CHRIST (Deemed to be University)

School of Engineering and Technology

Department of Electrical & Electronics Engineering

B. Tech (Electrical & Electronics Engineering)

Syllabus 2020-24

1. INTRODUCTION

CHRIST- Deemed to be University blossomed out of the educational vision of the Carmelites of Mary Immaculate (CMI) congregation founded by St Kuriakose Elias Chavara. He was a visionary, an educationist and a social reformer of the nineteenth century who founded the Congregation in 1831 in South India.

CHRIST- Deemed to be University was established in July 1969 as Christ College. It was the first institution in Karnataka to be accredited by the National Assessment and Accreditation Council (NAAC). University Grants Commission (UGC) conferred Autonomy to the institution in 2004. It became the first College in South India to be reaccredited with A+ by NAAC in 2005. UGC identified it as an Institution with Potential for Excellence in 2006.Under Section 3 of the UGC Act, 1956, Ministry of Human Resources Development of the Union Government of India, vide Notification No. F. 9-34/2007-U.3 (A), declared Christ College as a Deemed to be University, in the name and style of CHRIST- Deemed to be University in July 2008. The University was accredited with 'A' Grade by NAAC in 2016.

CHRIST- Deemed to be University offers 46 Bachelor, 47 Master, 16 MPhil and 17 PhD Programs in Humanities, Social Sciences, Sciences, Commerce and Management, Education, Law and Engineering. The University which celebrates diversity has students from all the states of India and 58 countries across the globe.

CHRIST- Deemed to be University rooted in Gospel values, is committed to provide holistic education through the development of intellectual competence, personal skills, inter-personal skills and societal skills. The University welcomes to its fold students from all over the country and the world in an environment of religious harmony and secularism.

VISION

"EXCELLENCE AND SERVICE"

CHRIST- Deemed to be University, a premier educational institution, is an academic fraternity of individuals dedicated to the motto of excellence and service. We strive to reach out to the star of perfection through an earnest academic pursuit for excellence and our efforts blossom into 'service' through our creative and empathetic involvement in the society to transform it.

Education prepares one to face the challenges of life by bringing out the best in him/her. If this is well accepted, education should be relevant to the needs of the time and address the problems of the day. Being inspired by Blessed Kuriakose Elias Chavara, the founder of Carmelites of Mary Immaculate and the pioneer in innovative education, CHRIST- Deemed to be University was proactive to define and redefine its mission and strategies reading the signs of the time.

MISSION STATEMENT

"CHRIST- Deemed to be University is a nurturing ground for an individual's holistic development to make effective contribution to the society in a dynamic environment."

CORE VALUES

The values which guide us at CHRIST- Deemed to be University are:

- Faith in God
- Moral Uprightness
- Love of Fellow Beings
- Social Responsibility
- Pursuit of Excellence

2. PROGRAMMES OFFERED

Undergraduate Programmes (B.Tech, 8 Semester Programme)

Bachelor of Technology in Automobile Engineering (AE)

Bachelor of Technology in Civil Engineering (CIVIL)

Bachelor of Technology in Computer Science and Engineering (CSE)

Bachelor of Technology in Electronics and Communication Engineering (ECE)

Bachelor of Technology in Electrical and Electronics Engineering (EEE)

Bachelor of Technology in Information Technology (IT)

Bachelor of Technology in Mechanical Engineering (ME)

Postgraduate Programmes (M. Tech, 4 Semester Programme)

Master of Technology in Computer Science and Engineering (CSE)

Master of Technology in Communication Systems (ECE)

Master of Technology in Information Technology (IT)

Master of Technology in Machine Design (MD)

Master of Technology in Power Systems (PS)

Master of Technology in Structural Engineering (SE)

Doctoral Programmes (Ph.D.) (Doctor of Philosophy)

Doctor of Philosophy (Ph.D.) in Computer Science and Engineering

Doctor of Philosophy (Ph.D.) in Electronics and Communication Engineering

Doctor of Philosophy (Ph.D.) in Civil Engineering

Doctor of Philosophy (Ph.D.) in Electrical and Electronics Engineering

Doctor of Philosophy (Ph.D.) in Mechanical Engineering

Doctor of Philosophy (Ph.D.) in Information Technology

3. ELIGIBLITY CRITERIA

For Undergraduate Programmes

A pass in PUC (10+2) or equivalent with 50% marks in aggregate with Mathematics, Physics and Chemistry is the minimum eligibility for admission.

