.
9.	Use MATLAB to plot Nyquist plot for a given system and comment upon stability.
10.	To design a PID controller for the given system to meet desired specifications. Observe the response using MATLAB.

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Course Outcome:

Course Code	Course Name	Course Outcome	Details
5EIU14	Control System Simulation Lab-I	CO 1	To understand the control system and its different types practically.
		CO 2	To develop the understanding of MATLAB programming.
		CO 3	To plot the bode plot, Nyquist plot for the given system.
		CO 4	To find out the root locus of the system practically.
		CO 5	To develop the practical understand of the subject.

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
5EIU14 Control System Simulation Lab-I	CO 1	2											
	CO 2	3											
	CO 3	2											
	CO 4	2											
	CO 5	1											

3: Strongly **2: Moderate** **1: Weak**

5EIU20		DECA	MM:50	0L:0T:0P	1 credit

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6EIU1	DCC	Neural Networks And Fuzzy Logic Control	MM:150	3L:1T:0P	4 Credit

NEUROPHYSIOLOGY: Introduction: Elementary neurophysiology – From neurons to ANNs - Neuron model McCulloch-Pitts model, Hebbian Hypothesis; limitations of single-layered neural networks. Applications Of Neural Networks: Pattern classification, Associative memories, Optimization, Applications in Image Processing-Iris, finger print & face, Applications in decision making.
THE PERCEPTRON: The Perceptron and its learning law. Classification of linearly separable patterns. Linear Networks: Adaline - the adaptive linear element. Linear regression. The Wiener-Hopf equation. The Least-Mean-Square (Widrow-Hoff) learning algorithm. Method of steepest descent. Adaline as a linear adaptive filter. A sequential regression algorithm. Multi-Layer Feedforward Neural Networks: Multi-Layer Perceptrons. Supervised Learning. Approximation and interpolation of functions. Back-Propagation Learning law. Fast training algorithms. Applications of multilayer perceptrons: Image coding, Paint-quality inspection, Nettalk.
FUZZY LOGIC: Introduction -Uncertainty & precision, Statistics and random process, Uncertainty in information, Fuzzy sets and membership. Membership Functions: Features of membership function. Standard forms and boundaries, Fuzzification, Membership value assignment – Intuition, Inference, Neural networks. Fuzzy To Crisp Conversions: Maximum membership principle.
DEFUZZIFICATION METHODS- Centroid method, Weighted average method, Meanmax membership. Fuzzy Rule Based Systems: Natural language, linguistic hedges, Rule based system –Canonical rule forms, Decomposition of compound rules, Likelihood and truth qualification Aggregation of Fuzzy rules. Graphical techniques of reference.
FUZZY CONTROL SYSTEM- Simple Fuzzy Logic controller, General FLC, Control System Design Problem Control (Decision) Surface, Assumptions in a Fuzzy Control System Design, Special forms of FLC system models, Industrial application: Aircraft Landing Control Problem. Fuzzy Engineering Process Control: Classical Feedback Control, Classical PID Control, Multi-input, Multi-output (MIMO) Control Systems, Fuzzy Statistical Process Control

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Text/Reference Books:

S.No.	Name of Book/publication/Authors
1.	S.N. Sivanandam, S. Sumathi and S.N. Deepa -Introduction to Neural Networks using MATLAB 6.0, Tata McGraw-Hill 2006.
2.	Timothy J. Ross -Fuzzy Logic with Engineering Applications, Third Edition 1995.
3.	Artificial Neural Network,Robert Schalloff, TMH 1997
4.	Fundamental Of Neural Network Architecture And Application, Laurene V. Fausett, Pearson 1993
5.	Neural Network Algorithm And Programing Tech, James A Freeman, Pearson 1991
6.	Neural N/W For Pattern Recognition, Cristopher, M.Bhishop, Oxford 1995
7.	Fuzzy Neuro Approach To Agent Application, Lee ,Raymond S.T., New Age 2008
8.	Fuzzy Logic and Neural Networks: Basic Concept And Application, A Lavala, Chemakesava R.,New Age 2012

Course Outcome:

Course Code	Course Name	Course Outcome	Details
6EIU1	Neural Networks And Fuzzy Logic Control	CO 1	**Discuss** the elementary neurophysiology with the study of Neurons and different models & applications for Neural Networks**.** (K2)
		CO 2	**Describe** the perceptron, the linear networks & the Multi-Layer Feed forward Neural Networks(K2).
		CO 3	**Explain** theFuzzy Logics, their uncertainty & precision & the Membership Function. (K6)
		CO 4	**Illustrate** the Defuzzification Methods & Fuzzy Rule based Systems (K4).
		CO 5	**Examine** Fuzzy Control Systems & Fuzzy Engineering Process Control & their applications (K3)

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CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
6EIU1 Neural Networks And Fuzzy Logic Control	**CO 1**	3		2		1							
	CO 2	3			2	1							
	CO 3	3			2	1							
	CO 4	2	3		1								
	CO 5	3		2	1								

3: Strong 2: Moderate 1: Weak

Lecture Plan:

Lecture No.	**Content to be taught**
Lecture 1	Introduction: Elementary neurophysiology
Lecture 2	Neuron model McCulloch-Pitts model
Lecture 3	Hebbian Hypothesis; limitations of single-layered neural networks
Lecture 4	Application in Pattern classification, Associative memories, Optimization
Lecture 5	Applications in Image Processing-Iris, finger print & face
Lecture 6	Applications in decision making
Lecture 7	The Perceptron and its learning law
Lecture 8	Classification of linearly separable patterns
Lecture 9	Adaline - the adaptive linear element, Linear regression.
Lecture 10	The Wiener-Hopf equation. The Least-Mean-Square (Widrow-Hoff) learning algorithm.
Lecture 11	Method of steepest descent. Adaline as a linear adaptive filter. A sequential regression algorithm
Lecture 12	Multi-Layer Perceptrons
Lecture 13	Supervised Learning

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Lecture 14	Approximation and interpolation of functions. Back-Propagation Learning law
Lecture 15	Fast training algorithms. Applications of multilayer perceptrons: Image coding,
Lecture 16	Paint-quality inspection, Nettalk.
Lecture 17	Introduction -Uncertainty & precision
Lecture 18	Statistics and random process, Uncertainty in information
Lecture 19	Fuzzy sets and membership
Lecture 20	Features of membership function
Lecture 21	Standard forms and boundaries
Lecture 22	Fuzzification, Membership value assignment – Intuition, Inference
Lecture 23	Neural networks & Maximum Membership Principle
Lecture 24	Neural networks & Maximum Membership Principle
Lecture 25	Centroid method
Lecture 26	Weighted average method
Lecture 27	Meanmax membership
Lecture 28	Natural language, linguistic hedges
Lecture 29	Rule based system –Canonical rule forms, Decomposition of compound rules
Lecture 30	Decomposition of compound rules
Lecture 31	Likelihood and truth qualification Aggregation of Fuzzy rules
Lecture 32	Graphical techniques of reference
Lecture 33	Simple Fuzzy Logic controller
Lecture 34	General FLC, Control System Design Problem Control (Decision) Surface
Lecture 35	General FLC, Control System Design Problem Control (Decision) Surface
Lecture 36	Assumptions in a Fuzzy Control System Design, Special forms of FLC system models
Lecture 37	Industrial application: Aircraft Landing Control Problem
Lecture 38	Classical Feedback Control
Lecture 39	Classical PID Control, Multi-input, Multi-output (MIMO) Control Systems
Lecture 40	Fuzzy Statistical Process Control

Content delivery method:

1. Chalk and Duster
2. PPT
3. Animation

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6EIU2	DCC	Control System- II	MM:150	3L:1T:0P	4 Credit

State space Model- Review of vectors and matrices, Canonical Model from Differential Equations and Transfer Functions, Interconnection of Subsystems.
Analysis of Linear State Equations- First Order Scaler Differential Equation, System modes and modal decomposition, State Transition Matrix, Time –varying matrix case, Solution of state equations. Pole placement by state feedback, Ackermann's Formula.
Lyapunov's stability theory for Linear System- Equilibrium points and stability concepts, Stability Definitions, Linear system stability, The Direct method of Lyapunov, Use of Lyapunov's method in feedback design.
Controllability & Observability- Definitions, Controllability/Observability Criteria, Design of state feedback control systems, Full-order and Reduced-order observer Design, Stabilizability and Detectability

Text/Reference Books:

1.	Modern Control Engineering, Ogata K, Prentice Hall, New Delhi. (2010).
2.	Linear System Theory, Hespanha, J.P., Princeton University Press.
3.	Mathematical Control Theory, Sontag, E.D., second edition, Springer Verlag, 2014.
4.	Ogata K, Discrete Time Control Systems PHI Learning. (2010).
5.	Richard Dorf & Robert Bishop,Modern Control Systems, Pearson Education. (2011).
6.	M .Gopal, Control Systems: Principles and Design, Mc Graw Hill Publications. (2008).
7.	Franklin Powell , Feedback Control Of Dynamical Systems, Pearson Education. (2008).
8.	Singh & Janardhanan - Modern control engineering, Cengage learning. (2010).

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Course Outcome:

Course Code	Course Name	Course Outcome	Details
6EIU2	Control System - II	CO 1	**Describe** State space model of a system and Lyapunov's stability theory. (K2)
		CO 2	**Define** stability, controllability and observability (K1)
		CO 3	**Analyze** Analysis of Linear State Equations System modes and modal decomposition (K4)
		CO 4	**Solve** Solution of state equations, Pole placement by state feedback, Ackermann's Formula. (K3)
		CO 5	**Explain** Lyapunov's stability theory for Linear System, Pole placement by state feedback, (K2)

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
6EIU2 Control System - II	CO 1	3	2	2									
	CO 2	3	3	3	1								
	CO 3	3	2	2									
	CO 4	3	3	3									
	CO 5	3	2	2									

3: Strong 2: Moderate 1: Weak

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Review of vectors and matrices
Lecture 2	Review of vectors and matrices

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Lecture 3	Canonical Model from Differential Equations and Transfer Functions
Lecture 4	Canonical Model from Differential Equations and Transfer Functions
Lecture 5	Canonical Model from Differential Equations and Transfer Functions
Lecture 6	Interconnection of Subsystems
Lecture 7	Interconnection of Subsystems
Lecture 8	Interconnection of Subsystems
Lecture 9	First order Scaler Differential Equation
Lecture 10	System modes and modal decomposition
Lecture 11	System modes and modal decomposition
Lecture 12	State Transition Matrix
Lecture 13	State Transition Matrix
Lecture 14	Time –varying matrix case
Lecture 15	Solution of state equations
Lecture 16	Solution of state equations
Lecture 17	Pole placement by state feedback, Ackermann's Formula
Lecture 18	Pole placement by state feedback, Ackermann's Formula
Lecture 19	Equalibrium points and stability concepts
Lecture 20	Equalibrium points and stability concepts
Lecture 21	Stability Definitions,
Lecture 22	Linear system stability
Lecture 23	Linear system stability
Lecture 24	The Direct method of Lyapunov
Lecture 25	The Direct method of Lyapunov
Lecture 26	Use of Lyapunov's method in feedback design
Lecture 27	Use of Lyapunov's method in feedback design
Lecture 28	Definitions, Controllability Criteria
Lecture 29	Definitions, Controllability Criteria
Lecture 30	Definitions, Observability Criteria
Lecture 31	Definitions, Observability Criteria
Lecture 32	Design of state feedback control systems
Lecture 33	Design of state feedback control systems
Lecture 34	Design of state feedback control systems
Lecture 35	Full-order observer Design
Lecture 36	Full-order observer Design
Lecture 37	Reduced-order observer Design
Lecture 38	Reduced-order observer Design
Lecture 39	Stabilizability
Lecture 40	Detectability

Content delivery method:

1. Chalk and Duster
2. Animation
3. Hands-out

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6EIU3	DCC	Power Electronics	MM:150	3L:0T:0P	3 credit

SEMICONDUCTOR POWER DEVICES: Introduction. Basic characteristics &working of Power Diodes, Diac, Triac, MOSFETs, IGBT, GTO, Power Transistor and SCR- Principle of operation, V-I Characteristics, Turn-On mechanism and its applications
CONVERTERS: Basic concept, Working Principles of Single phase half Wave bridge converter, Single Phase Full Bridge Converter, 3 Phase Bridge Converter.
INVERTERS: Voltage Source Inverter, Current Source Inverter, PWM Control of Voltage Source Converter and applications.
INDUSTRIAL POWER SUPPLIES: Principle of operation of choppers. Step up, Step down and reversible choppers. Chopper control techniques, High frequency electronic ballast, Switch Mode Power Supply: Fly back converter, forward/buck converter, Boost converter and buck-boost converter. Uninterruptible Power Supply.
MOTOR CONTROL: Introduction to speed control of DC motors using phase controlled converters and choppers, Basic idea of speed control of three phase induction motors using voltage and frequency control methods.
STEPPER MOTORS: Principle of operation, Types of stepper motor: Variable reluctance, Permanent magnet and hybrid stepper motors. Brushless DC motor and its control. Induction and dielectric heating control.