Lateral Entry:

Candidates who have successfully completed 3 year diploma in Engineering are eligible to apply for lateral entry into:

Automobile Engineering (AE)

B.Tech Civil Engineering (CE)

B.Tech Mechanical Engineering (ME)

B.Tech Computer Science and Engineering (CSE)

B.Tech Electronics & Communication Engineering (ECE)

B.Tech Electrical and Electronics Engineering (EEE)

B.Tech Information Technology (IT)

Candidates will be admitted to second year of the programme only after appearing the Christ deemed to be University selection process for engineering programmes.

For Postgraduate Programmes:

For Master of Technology in Computer Science and Engineering

A pass in B.Tech/B.E or M.Sc with 55% aggregate.

For Master of Technology in Communication Systems

A Pass in B.Tech/B.E or M.Sc in Electronics and VLSI Design with 55% aggregate.

For Master of Technology in Civil Engineering

A Pass in BE/B.Tech or M.Sc in Civil and VLSI Design with 55% aggregate.

For Master of Technology in Mechanical Engineering

A Pass in BE/B.Tech with 55% aggregate.

For Master of Technology in Power Systems

A Pass in BE/B.Tech with 55% aggregate.

For Doctoral Programmes (Ph.D.):

A pass with 55% marks in post-graduation and equivalent in the relevant subject from any recognized university.

A research proposal (Maximum 1500 words) has to be submitted along with the application.

4. SELECTION PROCESS

Candidates can process the admission based on the Undergraduate Entrance Test and Ranking by COMEDK.

OR

Christ Selection Process as given below:

Process	Particulars	Date	Venue/Centre
Entrance Test	Christ Entrance test for each candidate	As per the E-Admit Card	As per the E-Admit Card
Personal Interview	Personal interview for 15 minutes for each candidate by an expert panel	As per the E-Admit Card	As per the E-Admit Card
Academic Performance	Assessment of past performance in Class 10, Class 11/12 during the Personal Interview	As per the E-Admit Card	As per the E-Admit Card

5. ADMISSION PROCESS

Candidates will be intimated about the Selection status (Selected/Wait Listed/Not Selected) through the University Notice Board/on the "Application Status" link on University website. The Selection results will be declared within 24 hours of Personal Interview session.

The selected candidates must process admission at Office of Admissions, Central Block, Christ deemed to be University within 3 working days of declaration of Selection Process results/as per the stipulated date and time mentioned by Office of Admissions.

Selected candidates should collect the Fee Challan from the Office of Admissions and remit the Annual fee at the South Indian Bank, CHRIST- Deemed to be University Branch. The Offer of Admission will stand cancelled, if failing to remit the fee within the stipulated date and time.

Admission will not be processed without the presence of the candidate and the mandatory original documents mentioned below;

1. The Offer of Admission Card (E-Admission Card/Mail)
2. Class 10 Marks Statement
3. Class 11 Marks Statement, if Candidate is pursuing class 12 and appearing for final examination during March-April Month
4. Class 12 Marks Statement, if candidate has appeared and passed the Class 12 examination

The University ID card is a smart card, which is both an ID card as well as a South Indian Bank ATM card with a chip containing the student personal details. All transactions within the University campus after commencement of classes, including fees payment will be processed only through this card. It is also an access card for Library and other restricted places. Candidates are advised to collect the South Indian Bank account opening form along with fees challan and process it at the Bank branch within the University premises.

Candidates who fall under International student category (ISC), If selected, should register with the Foreigner Regional Registration Officer (FRRO/FRO) of the Local Police in Bangalore, India within 14 working days from the date of admission or arriving in Bangalore.

All International student category (ISC) candidates if studied in India should obtain an NOC from the previous qualifying institution.

6. GENERAL RULES

There is a grading scheme for each paper and for all the courses.

All marks will indicate the marks, percentage obtained, grade and grade point average.

The grade point average will be calculated as follows: for each subject, multiply the grade point with the number of credits; divide the sum of product by the total number of credits.

The CGPA [Cumulative GPA] is calculated by adding the total number of earned points [GP x Cr] for all semesters and dividing by the total number of credit hours for all semesters.

$$\text{GPA} = \frac{\sum[\text{GPA x Cr}]}{\sum \text{Cr}}$$

7. GRADING SCHEME FOR EACH PAPER: Undergraduate Courses

Percentage	Grade	Grade Point	Interpretation	Class
80 and above	A	4.0	Outstanding	First Class with Distinction
73-79	A-	3.67	Excellent	First Class
66-72	B+	3.33	Very Good	
60-65	B	3.0	Good	
55-59	B-	2.67	Average	Second Class
50-54	C+	2.33	Satisfactory	
45-49	C	2.00	Pass	Pass Class
40-44	D	1.0	Pass	
39 and below	F	0	Fails	Fail

8. GRADING SCHEME FOR EACH PAPER: Postgraduate Courses

Percentage	Grade	Grade Point	Interpretation	Class
80 and above	A+	4.0	Excellent	First Class with Distinction
70-79	A	3.5	Very Good	
65-69	B+	3.0	Good	First Class

60-64	B	2.5	Above Average	
55-59	C+	2.0	Average	Second Class
50-54	C	1.5	Satisfactory	
40-49	C-	1.0	Exempted if aggregate is more than 50%	Pass Class
39 and below	F	0	Fails	Fail

We believe that the student opportunities and experiences should lead to an appreciation of the holistic development of individual. We also try to pass to our students our passion for what we do, and to have the students comprehend that we also desire to continue to learn.

09. TEACHING PEDAGOGY

Team/Class room teaching.
Power Point presentations and hand-outs.
Simulated situations and role-plays.
Video films on actual situations.
Assignments.
Case Studies.
Exercises are solved hands on.
Seminars
Industry / Field visits.
Information and Communication Technology.
Project work.
Learning Management System- Moodle

10. ASSESSMENT PATTERN - BTECH COURSE 2018 BATCH

Following are the details of the modifications proposed for assessment pattern – B. Tech course AY 2017-18

	Category	Weightage for CIA	Weightage for ESE
1	Courses with theory and practical	70	30
2	Courses with only theory	50	50
3	Courses with only Practical	50	50

COURSES WITH THEORY AND PRACTICAL				
	Component	Assessed for	Minimum marks to pass	Maximum marks
1	Theory CIA	30	-	30
2	Theory ESE	30	12	30
3	Practical CIA	35	14	35
4	Attendance	05	-	05
4	Aggregate	100	40	100

DETAIL OF MARK FOR COURSES WITH THOERY AND PRACTICAL										
THEORY						PRACTICAL				
	Component	Assessed for	Scaled down to	Min. marks to pass	Max. marks	Component	Assessed for	Scaled down to	Min. marks to pass	Maximum marks
1	CIA-1	20	10	-	10	Overall CIA	50	35	14	35
2	CIA-2	50	10	-	10					
3	CIA-3	20	10	-	10					
4	Attendance	05	05	-	05	Attendance	NA	NA	-	-
5	ESE	100	30	12	30	ESE	NA	NA	-	-
TOTAL			65	-	65	TOTAL		35	14	35

Minimum marks required to pass in practical component is 40%.

Pass in practical component is eligibility criteria to attend Theory End semester examination for the same course.

A minimum of 40 % required to pass in ESE -Theory component of a course.

Overall 40 % aggregate marks in Theory & practical component, is required to pass a course.

There is no minimum pass marks for the Theory - CIA component.

Less than 40% in practical component is refereed as FAIL.

Less than 40% in Theory ESE is declared as fail in the theory component.