Text/Reference Books:

1.	Power Electronics Principles & Applications, Joseph Vithayathil, TMH, (2010).
2.	Power Eletronics, M.D.Singh, TMH, (2012).
3.	Industrial Electronics And Control, Ttti, TMH (2001)
4.	Power Electronics: Converters Applications., Mohan, Robbins, Wiley (1995)
5.	Power Electronics, Moorthi, Oxford (2005)
6.	Elements Of Power Electronics, Krein, Oxford (1998)
7.	Power Electronics, R.S.Murthy, Pearson (2012)
8.	Power Electronics: Circuits, Devices And Applications (2004)
9.	Industrial Electronics: Thomas E. Kissell, PHI (2004).

10. Power Electronics: Sivanagaraju, Reddy Prasad PHI (2010)

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6EIU4	DCC	Process Control System	MM:150	3L:0T:0P	3 credit

GENERAL CONCEPTS: General Concepts and terminology, Piping and Instrumentation diagram
TYPES OF DYNAMIC PROCESS: Instantaneous, Integral, First and second Order, self-regulating, interacting and non-interacting processes. Dead time elements
MATHEMATICAL MODELING OF SYSTEMS: Liquid Systems (Level and flow), perturbation variable and linearization methods. Response of a thermometer bulb, Concentration response of a stirred tank. Temperature response of a stirred tank, Process lag, load disturbance and their effect on processes.
BASIC CONTROL ACTION: Basic control action, two position, multi Position, continuous controller modes: proportional, integral and Derivative Composite Controller modes PI, PD, PID, Integral wind up and anti-wind up. Response of controllers for different test Input .Selection of control modes for processes like level, temperature and flow.
CONTROLLER TUNING METHODS: Evaluation criteria IAE, ISE, ITAE etc. process reaction curve method, continuous oscillation method, damped oscillation method, auto tuning.
FINAL CONTROL ELEMENTS: Pneumatic control value, construction details and types, value sizing, selection of control valves, Inherent and Installed characteristics valve actuators and positioners.
ADVANCED CONTROL SYSTEM: Cascade control, ratio control, feed forward control. Over-ride, split range and selective control. Multivariable process control, Interaction of control loops.
CASE STUDY: Distillation column, Basic features of composition control schemes. Control of overhead composition, Bottom composition and both product compositions, Location of sensing element, Control of columns with varying feed rates, Pressure control, Control of feed temperature and internal reflux control, boiler drum level control.

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Text/Reference Books:

1.	Peter Harriott, "Process Control", Tata McGraw Hill, New Delhi, 1985
2.	Surekha Bhanot "Process control principals and applications" , Oxford University press, 2007
3.	Principles of Industrial Instrumentation and Control Systems, Alavala, Cengage Learning 2004
4.	Process dynamics and Control, Sundaram, Cengage Learning, 2005

Course Outcome:

Course Code	Course Name	Course Outcome	Details
6EIU4	Process Control System	CO 1	To **discuss** the different types basics control actions and control system(K1)
		CO 2	To **identify** the different types of process control and interaction loop.(K4)
		CO 3	**Ability** to understand and analyze various control modes for various process.(K6)
		CO 4	**Explain** the basic concept of instrumentation and piping terminology.(K3)
		CO 5	To **develop** skills to build and trouble shoot different encountering problems.(K2)

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
6EIU4 Process Control System	CO 1	2	3	2	2								
	CO 2	1	3	3	1								
	CO 3	1	2	2	1								

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

3: Strong **2: Moderate** **1: Weak**

Lecture Plan:

Lecture No.	**Content to be taught**
Lecture 1	General Concepts and terminology,
Lecture 2	Piping and Instrumentation diagram
Lecture 3	Piping and Instrumentation diagram
Lecture 4	Types of dynamic process: Instantaneous, Integral,
Lecture 5	Types of dynamic process: First and second Order
Lecture 6	self-regulating, interacting
Lecture 7	non-interacting processes
Lecture 8	Dead time elements
Lecture 9	Liquid Systems (Level and flow),
Lecture 10	perturbation variable and linearization methods.
Lecture 11	Response of a thermometer bulb
Lecture 12	Concentration response of a stirred tank
Lecture 13	Concentration response of a stirred tank
Lecture 14	Temperature response of a stirred tank, Process lag
Lecture 15	Temperature response of a stirred tank, Process lag
Lecture 16	load disturbance and their effect on processes.
Lecture 17	load disturbance and their effect on processes.
Lecture 18	Basic control action, two position, multi Position,
Lecture 19	Basic control action, two position, multi Position,
Lecture 20	continuous controller modes: proportional, integral and Derivative Composite Controller modes
Lecture 21	continuous controller modes: proportional, integral and Derivative Composite Controller modes
Lecture 22	PI, PD, PID, Integral wind up and anti-wind up.
Lecture 23	PI, PD, PID, Integral wind up and anti-wind up.
Lecture 24	Response of controllers for different test Input .
Lecture 25	Selection of control modes for processes like level, temperature

	and flow.
Lecture 26	Evaluation criteria IAE, ISE, ITAE etc. process reaction curve method,
Lecture 27	continuous oscillation method,
Lecture 28	damped oscillation method,
Lecture 29	auto tuning.
Lecture 30	Pneumatic control valves,
Lecture 31	construction details and types, value sizing, selection of control valves,
Lecture 32	construction details and types, value sizing, selection of control valves
Lecture 33	Inherent and Installed characteristics valve actuators and positioners
Lecture 34	Cascade control, ratio control, feed forward control.
Lecture 35	Over-ride, split range and selective control.
Lecture 36	Multivariable process control,
Lecture 37	Interaction of control loops.
Lecture 38	Distillation column, Basic features of composition control schemes, Control of overhead composition
Lecture 39	Bottom composition and both product compositions, Location of sensing element
Lecture 40	Control of columns with varying feed rates, Pressure control, Control of feed temperature and internal reflux control, boiler drum level control.

Content delivery method:

1. Chalk and Duster
2. PPT
3. Animation

6EIU5.1	DEC	Optical Instrumentation	MM:150	3L:0T:0P	3 credit

OPTICAL FIBER OVERVIEW- Introduction, Ray theory, Optical fibers: multimode, single mode, step index, graded index, plastic & glass fibers. Transmission Characteristics of Optical Fibers - Introduction, Attenuation, Material absorption loss, Fiber bend loss, scattering, Dispersion (intermodal & intramodal), Dispersion Shifted Fibers, Dispersion Compensating Fibers. Manufacturing of optical Fibers – preparation of optical fiber, Liquid phase techniques, Vapour phase depositions techniques.
OPTICAL FIBER SOURCES- Laser- Emission and absorption of radiation, Einstein relation, Absorption of radiation, Population inversion, Optical feedback, Threshold condition. Population inversion and threshold, working of three levels & four level laser. Basic idea of solid state, semiconductors, gas & liquid laser. Basic concept of Q-switching and mode locking. Light Emitting Diode - Structure, Material, Characteristics, Power & Efficiency.
OPTICAL DETECTORS & CONNECTION - Optical detection principles, quantum efficiency, Responsivity, PIN photo diode, Avalanche photo diodes, Noise in Detectors, Photo Diode Materials. Fiber Alignment, fiber splices, fiber connectors, expanded beam connectors, fiber couplers.
OPTICAL FIBER MEASUREMENTS - Measurements of Fiber Attenuation, Dispersion, Refractive Index Profile, Cut off Wave Length, Numerical Aperture & Diameter. Field measurement through optical time domain reflectometry (OTDR), Laser based systems for measurement of distance, Velocity, Holography.
OPTICAL FIBER APPLICATIONS – Wavelength division multiplexing, DWDM, active and passive components, optical sensors, optical amplifiers, public network applications, military, civil and industrial applications.

Text/Reference Books:

1.	J.M. Senior, Optical Fiber Communication: Principles and Practice, Pearson Education. 2013
2.	R.P. Khare, Fiber Optics & Optoelectronics, Oxford Publications. 2014
3.	R.P. Khare, Fiber Optics & Optoelectronics, Oxford Publications 2004.
4.	J.Gowar, Optical Communication Systems, PHI 1999.
5.	A.Ghatak & K.Thygarajan, Introduction to Fiber Optics, Cambridge University Press 2006.
6.	Joseph C Palais, Fiber Optics Communication, PHI 2010.
7.	Harold Kolimbris, Fiber Optics Communication, Pearson Education 2009.
8.	D. Anuradha, Optical Fiber and Laser, Principles and Applications, New Age 2008.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
6EIU5.1	Optical Instrumentation	CO 1	To **identify** the basic knowledge of optical fiber communication and its necessity.(K2)
		CO 2	**Analysis** of different modes of propagation of optical fiber communication.(K5)
		CO 3	To **identify** and discuss different optical detection process.(K3)
		CO 4	To **develop** the different optical fiber communication generation sources and detection.(K6)
		CO 5	To **understand** the different measuring parameters and instruments.(K1)

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
6EIU5.1 Optical Instrumentation	CO 1	2	3	3	1	2							
	CO 2	3	1	1	2								
	CO 3	2	1	3									
	CO 4	1	3	1	2								
	CO 5	2	2	2	2	3							

3: Strongly **2: Moderate** **1: Weak**

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Lecture Plan:

Lecture No.	**Content to be taught**
Lecture 1	Zero Lecture: Overview of subject
Lecture 2	Introduction, Ray theory
Lecture 3	Optical fibers: multimode, single mode,
Lecture 4	step index, graded index optical fiber
Lecture 5	plastic & glass fibers.
Lecture 6	Transmission Characteristics of Optical Fibers – Introduction
Lecture 7	Attenuation, Material absorption loss, Fiber bend loss, scattering
Lecture 8	Dispersion (intermodal & intramodal), Dispersion Shifted Fibers,
Lecture 9	Dispersion Compensating Fibers.
Lecture 10	Manufacturing of optical Fibers – preparation of optical fiber
Lecture 11	Liquid phase techniques
Lecture 12	Vapour phase depositions techniques
Lecture 13	Laser- Emission and absorption of radiation,
Lecture 14	Einstein relation,
Lecture 15	Absorption of radiation,
Lecture 16	Population inversion, Optical feedback, Threshold condition.
Lecture 17	Population inversion and threshold, working of three levels & four level laser.
Lecture 18	Basic idea of solid state, semiconductors, gas & liquid laser.
Lecture 19	Basic concept of Q-switching and mode locking.
Lecture 20	Light Emitting Diode - Structure, Material, Characteristics, Power & Efficiency.
Lecture 21	Optical detection principles
Lecture 22	quantum efficiency,
Lecture 23	Responsivity,
Lecture 24	PIN photo diode,
Lecture 25	Avalanche photo diodes,
Lecture 26	Noise in Detectors,
Lecture 27	Photo Diode Materials.
Lecture 28	Fiber Alignment, fiber splices, fiber connectors, expanded beam connectors, fiber couplers.
Lecture 29	Measurements of Fiber Attenuation
Lecture 30	Dispersion
Lecture 31	Refractive Index Profile, Cut off Wave Length,
Lecture 32	Numerical Aperture & Diameter.
Lecture 33	Field measurement through optical time domain reflectometry (OTDR),
Lecture 34	Laser based systems for measurement of distance, Velocity, Holography.
Lecture 35	Wavelength division multiplexing

Lecture 36	DWDM
Lecture 37	active and passive components
Lecture 38	optical sensors, optical amplifiers
Lecture 39	public network applications, military
Lecture 40	civil and industrial applications

Content delivery method:

1. Chalk, Board and Duster
2. PPT
3. Animation
4. Hand-outs

6EIU5.2	DEC	Robotics	MM:150	3L:0T:0P	3 credit

INTRODUCTION- Introduction: Basic concepts, definition and origin of robotics, different types of robots, robot classification, applications, robot specifications
INTRODUCTION TO AUTOMATION – Components and subsystems, basic building block of automation, manipulator arms, wrists and end effectors. Transmission elements: Hydraulic, pneumatic and electric drives. Gears, sensors, materials, user interface, machine vision, implications for robot design, controllers.
KINEMATICS, DYNAMICS AND CONTROL- Object location, three dimensional transformation matrices, inverse transformation, kinematics and path planning, Jacobian work envelope, manipulator dynamics, dynamic stabilization, position control and force control, present industrial robot control schemes.
ROBOT PROGRAMMING- Robot programming languages and systems, levels of programming robots, problems peculiar to robot programming, control of industrial robots using PLCs.
AUTOMATION AND ROBOTS- Case studies, multiple robots, machine interface, robots in manufacturing and non-manufacturing applications, robot cell design, selection of a robot.

Text/Reference Books:

1.	Spong, M.W., Hutchinson, H., & Vidyasagar, M., “Robot Modeling and Control”, John Wiley (Wiley India Ed.), (2006).
2.	Asfahl C.R, “Robots and Manufacturing Automation”, John Wiley & Sons, New York, (1992).
3.	Klafter R.P, Chmiclewski T.A, Negin M, “Robotics Engineering: Integrated approach”, Prentice Hall, New Jersey, (1994)
4.	Mikell P, Weiss G.M, Nagel R.N and Odrey N.G, “Industrial Robotics”, McGraw Hill, New York, (1986).
5.	Deb S.R, Robotics Technology and Flexible Automation, Tata McGraw Hill, New Delhi, (1994).

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Course Outcome:

Course Code	Course Name	Course Outcome	Details
6EIU5.2	Robotics	CO 1	To **learn** the basics of robot designing.(K5)
		CO 2	To **deal** with the depth of modern technology and utilize its knowledge.(K2)
		CO 3	To have the clear **concept** of automation , microcontroller and kinematics.(K3)
		CO 4	To **design** their own robots for simple application with cost effective and little effort.(K1)
		CO 5	To **apply** their knowledge in real life.(K4)

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
6EIU5.2 Robotics	CO 1	1	3	1	2	3							
	CO 2	2	2	1	2	3							
	CO 3	3	3	2	1	2							
	CO 4	2	2	3	1	2							
	CO 5	1	3	1	2	3							

3: Strongly 2: Moderate 1: Weak

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Zero Lecture: Overview of subject
Lecture 2	Introduction: Basic concepts

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Lecture 3	definition and origin of robotics
Lecture 4	different types of robots,
Lecture 5	robot classification,
Lecture 6	applications,
Lecture 7	robot specifications
Lecture 8	Components and subsystems
Lecture 9	Components and subsystems
Lecture 10	basic building block of automation,
Lecture 11	basic building block of automation,
Lecture 12	manipulator arms, wrists and end effectors.
Lecture 13	manipulator arms, wrists and end effectors.
Lecture 14	Transmission elements: Hydraulic, pneumatic and electric drives.
Lecture 15	Transmission elements: Hydraulic, pneumatic and electric drives.
Lecture 16	Gears, sensors, materials, user interface, machine vision, implications for robot design, controllers.
Lecture 17	Gears, sensors, materials, user interface, machine vision, implications for robot design, controllers.
Lecture 18	Object location, three dimensional transformation matrices
Lecture 19	Object location, three dimensional transformation matrices
Lecture 20	inverse transformation, kinematics and path planning,
Lecture 21	inverse transformation, kinematics and path planning,
Lecture 22	Jacobian work envelope,
Lecture 23	manipulator dynamics,
Lecture 24	dynamic stabilization,
Lecture 25	position control and force control,
Lecture 26	position control and force control
Lecture 27	present industrial robot control schemes.
Lecture 28	Robot programming languages and systems,
Lecture 29	Robot programming languages and systems,
Lecture 30	levels of programming robots,
Lecture 31	levels of programming robots,
Lecture 32	problems peculiar to robot programming,
Lecture 33	problems peculiar to robot programming,
Lecture 34	control of industrial robots using PLCs.
Lecture 35	Case studies, multiple robots, machine interface,
Lecture 36	Case studies, multiple robots, machine interface,
Lecture 37	robots in manufacturing and non-manufacturing applications
Lecture 38	robots in manufacturing and non-manufacturing applications
Lecture 39	robot cell design,

Lecture 40	Selection of robot

Content delivery method:

1. Chalk, Board and Duster
2. PPT
3. Animation
4. Hand-outs

6EIU6.1	DEC	Computer Network	MM:150	2L:0T:0P	2 credit

Introduction to computer networks and the Internet: Application layer: Principles of network applications, The Web and Hyper Text Transfer Protocol, File transfer, Electronic ail, Domain name system, Peer-to-Peer file sharing, Socket programming, Layering concepts.
Switching in networks: Classification and requirements of switches, a generic switch, Circuit Switching, Time-division switching, Space-division switching, Cross bar switch and evaluation of blocking probability, 2-stage, 3-stage and n-stage networks, Packet switching, Blocking in packet switches, Three generations of packet switches ,switch fabric, Buffering, Multicasting, Statistical Multiplexing.
Transport layer: Connectionless transport - User Datagram Protocol, Connection oriented transport –Transmission Control Protocol, Remote Procedure Call. Congestion Control and Resource Allocation: Issues in Resource Allocation, Queuing Disciplines, TCP congestion Control, Congestion Avoidance Mechanisms and Quality of Service.
Network layer: Virtual circuit and Datagram networks, Router, Internet Protocol, Routing algorithms, Broadcast and Multicast routing
Link layer: ALOHA, Multiple access protocols, IEEE 802 standards, Local Area Networks, addressing, Ethernet, Hubs, Switches.

Text/Reference Books:

1.	J.F. Kurose and K. W. Ross, “Computer Networking – A top down approach featuring the Internet”, Pearson Education, 5th Edition
2.	L. Peterson and B. Davie, “Computer Networks – A Systems Approach” Elsevier Morgan Kaufmann Publisher, 5th Edition.
3.	T. Viswanathan, “Telecommunication Switching System and Networks”, Prentice Hall
4.	S. Keshav, “An Engineering Approach to Computer Networking” , Pearson Education
5.	B. A. Forouzan, “Data Communications and Networking”, Tata McGrawHill,4th Edition
6.	Andrew Tanenbaum, “Computer networks”, Prentice Hall
7.	D. Comer, “Computer Networks and Internet/TCP-IP”, Prentice Hall
8.	William Stallings, “Data and computer communications”, Prentice Hall

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Course Outcome:

Course Code	Course Name	Course Outcome	Details
6EIU6.1	Computer Networks	CO 1	Describe the significance and concepts of computer networks and services offered at each layer.
		CO 2	Analyse and appreciate the layered model for computer networking.
		CO 3	Identify basic protocols and design issues for layered model.
		CO 4	Design and implement protocols related to various networking layers.
		CO 5	Explain different switching in networks.

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
6EIU6.1 Computer Networks	CO 1	3	2	1									
	CO 2	2	3	1	2								
	CO 3	1	3	2	3								
	CO 4	1	2	3	2								
	CO 5	3	1										

3: Strongly 2: Moderate 1: Weak

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Zero Lecture: Overview of subject
Lecture 2	Introduction to computer networks and the Internet
Lecture 3	Application layer, Principles of network applications
Lecture 4	Detail explanation of web and Hyper Text Transfer Protocol
Lecture 5	File transfer, Electronic mail services
Lecture 6	Domain name system, Peer-to-Peer file sharing

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Lecture 7	Socket programming
Lecture 8	Layering concepts of networks
Lecture 9	Introduction of Switching in networks: Classification and requirements of switches
Lecture 10	A generic switch, Circuit Switching,
Lecture 11	Time-division switching, Space-division switching
Lecture 12	Crossbar switch and evaluation of blocking probability
Lecture 13	2-stage, 3-stage and n-stage networks
Lecture 14	2-stage, 3-stage and n-stage networks continued.
Lecture 15	Packet switching, Blocking in packet switches, Three generations of packet switches
Lecture 16	Switch fabric, Buffering, Multicasting
Lecture 17	Statistical Multiplexing, summary of switching networks.
Lecture 18	Introduction of Transport layer: Connectionless transport - User Datagram Protocol
Lecture 19	Connection-oriented transport – Transmission Control Protocol
Lecture 20	Remote Procedure Call
Lecture 21	Congestion Control and Resource Allocation: Issues in Resource Allocation, Queuing Disciplines
Lecture 22	Congestion Control and Resource Allocation: Issues in Resource Allocation, Queuing Disciplines Continued
Lecture 23	TCP congestion Control
Lecture 24	Congestion Avoidance Mechanisms and Quality of Service
Lecture 25	Congestion Avoidance Mechanisms and Quality of Service continued.
Lecture 26	Summary of transport layer and congestion control
Lecture 27	Introduction to network layer, Virtual circuit and datagram network,
Lecture 28	Routers, Internet Protocol
Lecture 29	Internet Protocol
Lecture 30	Routing Algorithms
Lecture 31	Broadcast and multicast routing
Lecture 32	Broadcast and multicast routing continued and review of network layer
Lecture 33	Introduction to data link layer and ALOHA
Lecture 34	Detail explanation of Multiple access protocols
Lecture 35	IEEE 802 standards
Lecture 36	Local area Networks
Lecture 37	Data link layer addressing
Lecture 38	Ethernet, Hub
Lecture 39	Switches
Lecture 40	Summary of data link layer and Review of whole syllabus

Content delivery method:

1. Chalk, Board and Duster
2. PPT
3. Animation
4. Hand-outs

Assignments:

Assignment 1	**Q1. (a)**Consider an FTP session in which the user three separate *get* commands. How many TCP connections are created during this session? Explain. **(b)** An IMAP server keeps track of which email messages have been read by a user and which have not. POP allows you to download an email message from the server while leaving it stored on the server, but does not remember which ones you've read. What are the pros and cons of these two approaches?
	Q2. Consider a 100 Mb/s link, preceded by a queue that can hold 1000 packets. Suppose packets with an average packet length of 125 bytes are arriving at the queue, at the rate of 85 thousand packets per second. What is the average number of packets in the queue? How long does it take to transmit a packet over the link? What is the average amount of time that a packet waits in the queue?
	1. **Q3. (a)**How many bytes are there in the UDP packet header? How many in the TCP header? **(b)**Give two reasons you might prefer to implement an application using UDP, rather than TCP.
(b)	**Q1.**Suppose a host receives 10 IP packets and the id field in these packets are: 3, 7, 8, 8, 8, 7, 9, 13, 3, 13. How many distinct packets were sent by the original host?
	Q2. Consider a router with 10 Gb/s links and designed for use in wide area networks with typical round-trip times of 200 ms. If the router has 16 links, how much memory is required for packet buffers, assuming each buffer is dimensioned according to the standard rule-of-thumb.

	2. **Q3. (a)** Consider a 100 Mb/s version of Ethernet using CSMA/CD. If the maximum separation between two nodes is 5 km, how efficient is the network if all packets have the minimum length? What if they have the maximum length? **(b)** How long is the payload of an Ethernet frame carrying an IPv4 packet that contains a minimum size UDP packet. How long is the frame if the IPv4 packet is a TCP packet with 40 bytes of user data? **(c)** How many distinct IP multicast addresses are there? How many distinct Ethernet multicast addresses are available for use with IP? Discuss how the difference in these two numbers might affect the operation of IP multicast, in the context of Ethernet LANs.

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6EIU6.2	**DEC**	**Control System Design**	**MM:150**	**2L:0T:0P**	**2 credit**

Design of Feedback Control Systems: Introduction; Approaches to System Design; Cascade Compensation Networks; Phase-Lead Design Using the Bode Diagram; Phase-Lead Design Using the Root Locus; System Design Using Integration Networks; Phase-Lag Design Using the Root Locus; Phase-Lag Design Using the Bode Diagram; Design on the Bode Diagram Using Analytical Methods; Systems with a Pre-filter; Design for Deadbeat Response; Design Examples
Design of State Variable Feedback Systems Introduction, State space representation of physical systems, State space models of some common systems like R-L-C networks, DC motor, inverted pendulum etc., Controllable Canonical Form, Observable Canonical Form, Diagonal Canonical Form, State transition matrix, Solution of state equations, Controllability and Observability, Full-State Feedback Control Design; Observer Design; Integrated Full-State Feedback and Observer; Tracking Reference Inputs; Internal Model Design; Design Examples.
Lyapunov's stability and optimal control positive/negative definite, positive/negative semi-definite functions, Lyapunov stability criteria, introduction to optimal control, Riccatti Equation, Linear Quadratic Regulator, Design Examples.

Text/Reference Books:

1.	Bernard Friedland, Control System Design: An Introduction to State-Space Methods (Dover Books on Electrical Engineering), Dover Publications Inc., 2005.
2.	Gene F. Franklin, J. Da Powell, Abbas Emami-Naeini, Feedback Control of Dynamic Systems, Pearson Prentice Hall, 7th Edition, 2014.
3.	Richard C Dorf, Robert H Bishop, Modern Control Systems, Pearson Education India, 12th Edition, 2013.
4.	Katsuhiko Ogata, Modern Control Engineering, Pearson, 5th Edition, 2009.
5.	Madan Gopal, Modern Control System Theory, New Age International Private Limited, 2014.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
6EIU6.2	Control System Design	CO 1	To impart knowledge in the concepts and techniques of linear and nonlinear control system analysis and synthesis in the modern control (state space) framework.
		CO 2	To teach the control design using the classical design principles
		CO 3	develop mathematical models for various physical systems.
		CO 4	design state feedback controllers and observers.
		CO 5	design nonlinear controllers using Lyapunov theory.

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
6EIU6.2 Control System Design	CO 1	2	1	2	3	1							
	CO 2	2	3	2	1	1							
	CO 3	1	3	2	1	3							
	CO 4	1	2	3	2	2							
	CO 5	1	3	2	3	1							

3: Strongly 2: Moderate 1: Weak

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Zero Lecture: Overview of subject

Lecture 2	Design of Feedback Control Systems: Introduction
Lecture 3	Approaches to System Design; Cascade Compensation Networks; Phase-Lead Design Using the Bode Diagram
Lecture 4	Phase-Lead Design Using the Root Locus;
Lecture 5	System Design Using Integration Networks
Lecture 6	Phase-Lag Design Using the Root Locus;
Lecture 7	Phase-Lag Design Using the Bode Diagram
Lecture 8	Design on the Bode Diagram Using Analytical Methods
Lecture 9	Systems with a Pre-filter;
Lecture 10	Design for Deadbeat Response
Lecture 11	Design Examples.
Lecture 12	Design of State Variable Feedback Systems Introduction
Lecture 13	State space representation of physical systems
Lecture 14	State space models of some common systems like R-L-C networks, DC motor, inverted pendulum etc
Lecture 15	State space models of some common systems like R-L-C networks, DC motor, inverted pendulum etc
Lecture 16	Controllable Canonical Form
Lecture 17	Controllable Canonical Form
Lecture 18	Observable Canonical Form
Lecture 19	Observable Canonical Form
Lecture 20	Diagonal Canonical Form
Lecture 21	State transition matrix
Lecture 22	State transition matrix
Lecture 23	Solution of state equations
Lecture 24	Solution of state equations
Lecture 25	Controllability
Lecture 26	Observability
Lecture 27	Full-State Feedback Control Design
Lecture 28	Observer Design
Lecture 29	Integrated Full-State Feedback and Observer
Lecture 30	Tracking Reference Inputs
Lecture 31	Internal Model Design
Lecture 32	Design Examples
Lecture 33	Lyapunov's stability and optimal control positive/negative definite, positive/negative semi-definite functions
Lecture 34	Lyapunov's stability and optimal control positive/negative definite, positive/negative semi-definite functions
Lecture 35	Lyapunov stability criteria
Lecture 36	introduction to optimal control
Lecture 37	Riccatti Equation
Lecture 38	Linear Quadratic Regulator
Lecture 39	Linear Quadratic Regulator
Lecture 40	Design Examples.