Students who failed in theory ESE have to attend only theory ESE to pass in the course

II. ASSESSMENT - ONLY FOR THEORY COURSE (without practical component)

Continuous Internal Assessment (CIA) : 50% (50 marks out of 100 marks)

End Semester Examination(ESE) : 50% (50 marks out of 100 marks)

Components of the CIA

CIA I : Subject Assignments / Online Tests	: 10 marks
CIA II: Mid Semester Examination (Theory)	: 25 marks
CIAIII: Quiz/Seminar/Case Studies/Project/ Innovative assignments/ presentations/ publications	: 10 marks
Attendance	: 05 marks
Total	: 50 marks

Mid Semester Examination (MSE): Theory Papers:

The MSE is conducted for 50 marks of 2 hours duration.

Question paper pattern; Five out of Six questions have to be answered. Each question carries 10 marks

End Semester Examination (ESE):

The ESE is conducted for 100 marks of 3 hours duration.

The syllabus for the theory papers are divided into FIVE units and each unit carries equal Weightage in terms of marks distribution.

Question paper pattern is as follows.

Two full questions with either or choice will be drawn from each unit. Each question carries 20 marks. There could be a maximum of three sub divisions in a question. The emphasis on the questions is to test the objectiveness, analytical skill and application skill of the concept, from a question bank which reviewed and updated every year

The criteria for drawing the questions from the Question Bank are as follows

50 % - Medium Level questions

25 % - Simple level questions

25 % - Complex level questions

Course Structure of I Year B.Tech

I Semester – Chemistry Cycle

Sl. No	Course No	Course Name	Hours			Total Marks	Credits			Total Credits
			L	T	P		L	T	P	
1	MA131	Mathematics – I	3	0	0	100	3	0	0	3
2	CH132	Chemistry	3	0	2	100	3	0	1	4
3	EC133	Basic Electronics	3	0	2	100	3	0	1	4
4	CS134	Computer Programming	3	0	2	100	3	0	1	4
5	ME135	Basic Mechanical Engineering and Nanoscience	3	0	0	100	3	0	0	3
6	HS136	Technical English	1	0	2	50	1	0	1	2
7	ME 151	Workshop Practice Lab	0	0	2	50	0	0	1	1
8	HE171	Holistic Education-I	1	0	0	---	1	0	0	1
		Total				600				22

I Semester – Physics Cycle

Sl. No	Course No	Course Name	Hours			Total Marks	Credits			Total Credits
			L	T	P		L	T	P	
1	MA131	Mathematics – I	3	0	0	100	3	0	0	3
2	PH132	Physics	3	0	2	100	3	0	1	4
3	EE133	Basic Electrical Engineering	3	0	2	100	3	0	1	4
4	CE134	Basics of Civil Engineering & Engineering Mechanics	3	0	2	100	3	0	1	4
5	EG135	Engineering Graphics	2	0	2	100	2	0	1	3
6	BS136	Bio Science	2	0	0	50	2	0	0	2
7	HE171	Holistic Education-I	1	0	0	---	1	0	0	1
		Total				550				21

II Semester – Chemistry Cycle

Sl. No	Course No	Course Name	Hours			Total Marks	Credits			Total Credits
			L	T	P		L	T	P	
1	MA231	Mathematics – II	3	0	0	100	3	0	0	3
2	CH232	Chemistry	3	0	2	100	3	0	1	4
3	EC233	Basic Electronics	3	0	2	100	3	0	1	4
4	CS234	Computer Programming	3	0	2	100	3	0	1	4
5	ME235	Basic Mechanical Engineering and Nanoscience	3	0	0	100	3	0	0	3
6	HS236	Technical English	1	0	2	50	1	0	1	2
7	ME 251	Workshop Practice Lab	0	0	2	50	0	0	1	1
8	HE271	Holistic Education-II	1	0	0	---	1	0	0	1
		Total				600				22