Content delivery method:

1. Chalk, Board and Duster
2. PPT
3. Animation
4. Hand-outs

6EIU11	DCC	Process Control Lab	MM:75	0L:0T:3P	2 credit

1.	To perform experiments on Linear system simulator.
2.	To draw response of temperature controlled process for On/Off, P, PI, PID Controller.
3.	Tuning of controllers on a pressure loop.
4.	To study the design and application of Lag compensator circuits.
5.	To study the design and application of Lead compensator circuit.
6.	To study process simulator. (a) To perform experiments on P, PI, PD, PID controller with Process simulation. (b) To study the effect of loading the process.
7.	To study the operation of linear & equal percentage type control valves and determine the Following:- (i) Valve flow coefficient (ii) characteristics of control valve (iii) Rangeability of control valves.
8.	To perform experiments on Ratio Control Scheme and Cascade Control Scheme on liquid level and flow system.
9.	To plot and analyze step/impulse response of a first order system in (i) Non interacting mode (ii) Interacting mode.
10.	(a) Study of basic logic operations, timer, counter, arithmetic operations in PLC. (b) Problem solving In PLC. (c) To perform experiments on PLC controlled process.

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Course Outcome:

Course Code	Course Name	Course Outcome	Details
6EIU11	Process Control Lab	CO 1	To analyze different types of process simulation.
		CO 2	To design the step and impulse response of the PLC control system.
		CO 3	To study the process simulation and know the effect of various loading process.
		CO 4	To understand the basic logic operations and arithmetic operation on PLC.
		CO 5	To develop the problem solving technique using PLC.

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
6EIU11 Process Control Lab	CO 1	2											
	CO 2	2											
	CO 3	3											
	CO 4	1											
	CO 5	2											

3: Strongly **2: Moderate** **1: Weak**

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6EIU12	**DCC**	**Control System Simulation Lab-II**	**MM:75**	**0L:0T:3P**	**2 credit**

List of Experiments	
The Lab work includes exercises based on following in MATLAB	
1.	Representation of a system in State Space, Conversion from TF to State Space, Discretising the given Continuous Time System.
2.	Representing the System in various Canonical Forms
3.	Diagonalisation, Finding Eigen values, Eigenvectors
4.	Computation of State Transition Matrix
5.	Plotting State Responses for given inputs.
6.	Check for Controllability, Observability of the System.
7.	Pole placement design using state feedback.
8.	Design Full Order Observer to Estimate States for the given System
9.	Design Reduced Order Observer for the given System
10.	Using Combined Estimator and Control Law Plot the Response for the given System
11.	Simulate different systems for plotting responses in SIMULINK.

Lab outcome:-

1	Understand and apply the representation of a system in state space & various canonical forms.(k1)
2	Examine state transition matrix & plot state responses for given inputs.(K3)
3	Analyze controllability & observability of the given system. (k4)
4	Design Full & reduced order observer for the given system. (K5)
5	Develop simulations for different systems in SIMULINK.(k3)

(3.strong 2. Moderate 1. low)

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CO-PO Mapping

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
6EIU12 Control System Simulation Lab-II	CO1	2	2	1	1	3							
	CO2												
	CO3	2	3	2	1	1							
	CO4	2	2	1		3							
	CO5	3	2	1	1								

6EIU13	DCC	Electronics Instrumentation Lab	MM:75	0L:0T:2P	1 credit

List of Experiments

Sr. No.	Name of Experiment
1.	Measurement of following parameters of op-amp : (a) Input impedance. (b) Output impedance. (c) Input & Output offset voltage. (d) Input bias currents. (e) Slew rate. (f) Supply voltage rejection ratio (SVRR). (g) Common mode rejection ratio (CMRR). (h) Gain Bandwidth product. (i) Power consumption. (j) Transient response.
Study & make the following circuits on breadboard using op-amplifiers.	
2	(a) Differentiator (b) Integrator
3.	(a) Wein's Bridge Oscillator (b) RC Phase shift Oscillator
4.	Following filters for first order response. (a) High pass filter (b) Low pass filter (c) Notch filter
5.	Wave generators – (a) Square wave generator (b) Saw tooth Generator
6.	Instrumentation amplifier.
7.	A Comparator.
8.	(a) Voltage to current converter. (b) Current to voltage converter.

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9.	Frequency divider
10.	Study and make the following circuits on bread board using 555 timer & determine the o/p frequency and Duty cycle: (a) Astable multivibrator (b) Monostable multivibrator (c) Bistable multivibrator

Course Outcome:

Course Code	Course Name	Course Outcome	Details
6EIU13	Electronic Instrumentation Lab	**CO 1**	To be able to apply the theatrical knowledge in practical life and solve many problems.
		CO 2	To learn the concept of electronics designing.
		CO 3	The ability to understand the multiple uses of a simple op-amp.
		CO 4	To be able to make projects using IC and know its applications.
		CO 5	To have the practical knowledge of basic circuits of electronics designing.

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CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
6EIU13 Electronic Instrumentation Lab	CO 1	3	2	3	1	3							
	CO 2	2	1	3	2								
	CO 3	2	1	3									
	CO 4	2	3			1							
	CO 5	2	1		3								

3: Strongly **2: Moderate** **1: Weak**

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6EIU14	DCC/IEC	Power Electronics Lab	MM:75	0L:0T:2P	1 credit

List of Experiments

Sr. No.	Name of Experiment
1.	Study the characteristics of SCR and observe the terminal configuration, measure the breakdown voltage, latching and holding current. Plot V-I characteristics.
2.	Perform experiment on triggering circuits for SCR. i.e. R triggering, R-C triggering and UJT triggering circuit.
3.	Study and test AC voltage regulators using triac, anti parallel thyristors and triac & diac
4.	Study and obtain the waveforms for single-phase bridge converter.
5.	Perform experiment on single phase PWM inverter.
6.	Perform experiment on buck, boost and buck-boost regulators.
7.	Control speed of a dc motor using a chopper and plot armature voltage versus speed characteristic.
8.	Control speed of a single-phase induction motor using single phase AC voltage regulator.
9.	(i) Study single-phase dual converter (ii) Study speed control of dc motor using single-phase dual converter
10.	Study single-phase cyclo converter.
11.	Perform experiment on Motor control – open loop & closed loop.
12.	Design, observe and perform experiment on various type of pulse generation from DSP/ FPGA platform. Perform experiment for PWM inverters and choppers.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
6EIU14	Power Electronics Lab	CO 1	Explain characteristics of SCR and use various triggering circuits for it.
		CO 2	Describe single phase half bridge and full bridge rectifier with R and RL load.

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		CO 3	Design and perform various pulse generations from DSP on PWM inverter and chopper.
		CO 4	Compare various configurations of DC regulators.
		CO 5	Explain speed control of dc motor using a chopper and single phase induction motor using AC voltage regulators.

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
6EIU14 Power Electronics Lab	**CO 1**	3	2	1	2	1							
	CO 2	3	2	1	1								
	CO 3	3	3	2	3	2							
	CO 4	3	1	1	2								
	CO 5	3	2	1	2	1							

6EIU20		**DECA**	**MM:50**	**0L:0T: 0P**	**1 credit**

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7EIU1	DCC	Distributed Control System	MM:150	3L:1T:0P	4 credit

INTRODUCTION- Hierarchical organization for a process computer control and computer system structure for a manufacturing complex. Centralized and distributed control concept. Lower level and higher level computer tasks and duties. Functional requirement of DPCS. Aims of plant automation and distributed computer control systems and subsystems. DPCS system configuration and integration with PLCs and computers.
ARCHITECTURE- Overviews of DPCS, systems architectures, data base organization. DPCS elements, comparison of different DPCS systems, state of the art in DPCS, configuration of control unit, different cards (I/O, O/P , Memory , PLC etc) system implementation concepts, work stations and its key – functions and function chart.
DCS DISPLAYS- Standard and user defined displays, continuous process display, Ground display, overview display, detail display, graphic display, trend display, loop display, alarm summary display, annunciator display, batch/ sequence display, tuning display, tuning panel, instrument faceplate.
DATA COMMUNICATIONS LINKS AND PROTOCOL - Communication Hierarchy (point to point to field bus) Network requirements, ISO reference model. Transmission media, network topologies, internetworking, data transmission, bus access methods, error handling Field buses, MAP and TOP Protocols. Features and capabilities of various field buses. FB standardization, comparison of MODBUS, PROFIBUS and FIPBUS, HART protocol, IEEE project 1002 on LAN implementation.
DCS CONTROL FUNCTIONS- control unit, sequential control, system maintenances, utility, switch instrument, batch system builder, graphic builder, feedback control builder, security, and process reporting function.

Text/Reference Books:

1.	John.W. Webb Ronald A Reis, “Programmable Logic Controllers - Principles and Applications”, 4th Edition, Prentice Hall Inc., New Jersey. 1998
2.	Lukcas M.P, “Distributed Control Systems”, Van Nostrand Reinhold Co., New York. 1986
3.	Frank D. Petruzella, “Programmable Logic Controllers”, 2nd Edition, McGraw Hill, New York. 1997
4.	Deshpande P.B and Ash R.H, “Elements of Process Control Applications”, ISA Press, New York. 1995
5.	Curtis D. Johnson, “Process Control Instrumentation Technology”, 7th Edition, Prentice Hall, New Delhi, 2002
6.	Krishna Kant, “Computer-based Industrial Control”, Prentice Hall, New Delhi, 1997

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7.	Process/Industrial Instruments and Control Hand Book, Gregory Mcmillan, TMH. 2009
8.	Process Control - Principles And Applications, Bhanot, Oxford. 2008
9.	Process Dynamics Control ,Dale E. Seborg, Oxford. 1994
10.	Advanced Process Control: Beyond Single Loop Control, Cecil Smith, Oxford. 2010

Course Outcome:

Course Code	Course Name	Course Outcome	Details
7EIU1	Distributed Control System	CO 1	**Describe** fundamentals of Distribute control systems (K1).
		CO 2	**Determine** the architecture of distributed control systems (K4).
		CO 3	**Classify** various DCS displays **(K3).**
		CO 4	**Analyse** industrial data transmission protocols (wired and wireless) and ISO/OSI reference models (K4).
		CO 5	**Interpret** the DCS control functions **(K2).**

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
7EIU1 Distributed Control System	CO 1	3	2										
	CO 2	2	3	1	3								
	CO 3	2	3										
	CO 4	2	3	3	1	2							
	CO 5	2	1										

3: Strongly 2: Moderate 1: Weak

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Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Zero Lecture
Lecture 2	Hierarchical organization for a process computer control and computer system for a manufacturing complex
Lecture 3	Centralized and distributed control concept
Lecture 4	Lower level and higher level computer tasks and duties. Functional requirement of DPCS
Lecture 5	DPCS system configuration and integration with PLCs and computers
Lecture 6	DPCS system configuration and integration with PLCs and computers
Lecture 7	Overviews of DPCS
Lecture 8	systems architectures, database organization.
Lecture 9	DPCS elements
Lecture 10	comparison of different DPCS systems
Lecture 11	state of the art in DPCS
Lecture 12	configuration of control unit
Lecture 13	different cards (I/O, O//P, Memory, PLC etc) system implementation concepts
Lecture 14	work stations and its key functions and function chart
Lecture 15	Standard and user defined displays
Lecture 16	continuous process display
Lecture 17	Ground display, overview display
Lecture 18	detail display, graphic display
Lecture 19	trend display, loop display
Lecture 20	alarm summary display, annunciator display
Lecture 21	batch/sequence display, tuning display
Lecture 22	tuning panel, instrument faceplate.
Lecture 23	Communication Hierarchy (point to point to field bus) Network requirements
Lecture 24	ISO reference model
Lecture 25	Transmission media, network Transmission media
Lecture 26	network topologies, internetworking, data transmission
Lecture 27	bus access methods, error handling
Lecture 28	Field buses, MAP and TOP Protocols. Features and capabilities of Field buses
Lecture 29	FB standardization, comparison of MODBUS, PROFIBUS and FIPBUS
Lecture 30	HART protocol
Lecture 31	IEEE project 1002 on LAN implementation
Lecture 32	IEEE project 1002 on LAN implementation
Lecture 33	Control unit, sequential control

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Lecture 34	system maintenances, utility
Lecture 35	switch instrument
Lecture 36	batch system builder
Lecture 37	graphic builder
Lecture 38	feedback control builder
Lecture 39	Security, and process reporting function
Lecture 40	Security, and process reporting function

Content delivery method:

1. Chalk and Duster
2. PPT
3. Hand-outs

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7EIU2	DCC	Digital Control	MM:150	3L:1T:0P	4 credit

INTRODUCTION-Digital Control systems, Quantizing and Quantization errors, data acquisition, conversion and distribution systems. The z-transforms of elementary functions, important properties,
THE inverse Z- TRANSFORM- Introduction, The inverse z-transform, z-plane analysis of discrete time control systems, z- Transform method of solving difference equations. Z-plane analysis of discrete time control systems
STATE SPACE ANALYSIS- State space representation of discrete time systems, solving the discrete time state space equations, pulse transfer function matrix, discretization of continuous time state space equations, Lyapunov stability analysis
POLE PLACEMENT AND OBSERVER DESIGN-Controllability, Observability, The transformations in state space design, design via pole placement, State observers
QUADRATIC OPTIMAL CONTROL SYSTEMS- Introduction, Quadratic optimal control, Steady state quadratic optimal control, Quadratic optimal control of a servo system.