II Semester – Physics Cycle

Sl. No	Course No	Course Name	Hours			Total Marks	Credits			Total Credits
			L	T	P		L	T	P	
1	MA231	Mathematics – II	3	0	0	100	3	0	0	3
2	PH232	Physics	3	0	2	100	3	0	1	4
3	EE233	Basic Electrical Engineering	3	0	2	100	3	0	1	4
4	CE234	Basics of Civil Engineering & Engineering Mechanics	3	0	2	100	3	0	1	4
5	EG235	Engineering Graphics	2	0	2	100	2	0	1	3
6	BS 236	Bio Science	2	0	0	50	2	0	0	2
7	HE271	Holistic Education-II	1	0	0	---	1	0	0	1
		Total				550				21

III Semester

Sl.No	Type	Course Name	L (Hrs)	T (Hrs	P (Hrs)	Hrs/ Week	Credits
1	PCC	Electrical Machines -I	3	0	0	3	3
2	PCC	Electrical Machines Laboratory - I	0	0	2	2	1
3	PCC	Analog & Digital Electronics	3	0	0	3	3
4	PCC	Analog & Digital Electronics Laboratory	0	0	2	2	1
5	PCC	Electrical Circuit Analysis	3	0	0	3	3
6	BSC	Mathematics-III	3	0	0	3	3
7	PCC	Electromagnetic Fields	3	0	0	3	3
8	MC	Cyber Security	2	0	0	2	0
9	HSMC	Technical Communication-II	2	0	0	2	2
10	HSMC	Holistic Education-III	1	0	0	1	1
11	MC	Constitution of India	1	0	0	1	0
		Total	20	0	16	43	38

IV Semester

Sl.No	Type	Course Name	L (Hrs)	T (Hrs	P (Hrs)	Hrs/ Week	Credits
1	PCC	Electrical Machines- II	3	0	0	3	3
2	PCC	Electrical Machines Laboratory - II	0	0	2	2	1
3	PCC	Control Systems	3	0	0	3	3
4	PCC	Control Systems Laboratory	0	0	2	2	1
5	PCC	Signals and Systems	3	0	0	3	3
6	PCC	Generation and Transmission	3	0	0	3	3
7	MC	Environmental Science	2	0	0	2	0
8	HSMC	Professional Ethics	3	0	0	3	3
9	BSC	Biology for Engineers Lab	0	0	2	2	1
10	HSMC	Holistic Education-IV	0	0	2	1	1
		Total	17	0	8	24	19

V Semester

Sl.No	Type	Course Name	L (Hrs)	T (Hrs	P (Hrs)	Hrs/ Week	Credits
1	PCC	Power Electronics	3	0	0	3	3
2	PCC	Power Electronics Laboratory	0	0	2	2	1
3	PCC	Microprocessors and Microcontrollers	3	0	0	3	3
5	PCC	Microprocessors and Microcontrollers Laboratory	0	0	2	2	1
6	PCC	Power Systems - I	3	0	0	3	3
7	PEC	Program Elective – 1	3	0	0	3	3
8	OE	Open Elective - 1	3	0	0	3	3
9	HSMC	Project Management & Finance	3	0	0	3	3
		Total	18	0	4	22	20

VI Semester

Sl.No	Type	Course Name	L (Hrs)	T (Hrs	P (Hrs)	Hrs/ Week	Credits
1	PCC	High Voltage Engineering	3	0	0	3	3
2	PCC	High Voltage Engineering and Protection Laboratory	0	0	2	2	1
3	PCC	Power Systems - II	3	0	0	3	3
4	PCC	Power Systems Laboratory -II	0	0	2	2	1
5	PCC	Digital Signal Processing	3	0	0	3	3
6	PCC	Smart Grids	3	0	0	3	3
7	OE	Open Elective - 2	3	0	0	3	3
8	OE	Open Elective - 3 (Global Elective)	3	0	0	3	3
		Total	18	0	4	22	20

VII Semester

Sl.No	Type	Course Name	L (Hrs)	T (Hrs	P (Hrs)	Hrs/ Week	Credits
1	PEC	Program Elective – 2	3	0	0	3	3
2	PEC	Program Elective – 3	3	0	0	3	3
3	PEC	Program Elective – 4	3	0	0	3	3
4	OE	Open Elective - 4	3	0	0	3	3
5	PROJ	Project Stage-I	0	0	6	6	3
6	PROJ	Service Learning	0	0	4	4	2
7	PROJ	Internship	0	0	4	4	2
		Total	12	0	14	26	19