Text/Reference Books:

1.	K. Ogata, “Discrete-Time Control systems”, PHI publications
2.	M. Gopal, “Digital Control and state variable methods”, Mc-Graw Hill publications
3.	Kannan M. Moudgalya, “Digital Control” Wiley India
4.	G. F Franklin, J. D. Powell and M. workman, “Digital control of dynamic systems”

Course Outcome:

Course Code	Course Name	Course Outcome	Details
7EIU2	Digital Control	CO 1	To introduce to discretization, Use of digital techniques in control systems
		CO 2	To understand Digital Control systems, Use of microprocessors and embedded controllers
		CO 3	To learn digital control system design methods based on state space analysis.
		CO 4	Ability to design Digital Control Systems, practical applications of digital control systems

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		CO 5	To be able to understand the practical applications of Digital Control Systems

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
7EIU2 Digital Control	CO 1												
	CO 2												
	CO 3												
	CO 4												
	CO 5												

3: Strongly 2: Moderate 1: Weak

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Zero Lecture
Lecture 2	Introduction to Digital control systems
Lecture 3	Quantizing and quantization errors
Lecture 4	Data acquisition , conversion and distribution systems
Lecture 5	The z-transform
Lecture 6	z- transforms of elementary functions
Lecture 7	The inverse z- transform
Lecture 8	z-transform method of solving difference equations
Lecture 9	The pulse transfer function
Lecture 10	State space representation of discrete time systems
Lecture 11	Canonical forms
Lecture 12	Eigenvalues and eigenvectors
Lecture 13	Similarity transformations
Lecture 14	Solving discrete time state space equations
Lecture 15	Solving discrete time state space equations
Lecture 16	Solving discrete time state space equations
Lecture 17	Discretization of continuous time state space equations
Lecture 18	Stability in digital control
Lecture 19	Jury's stability criterion

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Lecture 20	Lyapunov stability analysis
Lecture 21	Lyapunov stability analysis
Lecture 22	Controllability
Lecture 23	Kalman's method
Lecture 24	Gilbert's method
Lecture 25	Observabilty
Lecture 26	Kalman's method
Lecture 27	Gilbert's method
Lecture 28	Transformations in design
Lecture 29	Concept of state feedback
Lecture 30	Pole placement in control
Lecture 31	Design via state feedback
Lecture 32	Design via state feedback
Lecture 33	Design via state feedback
Lecture 34	Effect of pole zero cancellations
Lecture 35	Effect of discretization on controllability and observability
Lecture 36	State observers
Lecture 37	Steady state quadratic optimal control
Lecture 38	Servo system example
Lecture 39	Digital control using MATLAB
Lecture 40	Digital control using MATLAB

Content delivery method:

4. Chalk and Duster
5. PPT
6. Hand-outs

7EIU3	**DCC**	**Digital Image & Video Processing**	**MM:150**	**3L:0T:0P**	**3 credit**

Digital Image Fundamentals-Elements of visual perception, image sensing and acquisition, image sampling and quantization, basic relationships between pixels – neighborhood, adjacency, connectivity, distance measures.
Image Enhancements and Filtering-Gray level transformations, histogram equalization and specifications, pixel-domain smoothing filters – linear and order-statistics, pixel-domain sharpening filters – first and second derivative, two-dimensional DFT and its inverse, frequency domain filters – low-pass and high-pass.
Color Image Processing-Color models–RGB, YUV, HSI; Color transformations-formulation, color complements, color slicing, tone and color corrections; Color image smoothing and sharpening; Color Segmentation.
Image Segmentation- Detection of discontinuities, edge linking and boundary detection, Thresholding – global and adaptive, region-based segmentation.
Wavelets and Multi-resolution image processing- Uncertainty principles of Fourier Transform, Time-frequency localization, continuous wavelet transforms, wavelet bases and multi-resolution analysis, wavelets and Sub-band filter banks, wavelet packets.
Image Compression-Redundancy–inter-pixel and psycho-visual; Lossless compression – predictive, entropy; Lossy compression- predictive and transform coding; Discrete Cosine Transform; Still image compression standards – JPEG and JPEG-2000.
Fundamentals of Video Coding- Inter-frame redundancy, motion estimation techniques – full search, fast search strategies, forward and backward motion prediction, frame classification – I, P and B; Video sequence hierarchy – Group of pictures, frames, slices, macro-blocks and blocks; Elements of a video encoder and decoder; Video coding standards – MPEG and H.26X.
Video Segmentation- Temporal segmentation–shot boundary detection, hard-cutsand soft-cuts;spatial segmentation – motion-based; Video object detection and tracking.

Text/Reference Books:

1.	R.C. Gonzalez and R.E. Woods, Digital Image Processing, Second Edition, Pearson Education 3rd edition 2008

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2	R.C.Gonzalez, R.E.Woods and S.L.Eddins, Digital Image Processing using Matlab,McGraw Hill,2nd Edition
3.	Anil Kumar Jain, Fundamentals of Digital Image Processing, Prentice Hall of India.2nd edition 2004
4.	Murat Tekalp , Digital Video Processing" Prentice Hall, 2nd edition 2015

Course Outcome:

Course Code	Course Name	Course Outcome	Details
7EIU3	**Digital Image & Video Processing**	**CO 1**	Able to represent the images mathematically and analyse them.
		CO 2	Understand the Fundamental technologies for digital image compression, analysis, and processing.
		CO 3	Able to enhance required properties of images as per application.
		CO 4	Develop algorithms for image compression and coding.
		CO 5	Acquire an appreciation for the image processing techniques and their application to real world problems.

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
7EIU3 Digital Image & Video Processing	**CO 1**	3	2										
	CO 2	3	1	2									
	CO 3		2	2	1								
	CO 4	1	2	3		1							
	CO 5		2	3	1								

3: Strongly **2: Moderate** **1: Weak**

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Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Zero Lecture
Lecture 2	Elements of visual perception, image sensing and acquisition
Lecture 3	Image sensing and acquisition, image sampling and quantization
Lecture 4	Basic relationships between pixels – neighbourhood, adjacency, connectivity, distance measures.
Lecture 5	Gray level transformations, histogram equalization and specifications
Lecture 6	Pixel-domain smoothing filters – linear and order-statistics
Lecture 7	Pixel-domain sharpening filters – first and second derivative,
Lecture 8	Two-dimensional DFT and its inverse
Lecture 9	Frequency domain filters – low-pass and high-pass.
Lecture 10	Color models–RGB, YUV, HSI;
Lecture 11	Color transformations– formulation, color complements
Lecture 12	Color slicing, tone and color corrections
Lecture 13	Color image smoothing and sharpening; Color Segmentation
Lecture 14	Image Segmentation- Detection of discontinuities,
Lecture 15	Edge linking and boundary detection
Lecture 16	Thresholding – global and adaptive, region-based segmentation.
Lecture 17	Thresholding – global and adaptive, region-based segmentation.
Lecture 18	Wavelets and Multi-resolution image processing- Uncertainty principles of Fourier Transform, Time-frequency localization
Lecture 19	Continuous wavelet transforms
Lecture 20	Wavelet bases and multi-resolution analysis
Lecture 21	Wavelets and Sub band filter banks, wavelet packets.
Lecture 22	Image Compression-Redundancy–inter-pixel and psycho-visual
Lecture 23	Lossless compression – predictive, entropy
Lecture 24	Lossy compression- predictive and transform coding
Lecture 25	Discrete Cosine Transform
Lecture 26	Still image compression standards – JPEG and JPEG-2000
Lecture 27	Still image compression standards – JPEG and JPEG-2000
Lecture 28	Fundamentals of Video Coding- Inter-frame redundancy
Lecture 29	Motion estimation techniques – full search, fast search strategies
Lecture 30	Forward and backward motion prediction
Lecture 31	Frame classification – I, P and B
Lecture 32	Video sequence hierarchy – Group of pictures, frames, slices, macro-blocks and blocks
Lecture 33	Elements of a video encoder and decoder
Lecture 34	Video coding standards – MPEG and H.26X.
Lecture 35	Video Segmentation
Lecture 36	Temporal segmentation–shot boundary detection, hard-cutsand soft-cuts

Lecture 37	Temporal segmentation–shot boundary detection, hard-cutsand soft-cuts
Lecture 38	Spatial segmentation – motion-based;
Lecture 39	Video object detection and tracking.
Lecture 40	Video object detection and tracking.

Content delivery method:

1. Chalk and Duster
2. PPT
3. Animation

Assignments:

Assignment 1	**Q1.** Write a function flip-image which takes an image and reflects it in both the horizontal and vertical dimensions.
	Q2. Implement code for histogram equalization submit your code and the output images?
	Q3. Implement code to add and remove the salt-and-pepper noise submit your code and the output image?
Assignment 2	**Q1.** Write a function color-image-crop which acts like image-crop but works for color-images
	Q2. Write a function Gaussian-low pass which takes an integer n and a float variance as arguments and returns the frequency domain representation of a Gaussian low pass filter of size n×n. Your filter should be a Gaussian of variance cantered on the zero spatial frequency?
	Q3. Implement wiener filter apply it to different test images and display the images before and after Wiener filtering.

7EIU4	DCC	Artificial intelligence	MM:150	3L:0T:0P	3 credit

Introduction to Artificial Intelligence: Intelligent Agents, State Space Search, Uninformed Search, Informed Search, Two Players Games, Constraint Satisfaction Problems.
Knowledge Representation: Knowledge Representation And Logic, Interface in Propositional Logic, First Order Logic, Reasoning Using First Order Logic, Resolution in FOPL
KNOWLEDGE ORGANIZATION: Rule based System, Semantic Net, Reasoning in Semantic Net Frames, Planning
KNOWLEDGE SYSTEMS: Rule Based Expert System, Reasoning with Uncertainty, Fuzzy Reasoning
KNOWLEDGE ACQUISITION: Introduction to Learning, Rule Induction and Decision Trees, Learning Using neural Networks, Probabilistic Learning Natural Language Processing

Text/Reference Books:

1.	Elaine Rich and Kevin Knight, Artificial Intelligence 3/e, TMH (1991)
2.	Padhy: Artificial Intelligence & Intelligent Systems, Oxford (2005)
3.	James A Anderson, An introduction to Neural Networks. Bradford Books 1995
4.	Dan. W Patterson, Artificial Intelligence and Expert Systems, PHI 1990
5.	Kumar Satish, “Neural Networks” Tata Mc Graw Hill 2004
6.	S. Rajsekaran & G.A. Vijayalakshmi Pai, “Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications” Prentice Hall of India. 2006
7.	Siman Haykin,”Neural Netowrks” Prentice Hall of India 1990
8.	Artificial Intelligence, Kaushik, cengage learning

Course Outcome:

Course Code	Course Name	Course Outcome	Details
7EIU4	Artificial Intelligence	CO 1	**Generalise** the basic introduction to Artificial Intelligence. (K5)
		CO 2	**Deduce** the knowledge representation & Logic. (K4)
		CO 3	**Interpret** the knowledge organization in detail. (K3)

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		CO 4	**Illustrate** the different knowledge systems of artificial intelligence. (K4)
		CO 5	**Investigate** the study of knowledge acquisition for Learning & processing. (K4)

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
7EIU4 Artificial Intelligence	CO 1	3	2		1								
	CO 2	1	3	2									
	CO 3	3	2	1									
	CO 4	2		3	1								
	CO 5	1			3	2							

3: Strongly **2: Moderate** **1: Weak**

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Intelligent Agents
Lecture 2	State Space Search
Lecture 3	Uninformed Search
Lecture 4	Informed Search
Lecture 5	Informed Search
Lecture 6	Two Players Games
Lecture 7	Two Players Games
Lecture 8	Constraint Satisfaction Problems
Lecture 9	Constraint Satisfaction Problems
Lecture 10	Knowledge Representation And Logic
Lecture 11	Interface in Propositional Logic
Lecture 12	First Order Logic
Lecture 13	Reasoning Using First Order Logic
Lecture 14	Rule based System
Lecture 15	Rule based System
Lecture 16	Semantic Net
Lecture 17	Semantic Net
Lecture 18	Reasoning in Semantic Net Frames
Lecture 19	Reasoning in Semantic Net Frames
Lecture 20	Reasoning in Semantic Net Frames