VIII Semester

Sl.No	Type	Course Name	L (Hrs)	T (Hrs	P (Hrs)	Hrs/ Week	Credits
1	PEC	Program Elective –5	3	0	0	3	3
2	PEC	Program Elective –6	3	0	0	3	3
3	PROJ	Project Stage-II	0	0	16	16	8
		Total	6	0	16	22	14

Semester	Elective Courses
V	Wind and Solar Energy Systems
V	Electrical Machine Design
V	Power System Protection
V	Internet of Things
V	Utilization of Electrical Energy
V	Object Oriented Programming
VII	Industrial Drives
VII	Electrical and Hybrid Vehicles
VII	Power System Dynamics and Control
VII	Digital Control Systems
VII	Control Systems Design
VII	Electric Mobility
VII	Advanced Converter Design
VII	Programmable Logic Controllers
VII	Mobile Communication Networks
VII	Digital Communication
VII	Wireless Sensor Networks
VIII	HVDC Transmission Systems
VIII	Power Quality and FACTS
VIII	Electrical Energy Conservation and Auditing
VIII	Computer Architecture
VIII	Energy Storage systems
VIII	Special Electrical Machines
VIII	Embedded Control Systems
VIII	Robotics and Automation
VIII	Computer Communication Networks
VIII	Optical Fiber Communication

Semester	HSMC	BSC	ESC	PCC	PEC	OE	PROJ	Total
I	1	9	11					21
II	3	7	11					21
III	3	3		14				20
IV	4	1		14				19
V	3			11	3	3		20
VI				15		6		21
VII					9	6	7	22
VIII					9		9	18
Total	14	20	22	54	21	15	16	162

COURSE STRUCTURE

Course Structure of I Year B.Tech

I Semester – Chemistry Cycle

Sl. No	Course No	Course Name	Hours			Total Marks	Credits			Total Credits
			L	T	P		L	T	P	
1	MA131	Mathematics – I	3	0	0	100	3	0	0	3
2	CH132	Chemistry	3	0	2	100	3	0	1	4
3	EC133	Basic Electronics	3	0	2	100	3	0	1	4
4	CS134	Computer Programming	3	0	2	100	3	0	1	4
5	ME135	Basic Mechanical Engineering and Nanoscience	3	0	0	100	3	0	0	3
6	HS136	Technical English	1	0	2	50	1	0	1	2
7	ME 151	Workshop Practice Lab	0	0	2	50	0	0	1	1
8	HE171	Holistic Education-I	1	0	0	---	1	0	0	1
		Total				600				22

I Semester – Physics Cycle

Sl. No	Course No	Course Name	Hours			Total Marks	Credits			Total Credits
			L	T	P		L	T	P	
1	MA131	Mathematics – I	3	0	0	100	3	0	0	3
2	PH132	Physics	3	0	2	100	3	0	1	4
3	EE133	Basic Electrical Engineering	3	0	2	100	3	0	1	4
4	CE134	Basics of Civil Engineering & Engineering Mechanics	3	0	2	100	3	0	1	4
5	EG135	Engineering Graphics	2	0	2	100	2	0	1	3
6	BS136	Bio Science	2	0	0	50	2	0	0	2
7	HE171	Holistic Education-I	1	0	0	---	1	0	0	1
		Total				550				21

II Semester – Chemistry Cycle

Sl. No	Course No	Course Name	Hours			Total Marks	Credits			Total Credits
			L	T	P		L	T	P	
1	MA231	Mathematics – II	3	0	0	100	3	0	0	3
2	CH232	Chemistry	3	0	2	100	3	0	1	4
3	EC233	Basic Electronics	3	0	2	100	3	0	1	4
4	CS234	Computer Programming	3	0	2	100	3	0	1	4
5	ME235	Basic Mechanical Engineering and Nanoscience	3	0	0	100	3	0	0	3
6	HS236	Technical English	1	0	2	50	1	0	1	2
7	ME 251	Workshop Practice Lab	0	0	2	50	0	0	1	1
8	HE271	Holistic Education-II	1	0	0	---	1	0	0	1
		Total				600				22