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Lecture 21	Planning
Lecture 22	Planning
Lecture 23	Planning
Lecture 24	Programmable parallel ports.
Lecture 25	Programmable parallel ports.
Lecture 26	Interfacing microprocessor to keyboard and alphanumeric displays.
Lecture 27	Interfacing microprocessor to keyboard and alphanumeric displays.
Lecture 28	Interfacing microprocessor to keyboard and alphanumeric displays.
Lecture 29	Memory interfacing and Decoding
Lecture 30	Memory interfacing and Decoding
Lecture 31	DMA controller
Lecture 32	DMA controller
Lecture 33	Introduction to Learning
Lecture 34	Introduction to Learning
Lecture 35	Rule Induction and Decision Trees
Lecture 36	Rule Induction and Decision Trees
Lecture 37	Learning Using neural Networks
Lecture 38	Learning Using neural Networks
Lecture 39	Probabilistic Learning Natural Language Processing
Lecture 40	Probabilistic Learning Natural Language Processing

Content delivery method:

1. Chalk and Duster
2. PPT
3. Animation

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7EIU5.1	DEC	Analytical & Environmental Instrumentation	MM:150	3L:0T:0P	3 credit

SPECTROSCOPIC ANALYSIS- Absorption and reflection techniques, Atomic techniques emission, absorption and fluorescence, X-ray spectroscopy, Photo acoustic spectroscopy, Microwave spectroscopy, Mass spectrometers.
GAS ANALYSIS - Infrared and ultraviolet absorption analyzers, Paramagnetic oxygen analyzers, Thermal conductivity analyzers and Chemi luminescence analyzers.
CHROMATOGRAPHY- Paper and thin layer chromatography. Basic parts of gas chromatography, Types of columns, Detection systems- thermal conductivity, Flame ionization, Electron capture detector. Types of liquid chromatography, Liquid chromatography, Column and detection systems.
ENVIRONMENTAL POLLUTION MONITORING- Air pollutants, Air pollution monitoring instruments- carbon mono oxide, sulpher dioxide, nitrogen oxide, hydro carbon & ozone. Smoke monitor, Dust monitor, Visible emission monitoring system.
LIQUID ANALYSIS- PH meter, Conductivity meter, Analyzers for measurement of ammonia, silica, sodium and dissolved oxygen

Text/Reference Books:

1.	Instrumentation technology, Jones E.B., Newnes-Butterworths 1974.
2.	Instrument Engineer's Hand Book, Process Meas. & Analysis, Bela G. Liptak, Butterworth-Heinemann Ltd 1995.
3.	Mechanical & Industrial Measurements, Jain R.K., Khanna Publications 1988.
4.	Handbook of Analytical Instruments, Khandpur R.S., Tata McGraw Hill 2006.
5.	Principles of instrumental Analysis, Douglas A Skoog, Cengage Leaning 1998.

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Course Outcome:

Course Code	Course Name	Course Outcome	Details
7EIU5.1	Analytical & Environmental Instrumentation	CO 1	**Discuss** the various Spectroscopic analysis**.** (K2)
		CO 2	**Analyse** the different Gas analyzers. (K2)
		CO 3	**Infer** about the basics of Chromatography. (K4)
		CO 4	**Illustrate** theEnvironmental Pollution Monitoring & systems to control. (K4)
		CO 5	**Investigate** the PH meter, Conductivity meter & various Analyzers to study Liquid Analysis. (K4)

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
7EIU5.1 Analytical & Environmental Instrumentation	CO 1	3		2	1								
	CO 2	2	3	1									
	CO 3	3		2	1								
	CO 4	2		1		3							
	CO 5	1	3			2							

3: Strongly **2: Moderate** **1: Weak**

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Absorption and reflection techniques, Atomic techniques emission
Lecture 2	Absorption and fluorescence
Lecture 3	X-ray spectroscopy
Lecture 4	Photo acoustic spectroscopy
Lecture 5	Microwave spectroscopy
Lecture 6	Mass spectrometers
Lecture 7	Infrared and ultraviolet absorption analyzers
Lecture 8	Infrared and ultraviolet absorption analyzers

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Lecture 9	Paramagnetic oxygen analyzers
Lecture 10	Paramagnetic oxygen analyzers
Lecture 11	Thermal conductivity analyzers
Lecture 12	Thermal conductivity analyzers
Lecture 13	Chemiluminescence analyzers
Lecture 14	Paper and thin layer chromatography
Lecture 15	Basic parts of gas chromatography
Lecture 16	Types of columns, Detection systems- thermal conductivity
Lecture 17	Types of columns, Detection systems- thermal conductivity
Lecture 18	Flame ionization
Lecture 19	Electron capture detector
Lecture 20	Types of liquid chromatography,
Lecture 21	Liquid chromatography
Lecture 22	Column and detection systems
Lecture 23	Column and detection systems
Lecture 24	Air pollutants
Lecture 25	Air pollution monitoring instrument- carbon mono oxide
Lecture 26	Air pollution monitoring instrument- carbon mono oxide
Lecture 27	Air pollution monitoring instrument- sulpher dioxide
Lecture 28	Air pollution monitoring instrument- nitrogen oxide
Lecture 29	Air pollution monitoring instrument- nitrogen oxide
Lecture 30	Air pollution monitoring instrument- hydro carbon & ozone
Lecture 31	Air pollution monitoring instrument- hydro carbon & ozone
Lecture 32	Smoke monitor
Lecture 33	Dust monitor
Lecture 34	Visible emission monitoring system
Lecture 35	PH meter
Lecture 36	Conductivity meter
Lecture 37	Analyzers for measurement of ammonia
Lecture 38	Analyzers for measurement of silica
Lecture 39	Analyzers for measurement of sodium
Lecture 40	Analyzers for measurement of dissolved oxygen

Content delivery method:

1. Chalk and Duster
2. PPT
3. Animation

7EIU5.2	DEC	Network Control System	MM:150	3L:0T:0P	3 credit

Network Models - graphs, random graphs, random geometric graphs, state-dependent graphs, switching networks.
Decentralized Control - limited computational, communications, and controls resources in networked control systems.
Multi-Agent Robotics - formation control, sensor and actuation models.
Mobile Sensor Networks - coverage control, voronoi-based cooperation strategies.
Mobile communications networks, connectivity maintenance.

Text/Reference Books:

1.	P. J. Antsaklis and P. Tabuada, Networked Embedded Sensing and Control, Springer, 2006.
2.	F. Bullo, J. Cortes, and S. Martinez, Princeton, Distributed Control of Robotic Networks, University Press, 2009.
3.	Mehran Mesbahi and Magnus Egerstedt, Graph Theoretic Methods in Multiagent Networks, Princeton University Press, 2010.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
7EIU5.2	Network Control System	CO 1	To introduce different network control system techniques.
		CO 2	To introduce different applications suited for network control systems
		CO 3	design control system in the presence of quantization, network delay or packet loss.
		CO 4	understand distributed estimation and control suited for network control system.
		CO 5	develop simple application suited for network control systems.

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
7EIU5.2 Network Control System	**CO 1**	2	2	2		2							
	CO 2	2	2		1	2							
	CO 3	2	2	2		2							
	CO 4	2	3	3		2							
	CO 5	2	2	2		2							

3: Strongly **2: Moderate** **1: Weak**

Lecture Plan:

Lecture No.	**Content to be taught**
Lecture 1	Zero Lecture
Lecture 2	Network Models – graphs
Lecture 3	Network Models – graphs
Lecture 4	Network Models – random graphs
Lecture 5	random geometric graphs
Lecture 6	random geometric graphs
Lecture 7	state-dependent graphs
Lecture 8	state-dependent graphs
Lecture 9	switching networks
Lecture 10	switching networks
Lecture 11	Decentralized Control - limited computational
Lecture 12	Decentralized Control - limited computational
Lecture 13	Decentralized Control - limited computational
Lecture 14	communications, and controls resources in networked control systems.
Lecture 15	communications, and controls resources in networked control systems.
Lecture 16	communications, and controls resources in networked control systems.
Lecture 17	Multi-Agent Robotics - formation control
Lecture 18	Multi-Agent Robotics - formation control
Lecture 19	Multi-Agent Robotics - formation control
Lecture 20	Multi-Agent Robotics - formation control
Lecture 21	Multi-Agent Robotics - sensor and actuation models

Lecture 22	Multi-Agent Robotics - sensor and actuation models
Lecture 23	Multi-Agent Robotics - sensor and actuation models
Lecture 24	Multi-Agent Robotics - sensor and actuation models
Lecture 25	Mobile Sensor Networks - coverage control
Lecture 26	Mobile Sensor Networks - coverage control
Lecture 27	Mobile Sensor Networks - coverage control
Lecture 28	Mobile Sensor Networks - voronoi-based cooperation strategies
Lecture 29	Mobile Sensor Networks - voronoi-based cooperation strategies
Lecture 30	Mobile Sensor Networks - voronoi-based cooperation strategies
Lecture 31	Mobile communications networks
Lecture 32	Mobile communications networks
Lecture 33	Mobile communications networks
Lecture 34	Mobile communications networks
Lecture 35	Mobile communications networks
Lecture 36	Mobile communications networks
Lecture 37	connectivity maintenance
Lecture 38	connectivity maintenance
Lecture 39	connectivity maintenance
Lecture 40	connectivity maintenance

Content delivery method:

1. Chalk and Duster
2. PPT
3. Animation

7EIU6.1	**IEC**	**MOOC COURSE**			**4 credit**

7EIU11	DCC	Real Time Control Lab	MM:75	0L:0T:3P	2 credit

List of Experiments

S.No.	Contents
1	Characteristics of control valve
2	Closed loop response of flow control loop.
3	Closed loop response of level control loop
4	Closed loop response of temperature control loop
5	Operation of on-off controlled thermal process. Response of on-off controller
6	Response of P+I+D controller. Tuning of PID controller
7	Measurement & Control of level using PID.
8	Measurement & Control of flow using PID
9	Measurement & Control of pressure using PID.
10	Measurement & Control of flow using PLC.
11	Measurement & Control of level using PLC.
12	Measurement & Control of pressure using PLC.
13	Measurement & Control of temperature using PLC.
14	Using SCADA for process control: • preparation of process graphics • tagging trends • reporting • process monitoring and control
15	Study of Communication and Configuration of HART Field Devices: • Communicate with HART device • Re-ranging of HART Field Devices • Basic setup of HART Device • Detailed setup of HART Device

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16	Study of Process Calibrator: • Test & Calibration of Process Indicators & Controllers using • Resistance, RTD, Thermocouple • mili Volts, 4-20 mA, • Frequency & Volt • Error calculation.
17	Study of thermal Imager: Non-contact type temperature measurement of Process, Machines, Material etc.
18	Study of Vibration Analyzer: Measurement and Analysis of vibration in electrical and mechanical machines.
19	Familiarization with the Instrumentation and Process Control Training System (IA- FLTP): Process Workstation, Instrumentation Workstation, PID Controller, ON/OFF Controller, Programmable Logic Controller, Signal Isolator, Flow Meter, Level Transmitter, Temperature Sensor, Emergency Push-Button, Pneumatic Unit, Trend Recorder, Pressure Gauge, Pressure Transmitter, Pneumatic Control Valve, Accessories, Basic Setup.
20	I.S.A. Standard and Instrument Symbols. Introduction to Measurement instruments.
21	Study of Interacting systems and Non-interacting systems.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
7EIU11	Real Time Control Lab	CO 1	**CO1: Demonstrate** the ability to apply what they have learned theoretically in the field of control (K3)
		CO 2	**CO2: Deduce** the measurement and perform control of parameters with PID and PLC controllers (K4).
		CO 3	**CO3: Examine** the Instrumentation and Process Control Training System(K1).
		CO 4	**CO4: Extend** learning to basic understanding of industrial tools like SCADA used in the industry (K2).

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CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
7EIU11 Real Time Control Lab	**CO 1**	2	3		3								
	CO 2	2	3	1	1	3							
	CO 3	2	1	1	3								
	CO 4	2	2	1	2	3							

3: Strongly **2: Moderate** **1: Weak**

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7EIU12	DCC	Analytical Instrumentation Lab	MM:75	0L:0T:2P	1 credit

List of Experiments
1. To measure pH value of given solution using pH meter. 2. To determine suspended particular matter using right volume air samples. 3. Find out concentration of (Na or K) by flamephoto meter in the given sample. 4. To measure transmittance and absorption of a solution using Single beam spectrophoto meter. 5. To study water analysis kit & measure pH, temperature, conductivity, dissolved O2 of a given solution. 6. To measure the conductivity of solution indicator controller. 7. To study the analysis of flue gases. 8. To study ion selective electrode. 9. To study pH monitor and controller. 10. To study silica analyzer and zirconia based oxygen analyzer. 11. To study gas/ liquid chromatograph.