II Semester – Physics Cycle

Sl. No	Course No	Course Name	Hours			Total Marks	Credits			Total Credits
			L	T	P		L	T	P	
1	MA231	Mathematics – II	3	0	0	100	3	0	0	3
2	PH232	Physics	3	0	2	100	3	0	1	4
3	EE233	Basic Electrical Engineering	3	0	2	100	3	0	1	4
4	CE234	Basics of Civil Engineering & Engineering Mechanics	3	0	2	100	3	0	1	4
5	EG235	Engineering Graphics	2	0	2	100	2	0	1	3
6	BS 236	Bio Science	2	0	0	50	2	0	0	2
7	HE271	Holistic Education-II	1	0	0	---	1	0	0	1
		Total				550				21

DETAILED SYLLABUS

MA131 MATHEMATICS I

(Common for all branches)

Unit-1 Linear Algebra 5 Hours

Fundamental concepts of Matrix, Rank of a Matrix, Consistency and solution of linear simultaneous equations, Eigen values and Eigen Vectors, Diagonalization.

Unit-2 Differential Calculus – I 10 Hours

Partial Differentiation: Partial derivatives, Total differential coefficient, differentiation of composite and implicit functions, Jacobians and properties. Leibnitz's Rule of differentiation under integral sign.

Unit-3 Integral Calculus – I 10 Hours

Reduction formulae for the integration of $\sin^n x$, $\cos^n x$, $\sin^m x \cos^n x$ and evaluation of these integrals with standard limits - Problems. Derivative of arc length, Applications of integration to find surfaces of revolution and volumes of solids of revolution.

Unit-4 Differential Equation – I 10 Hours

Solution of first order and first degree differential equations: Reducible to Homogeneous, Linear and Exact differential equation, Applications of differential equations. orthogonal trajectories.

Unit-5 Vector Calculus – I 10 Hours

Vector differentiation. Velocity, Acceleration of a particle moving on a space curve. Vector point function. directional derivative, Gradient, Divergence, Curl, Laplacian. Solenoidal and Irrotational vectors - Problems. Standard vector identities.

Text Books:

T1. Dr. B. S. Grewal, "Higher Engineering Mathematics", 39th Edition, Khanna Publishers, July 2005.

T2. H. K. Das & Rajnish Verma, "Higher Engineering Mathematics", S. Chand & Company Ltd., 2011.

Reference Books:

R1. Erwin Kreyszig, "Advanced Engineering Mathematics", 8th Edition, John Wiley & Sons, Inc, 2005

R2. Thomas and Finney, "Calculus", 9th Edition, Pearson Education, 2004

R3. Peter V. O'Neil, "Advanced Engineering Mathematics", Thomson Publication, Canada, 2007

R4. B. V. Ramana, "Higher Engineering Mathematics", Tata McGraw – Hill, 2009.

R5. Michael Artin, "Algebra", 2nd Edition, Prentice Hall of India Private Limited, New Delhi, 2002
R6. Kenneth Hoffman and Ray Kunze, "Linear Algebra", 2nd Edition, Prentice Hall of India, Private Limited, New Delhi, 2002
R7. George F. Simmons and Steven G. Krantz, "Differential Equation, Theory, Technique and Practice", Tata McGraw – Hill, 2006.
R8. M. D. Raisinghania, "Ordinary and Partial Differential Equation", Chand (S.) & Co. Ltd., India, March 17, 2005.

CH 132 / CH 232 CHEMISTRY

(Common for all branches)

Unit-1 Techniques and Applications **10 hours**

Introduction- Types of spectrum - electromagnetic spectrum - molecular energy levels - Beer Lambert's law (Numericals). UV-Visible Spectroscopy – Principle - Types of electronic transitions - Energy level diagram of ethane and butadiene
Instrumentation of UV-Visible spectrometer and applications.
IR-Spectroscopy – Principle - Number of vibrational modes - Vibrational energy states of a diatomic molecule and -Determination of force constant of diatomic molecule (Numerical) –Applications.