Lab outcome:-

1. Understand and use of pH meter, pH monitor & controller.(k1)
2. **Examine** pH, temperature, conductivity, dissolved O2 of a given solution.(K3)
3. **Analyze** flue gases, concentration through flamephoto meter, transmittance & absorption through spectrophoto meter. (k4)
4. **Illustrate** ion selective electrode. (K2)
5. Estimate the use of silica analyzer and zirconia based oxygen analyzer, gas/ liquid chromatograph .(K2)

(3.strong 2. Moderate 1. low)

CO-PO Mapping

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
7EIU12 Analytical Instrumentation Lab	CO1	2	2	1	1	3							
	CO2												
	CO3	2	3	2	1	1							
	CO4	2	2	1		3							
	CO5	3	2	1	1								

7EIU13	**DCC**	**Minor Project**	**MM:75**	**0L:0T:2P**	**1 credit**

7EIU14	**DCC**	**Practical Training**	**MM:225**	**0L:0T: 4P**	**4 credit**

7EIU20		**DECA**	**MM:50**	**0L:0T: 0P**	**1 credit**

8EIU1.1	**DEC**	**MEMS & Nano Technology**	**MM:150**	**3L:0T:0P**	**3 credit**

Introduction to Nanoelectronics: Top Down and Bottom UP Approach, Nanotechnology Potentials, Idea of band structure – Metals, Insulators and Semiconductors. Effect of crystal size on density of states and band gap, Electronic structure of nanoparticles. Nanostructured crystals, Size and dimensionality effects – Single electron tunneling – Applications – Superconductivity, Graphenes and CNT.
Nano Fabrication and Patterning Techniques: Si processing methods, Cleaning/etching, Oxidation, Gettering, doping, Epitaxy. CVD & MOCVD, Physical Vapor Deposition (PVD), Liquid Phase Techniques, Self assembly and catalysis. Etching: Wet and Dry, Nanolithography, Nanoimprinting, XRay Lithography(XRL), Particle beam lithography(e-beam, FIB, shadow mask evaporation),
General Characterization Techniques: X- Ray Diffraction studies – Bragg's law – particle size – Scherrer's equation, Infrared Spectroscopy of Semiconductors, Raman Spectroscopy, Dynamic Light Scattering (DLS), NMR Spectroscopy, ESR Spectroscopy. photo electron spectroscopy(XPS)-SEM, TEM, STM, Atomic force microscopy(AFM).
Electrical, Magnetic, Mechanical and Optical Properties and Applications: Electronic and electrical properties -One dimensional systems-Metallic nanowires, Quantum dots -Two dimensional systems - Quantum wells. Magnetic properties -Transport in a magnetic field. Mechanical properties, Optical properties, Evolving interfaces of Nano in NanoBiology, Nano Sensors and Nanomedicines
MEMS and Microsystems: Evolution of Micro Fabrication – Micro Systems and Microelectronics. Application of MEMS in Various Fields. Introduction – Substrate and Wafer, Active Substrate Material. Silicon as a substrate material, MEMS packaging. Case study on pressure sensor with packaging.

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Text/Reference Books:

1.	Nano Essentials, T Pradeep, Mc Graw Hill, (2008).
2.	Nanotechnology-Enabled Sensors, Kourosh Kalantar-zadehand Benjamin Fry, Springer, (2007).
3.	Fundamental of Nanoelectronics, George W. Hanson, Pearson 2009
4.	Principal of Nanotechnology, G. A. Mansoori, Wiley 2005
5.	Mems and Micro Systems, Mahalik, TMH 2007
6.	MEMS, Gabriel, Wiley 2006
7.	MEMS, A.R. Jha, CRC 2008
8.	MEMS & Microsystems, Design and Manufacture, Tai-Ran HSU, TMH 2013

Course Outcome:

Course Code	Course Name	Course Outcome	Details
8EIU1.1	MEMS & Nano Technology	CO 1	**Outline**the fundamental concept of Nanoelectronics (K1).
		CO 2	**Explain** the fabrication and the MEMS manufacturing technologies (K2).
		CO 3	**Identify** general characterization techniques in nanotechnology(K4).
		CO 4	**Interpret** the fundamental concepts of nanotechnology and its applications(K3).
		CO 5	**Illustrate** learning via a case study (K2).

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
8EIU1.1 MEMS & Nano Technology	CO 1	3	2	1									
	CO 2	2	2	3									
	CO 3	2	3	2	3								
	CO 4	2	1										
	CO 5	3	2	3	2	2							

3: Strongly **2: Moderate** **1: Weak**

Lecture Plan:

Lecture No.	Content to be taught
Lecture 1	Top Down and Bottom UP Approach, Nanotechnology Potentials,
Lecture 2	IdeaofbandstructureMetals,InsulatorsandSemiconductors.Effectofcrystalsizeon density of states and bandgap
Lecture 3	Ideaofbandstructure–Metals,InsulatorsandSemiconductors.Effectofcrystalsizeon density of states and bandgap
Lecture 4	Ideaofbandstructure–Metals,InsulatorsandSemiconductors.Effectofcrystalsizeon density of states and bandgap
Lecture 5	Electronic structure of nano particles. Nano structured crystals, Size and dimensionality effects - Single electron tunneling
Lecture 6	Electronic structure of nanoparticles. Nanostructured crystals, Size and dimensionality effects - Single electron tunneling
Lecture 7	Applications - Superconductivity, Graphenes and CNT.
Lecture 8	Applications - Superconductivity, Graphenes and CNT.
Lecture 9	Siprocessingmethods,Cleaning/etching,Oxidation,Gettering,doping,Epitaxy
Lecture 10	Siprocessingmethods,Cleaning/etching,Oxidation,Gettering,doping,Epitaxy
Lecture 11	CVD&MOCVD,PhysicalVaporDeposition(PVD),LiquidPhaseTechniques, Selfassemblyandcatalysis
Lecture 12	CVD&MOCVD,PhysicalVaporDeposition(PVD),LiquidPhaseTechniques, Selfassemblyandcatalysis
Lecture 13	CVD&MOCVD,PhysicalVaporDeposition(PVD),LiquidPhaseTechniques, Selfassemblyandcatalysis
Lecture 14	Etching:WetandDry,Nanolithography,Nanoimprinting,X-RayLithography(XRL),Particlebeamlithography(e-beam,FIB,shadowmaskevaporation),
Lecture 15	Etching:WetandDry,Nanolithography,Nanoimprinting,X-RayLithography(XRL),Particlebeamlithography(e-beam,FIB,shadowmaskevaporation),
Lecture 16	Etching:WetandDry,Nanolithography,Nanoimprinting,X-RayLithography(XRL),Particlebeamlithography(e-beam,FIB,shadowmaskevaporation),
Lecture 17	Etching:WetandDry,Nanolithography,Nanoimprinting,X-RayLithography(XRL),Particlebeamlithography(e-beam,FIB,shadowmaskevaporation),
Lecture 18	X-RayDiffractionstudies–Bragg'slaw–particlesize–Scherrer'sequation,
Lecture 19	X-RayDiffractionstudies–Bragg'slaw–particlesize–Scherrer'sequation,
Lecture 20	InfraredSpectroscopyofSemiconductors,RamanSpectroscopy,DynamicLightScattering(DLS),NMRSpectroscopy,ESRSpectroscopy

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Lecture 21	InfraredSpectroscopyofSemiconductors,RamanSpectroscopy,DynamicLightScattering(DLS),NMRSpectroscopy,ESRSpectroscopy
Lecture 22	InfraredSpectroscopyofSemiconductors,RamanSpectroscopy,DynamicLightScattering(DLS),NMRSpectroscopy,ESRSpectroscopy
Lecture 23	InfraredSpectroscopyofSemiconductors,RamanSpectroscopy,DynamicLightScattering(DLS),NMRSpectroscopy,ESRSpectroscopy
Lecture 24	Photoelectronspectroscopy(XPS)-SEM,TEM,STM,Atomicforcemicroscopy(AFM).
Lecture 25	Photoelectronspectroscopy(XPS)-SEM,TEM,STM,Atomicforcemicroscopy(AFM).
Lecture 26	Photoelectronspectroscopy(XPS)-SEM,TEM,STM,Atomicforcemicroscopy(AFM).
Lecture 27	Electronicandelectricalproperties-Onedimensionalsystems-Metallicnanowires
Lecture 28	Electronicandelectricalproperties-Onedimensionalsystems-Metallicnanowires
Lecture 29	Quantumdots-Two dimensional systems-Quantumwells.
Lecture 30	Magneticproperties-Transportinamagneticfield.Mechanicalproperties, Optical properties
Lecture 31	Magneticproperties-Transportinamagneticfield.Mechanicalproperties, Optical properties
Lecture 32	EvolvinginterfacesofNanoinNanoBiology,NanoSensorsandNanomedicines
Lecture 33	EvolvinginterfacesofNanoinNanoBiology,NanoSensorsandNanomedicines
Lecture 34	Evolution of Micro Fabrication–Micro Systems and Microelectronics, Application of MEMS in Various Fields
Lecture 35	Evolution of Micro Fabrication–Micro Systems and Microelectronics, Application of MEMS in Various Fields
Lecture 36	Evolution of Micro Fabrication–Micro Systems and Microelectronics, Application of MEMS in Various Fields
Lecture 37	Introduction–SubstrateandWafer,ActiveSubstrateMaterial.Siliconasasubstratematerial,MEMSpackaging
Lecture 38	Introduction–SubstrateandWafer,ActiveSubstrateMaterial.Siliconasasubstratematerial,MEMSpackaging
Lecture 39	Case study on pressure sensor with packaging.
Lecture 40	Case study on pressure sensor with packaging.

Content delivery method:

1. Chalk and Duster
2. PPT
3. Animation

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8EIU1.2	DEC	Fault Detection & Diagnosis	MM:150	3L:0T:0P	3 credit

Introduction to Fault Detection and Diagnosis: Scope of FDD: Types of faults and different tasks of Fault Diagnosis and Implementation - Different approaches to FDD: Model free and Model based approaches. Classification of Fault and Disturbances- Different issues involved in FDD- Typical applications.
Analytical Redundancy Concepts: Introduction- Mathematical representation of Fault and Disturbances: Additive and Multiplicative types – Residual Generation: Detection, Isolation, Computational and stability properties – Design of Residual generator – Residual specification and Implementation.
Design of Structured Residuals: Introduction- Residual structure of single fault Isolation: Structural and Canonical structures- Residual structure of Multiple fault Isolation: Diagonal and Full Row canonical concepts – Introduction to parity equation implementation and alternative representation.
Design of Directional structured Residuals: Introduction – Directional Specifications: Directional specification with and without disturbances – Parity Equation Implementation – Linearly dependent column.
Advanced level issues and design involved in FDD: Introduction of Residual generation of parametric fault – Robustness Issues –Statistical Testing of Residual generators – Application of Neural and Fuzzy logic schemes in FDD – Case study.

Text/Reference Books:

1.	Janos J. Gertler, Fault Detection and Diagnosis in Engineering systems, Macel Dekker, 2nd Edition, 1998.
2.	Rolf Isermann, Fault-Diagnosis Systems an Introduction from Fault Detection to Fault Tolerance, Springer Verlag, 2006.
3.	Sachin. C. Patwardhan, Fault Detection and Diagnosis in Industrial Process – Lecture Notes, IIT Bombay, February 2005.
4.	Rami S. Mangoubi, Robust Estimation and Failure detection. Springer-Verlag-London 1998.

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5.	Steven X. Ding, Model based Fault Diagnosis Techniques: Schemes, Algorithms, and Tools, Springer Publication, 2012.
6.	Hassan Noura, Didier Theilliol, Jean-Christophe Ponsart, Abbas Chamseddine, FaultTolerant Control Systems: Design and Practical Applications, Springer Publication, 2009.
7.	Mogens Blanke, Michel Kinnaert, Jan Lunze, Marcel Staroswiecki., Diagnosis and Fault-Tolerant Control, Springer, 2016.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
8EIU1.2	Fault Detection & Diagnosis	CO 1	To impart knowledge in fault detection and identification
		CO 2	To introduce different structure residual technique for the fault identification
		CO 3	identify the different type of faults occurred in a system
		CO 4	apply mathematical techniques to detect faults
		CO 5	apply structured and directional techniques for FDI design.

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
8EIU1.2 Fault Detection & Diagnosis	CO 1	3		2	1								
	CO 2			3	2	1							
	CO 3	3	2	1									
	CO 4	1	2		3								
	CO 5	1	3	2									

3: Strongly **2: Moderate** **1: Weak**

Lecture Plan:

Lecture No.	Content to be taught

Lecture 1	Introduction to Fault Detection and Diagnosis
Lecture 2	Scope of FDD: Types of faults and different tasks of Fault Diagnosis and Implementation
Lecture 3	Scope of FDD: Types of faults and different tasks of Fault Diagnosis and Implementation
Lecture 4	Different approaches to FDD: Model free
Lecture 5	Different approaches to FDD: Model based approaches.
Lecture 6	Classification of Fault and Disturbances
Lecture 7	Different issues involved in FDD
Lecture 8	Typical applications.
Lecture 9	Analytical Redundancy Concepts: Introduction
Lecture 10	Mathematical representation of Fault and Disturbances: Additive
Lecture 11	Mathematical representation of Fault and Disturbances: Additive and Multiplicative types
Lecture 12	Residual Generation: Detection
Lecture 13	Residual Generation: solation
Lecture 14	Computational and stability properties
Lecture 15	Design of Residual generator
Lecture 16	Residual specification and Implementation
Lecture 17	Design of Structured Residuals: Introduction
Lecture 18	Residual structure of single fault Isolation: Structural
Lecture 19	Residual structure of single fault Isolation: Canonical structures
Lecture 20	Residual structure of Multiple fault Isolation: Diagonal
Lecture 21	Residual structure of Multiple fault Isolation: Full Row canonical concepts
Lecture 22	Residual structure of Multiple fault Isolation: Full Row canonical concepts
Lecture 23	Introduction to parity equation implementation and alternative representation
Lecture 24	Introduction to parity equation implementation and alternative representation
Lecture 25	Design of Directional structured Residuals: Introduction
Lecture 26	Design of Directional structured Residuals: Introduction
Lecture 27	Directional Specifications: Directional specification with and without disturbances
Lecture 28	Directional Specifications: Directional specification with and without disturbances
Lecture 29	Parity Equation Implementation
Lecture 30	Parity Equation Implementation
Lecture 31	Linearly dependent column.
Lecture 32	Advanced level issues and design involved in FDD: Introduction of Residual generation of parametric fault
Lecture 33	Advanced level issues and design involved in FDD: Introduction of Residual generation of parametric fault

Lecture 34	Robustness Issues
Lecture 35	Statistical Testing of Residual generators
Lecture 36	Statistical Testing of Residual generators
Lecture 37	Application of Neural and Fuzzy logic schemes in FDD
Lecture 38	Application of Neural and Fuzzy logic schemes in FDD
Lecture 39	Application of Neural and Fuzzy logic schemes in FDD
Lecture 40	Case study.

Content delivery method:

1. Chalk and Duster
2. PPT
3. Animation

8EIU2.1	DEC	Wireless Sensor Networks	MM:150	3L:0T:0P	3 credit

Introduction- to Sensor Networks, unique constraints and challenges, Advantage of Sensor Networks, Applications of Sensor Networks, Types of wireless sensor networks Mobile Ad-hoc Networks (MANETs) and Wireless Sensor Networks, Enabling technologies for Wireless Sensor Networks.
Issues and challenges in wireless sensor networks Routing protocols, MAC protocols: Classification of MAC Protocols, S-MAC Protocol, B-MAC protocol, IEEE 802.15.4 standard and ZigBee, Dissemination protocol for large sensor network. Data dissemination, data gathering, and data fusion; Quality of a sensor network; Real-time traffic support and security protocols.
Design Principles for WSNs, Gateway Concepts Need for gateway, WSN to Internet Communication, and Internet to WSN Communication.
Single-node architecture, Hardware components & design constraints, Operating systems and execution environments, introduction to TinyOS and nesC.

Text/Reference Books:

1.	WaltenegusDargie , Christian Poellabauer, "Fundamentals Of Wireless Sensor Networks Theory And Practice", By John Wiley & Sons Publications, 2011.
2.	SabrieSoloman, "Sensors Handbook" by McGraw Hill publication. 2009.
3.	Feng Zhao, Leonidas Guibas, "Wireless Sensor Networks", Elsevier Publications,2004.
4.	KazemSohrby, Daniel Minoli, "Wireless Sensor Networks": Technology, Protocols and Applications, Wiley-Inter science.
5.	Philip Levis, And David Gay "TinyOS Programming" by Cambridge University Press 2009.

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8EIU2.2	DEC	Scientific Computing	MM:150	3L:0T:0P	3 credit

Introduction: Sources of Approximations, Data Error and Computational, Truncation Error and Rounding Error, Absolute Error and Relative Error, Sensitivity and Conditioning, Backward Error Analysis, Stability and Accuracy.
Computer Arithmetic: Floating Point Numbers, Normalization, Properties of Floating Point System, Rounding, Machine Precision, Subnormal and Gradual Underflow, Exceptional Values, Floating-Point Arithmetic, Cancellation.
System of liner equations: Linear Systems, Solving Linear Systems, Gaussian elimination, Pivoting, Gauss-Jordan, Norms and Condition Numbers, Symmetric Positive Definite Systems and Indefinite System, Iterative Methods for Linear Systems Linear least squares: Data Fitting, Linear Least Squares, Normal Equations Method, Orthogonalization Methods, QR factorization, Gram-Schmidt Orthogonalization, Rank Deficiency, and Column Pivoting Eigen values and singular values: Eigen values and Eigenvectors, Methods for Computing All Eigen values, Jacobi Method, Methods for Computing Selected Eigen values, Singular Values Decomposition, Application of SVD **Nonlinear equations:** Fixed Point Iteration, Newton's Method, Inverse Interpolation Method Optimization: One-Dimensional Optimization, Multidimensional Unconstrained Optimization, Nonlinear Least Squares Interpolation: Purpose for Interpolation, Choice of Interpolating, Function, Polynomial Interpolation, Piecewise Polynomial Interpolation Numerical Integration And Differentiation: Quadrature Rule, Newton-Cotes Rule, Gaussian Quadrature Rule, Finite Difference Approximation.
Initial Value Problems for ODES, Euler's Method, Taylor Series Method, Runga-Kutta Method, Extrapolation Methods, Boundary Value Problems For ODES, Finite Difference Methods, Finite Element Method, Eigen value Problems Partial Differential Equations, Time Dependent Problems, Time Independent Problems, Solution for Sparse Linear Systems, Iterative Methods, Fast Fourier Transform, FFT Algorithm, Limitations, DFT, Fast polynomial Multiplication, Wavelets,Random Numbers And Simulation, Stochastic Simulation, Random Number Generators, Quasi-Random

Sequences.

Text/ Reference Books:

1.	Heath Michael T., “Scientific Computing: An Introductory Survey” , McGraw-Hill, 2nd Ed., 2002.
2.	Press William H., Saul A. Teukolsky, Vetterling William T and Brian P. Flannery, “Numerical Recipes: The Art of Scientific Computing”, Cambridge University Press, 3rd Ed., 2007
3.	Xin-she Yang (Ed.)., “Introduction To Computational Mathematics”, World Scientific Publishing Co., 2nd Ed., 2008.
4.	Kiryanov D. and Kiryanova E., “Computational Science”, Infinity Science Press, 1st Ed., 2006
5.	Quarteroni, Alfio, Saleri, Fausto, Gervasio and Paola, “Scientific Computing With MATLAB And Octave”, Springer, 3rd Ed., 2010

8EIU3.1	**DEC**	**Process Modelling & Optimization**	**MM:150**	**3L:0T:0P**	**3 credit**

Definition of process model, physical and mathematical modeling, deterministic and stochastic process, classification of models, model building, black-box model, white box model, gray model, classification of mathematical methods.
Mathematical models of chemical engineering systems: Introduction, uses of mathematical models, scope of coverage, principles of formulation, fundamental laws, continuity equations, energy equations, equation of motion, transport equation, equation of state, equilibrium, kinetics. Examples of mathematical models of chemical engineering systems
The nature and organization of optimization problems: Scope and hierarchy of optimization, examples of applications of optimization, the essential features of optimization problems, general procedure for solving optimization problems, obstacles to optimization.
Developing models for optimization: Classification of models, selecting functions to fit empirical data, factorial experimental designs, degrees of freedom, formulation of the objective function. Basic concepts of optimization: Continuity of function, NLP problem statement, convexity and its applications, interpretation of the objective function in terms of its quadratic approximation, necessary and sufficient conditions for an extremum of an unconstrained function.
Optimization of unconstrained functions: One-dimensional search numerical methods for optimizing a function of one variable, scanning and bracketing procedures, Newton and Quasi-Newton methods of uni-dimensional search, polynomial approximation methods, how one-dimensional search is applied in a multidimensional problem, evaluation of uni-dimensional search methods. Application of optimizations: Examples of optimization in chemical processes.

Text/Reference Books:

1.	B Wayne Bequette, Process Dynamics: Modeling, Analysis and Simulation, Prentice Hall International Inc. 1st Edition, 1998.

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2.	William L. Luyben, Process Modeling, Simulation and Control for Chemical Engineers, McGraw Hill International Editions, 2nd Edition,1989.
3.	Edger, Himmelblau, Lasdon, Optimization of Chemical Processes, McGraw-Hill International Edition, 2nd Edition, 2001.
4.	MC Joshi and K M Moudgalya, Optimization: Theory and Practice, Narosa Publishing, 1st Edition,2013.
5.	Singiresu S. Rao, Engineering Optimization Theory and Practices, John Wiley & Sons, 4th Edition, 2009.
6.	W D Seider, J D Seader and D R Lewin, Product and Process Design Principles-Synthesis, Analysis, and Evaluation, John Wiley and Sons Inc, 3rd Edition 2012.
7.	Gordon S. G. Beveridge and Rober S. Schechter, Optimization: Theory and Practice, McGraw-Hill Book Company, 1st Edition, 2010
8.	K. Deb, Optimization for Engineering Design, Prentice-Hall India learning private limited, 2nd Edition, 2012.

Course Outcome:

Course Code	Course Name	Course Outcome	Details
8EIU3.1	Process Modelling & Optimization	CO 1	To introduce different modelling techniques both analytical and model driven
		CO 2	To impart knowledge in objective function formulation and optimization techniques
		CO 3	apply the computational techniques to solve the process models
		CO 4	utilize the principles of engineering to develop equality and inequality constraints.
		CO 5	know about and use optimization as a tool in process design and operation

CO-PO Mapping:

Subject	Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
Process Modelling & Optimizati	CO 1	2	3	2	2	2							
	CO 2	1	3	3	1	1							
	CO 3	1	2	2	1	1							

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

3: Strongly **2: Moderate** **1: Weak**

Lecture Plan:

Lecture No.	**Content to be taught**
Lecture 1	Definition of process model
Lecture 2	physical and mathematical modeling
Lecture 3	deterministic and stochastic process
Lecture 4	classification of models
Lecture 5	model building,
Lecture 6	black-box model
Lecture 7	white box model
Lecture 8	gray model
Lecture 9	classification of mathematical methods
Lecture 10	Mathematical models of chemical engineering systems: Introduction
Lecture 11	uses of mathematical models,
Lecture 12	scope of coverage
Lecture 13	principles of formulation
Lecture 14	fundamental laws,
Lecture 15	continuity equations
Lecture 16	energy equations
Lecture 17	equation of motion, transport equation
Lecture 18	equation of state, equilibrium, kinetics
Lecture 19	Examples of mathematical models of chemical engineering systems
Lecture 20	The nature and organization of optimization problems: Scope and hierarchy of optimization
Lecture 21	examples of applications of optimization
Lecture 22	the essential features of optimization problems
Lecture 23	general procedure for solving optimization problems
Lecture 24	obstacles to optimization
Lecture 25	Developing models for optimization: Classification of models
Lecture 26	selecting functions to fit empirical data
Lecture 27	factorial experimental designs
Lecture 28	degrees of freedom, formulation of the objective function
Lecture 29	Basic concepts of optimization: Continuity of function

Lecture 30	NLP problem statement, convexity and its applications
Lecture 31	interpretation of the objective function in terms of its quadratic approximation
Lecture 32	necessary and sufficient conditions for an extremum of an unconstrained function.
Lecture 33	Optimization of unconstrained functions: One-dimensional search numerical methods for optimizing a function of one variable
Lecture 34	scanning and bracketing procedures
Lecture 35	Newton and Quasi-Newton methods of uni-dimensional search
Lecture 36	polynomial approximation methods
Lecture 37	how one-dimensional search is applied in a multidimensional problem
Lecture 38	evaluation of uni-dimensional search methods
Lecture 39	Application of optimizations: Examples of optimization in chemical processes.
Lecture 40	Application of optimizations: Examples of optimization in chemical processes.

Content delivery method:

1. Chalk and Duster
2. PPT
3. Animation

8EIU3.2	**DEC**	**Reliability Engineering**	**MM:150**	**3L:0T:0P**	**3 credit**

1.	**Elements of Probability:** Introduction, Probability concept, impossible and certain events, definition of Reliability, Reliability exposed as a probability.
2.	**Failure data Analysis:** Introduction, failure data, mean failure rate, mean time to failure, mean time between failures, MTTF in terms of failure density, reliability in terms of Hazard rate and failure density, mean time to failure in integral form.
3.	**Hazard Models:** Introduction, constant hazard, linearly increasing hazard, Weibull model, expected value, standard deviation and variance.
4.	**System Reliability:** Introduction, series configuration, parallel configuration mixed configurations, Application to specific Hazard models, logic diagrams.
5.	**Reliability Improvement:** Introduction, improvement of components, redundancy, element, unit, standby.
6.	**Fault Tree Analysis:** Introduction, fault tree construction, calculation of reliability form fault tree.
7.	**Maintainability and Availability:** Tie Set and cut set, Maintainability, availability, Reliability and maintainability Trade off.

Text/Reference Book:

1.	Srinath LS, "Reliability Engineering," East West Press

8EIU4.1	**IEC**	**MOOC COURSE**			**3 credit**

8EIU13	**DCC**	**Seminar**	**MM:225**	**0L:0T: 4P**	**4 credit**

8EIU14	**DCC**	**Project**	**MM:525**	**0L:0T: 18P**	**12 credit**

8EIU20		**DECA**	**MM:50**	**0L:0T: 0P**	**1 credit**

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