Unit-2 Electrochemical Energy Systems **8 hours**

Conductance, Ionic conductance, Transport number, Ionic mobility, activity coefficient and mean activity coefficients. Single electrode potential- origin, sign conventions. Derivation of Nernst equation. Standard electrode potential Construction of Galvanic cell–classification - primary, secondary and concentration cells, Concentration cell with and without transference, EMF of a cell, notation and conventions. Reference electrodes –calomel electrode, Ag/AgCl electrode. Measurement of single electrode potential. Numerical problems on electrode potential and EMF. Ion-selective electrode- glass electrode, Determination of pH using glass electrode.

Unit-3 Corrosion Science **9 hours**

Corrosion - definition, Chemical corrosion and Electro-chemical theory of corrosion, Types of corrosion, Differential metal corrosion, Differential aeration corrosion (pitting and water line corrosion), Stress corrosion. Factors affecting the rate of corrosion, Corrosion control: Inorganic coatings – Anodizing and Phosphating, Metal coatings –Galvanization and Tinning, Corrosion Inhibitors, Cathodic and Anodic protection.

Unit-4 Chemical Thermodynamics **11 hours**

Definition of thermodynamic terms: system, surrounding etc. Types of systems, intensive and extensive properties.
First law of thermodynamics, internal energy, enthalpy, relation between internal energy & enthalpy, heat capacity, free energy.

Second law of thermodynamics , Spontaneous & non spontaneous reactions, Gibbs-Helmholtz equation & related problems. Clausius-Clapeyron equation, Lavoisier & Laplace law, Exergonic & endergonic reactions in cells, Hess's law & its applications, van't Hoff isotherm, Equilibrium constant.

Unit-5 Material Characterization & Water Technology **7 hours**

Theory and Applications of X-ray Photo electron Spectroscopy(XPS), Powder Xray diffraction (pXRD)

Water Technology: Impurities in water,. Biochemical Oxygen Demand and Chemical Oxygen Demand. Numerical problems on BOD and COD. Sewage treatment. Purification of water- Desalination - Flash evaporation- Electro dialysis and Reverse Osmosis.

List of Experiments (If any):

PART – A **2 hours for each Practical**

- Determination of viscosity coefficient of a given liquid using Ostwald's viscometer.
- Determination of copper by spectrophotometric method.
- Conductometric estimation of an acid using standard NaOH solution
- Determination of pKa value of a weak acid using pH meter.
- Potentiometric estimation of FAS using standard $K_2Cr_2O_7$ solution.

PART – B **2 hours for each Practical**

1. Determination of Total Hardness of a sample of water using disodium salt of EDTA.
2. Determination of percentage of Copper in brass using standard sodium thiosulphate solution.
3. Determination of Calcium Oxide (CaO) in the given sample of cement by Rapid EDTA method
4. Determination of Iron in the given sample of Haematite ore solution using potassium dichromate crystals by external indicator method.
5. Determination of Chemical Oxygen Demand (COD) of the given industrial waste Water sample.

Text Books:

T1. Dr. B.S. Jai Prakash, "Chemistry for Engineering Students", Subhas Stores, Bangalore, Reprint 2015

T2. M. M. Uppal, "Engineering Chemistry", Khanna Publishers, Sixth Edition, 2002

T3. Jain and Jain, "A text Book of Engineering Chemistry", S. Chand & Company Ltd. New Delhi, 2009, Reprint- 2016

Reference Books:

R1. Atkins P.W. "Physical chemistry" ELBS 9 Edition 2009, London

R2. Stanley E. Manahan, "Environmental Chemistry", Lewis Publishers, Reprint 2009

R3. B. R. Puri, L. R. Sharma & M. S. Pathania, "Principles of Physical Chemistry", S. Nagin Chand & Co., 33rd Ed., Reprint- 2016

R4. Kuriakose J.C. and Rajaram J. " Chemistry in Engineering and Technology" Vol I & II, Tata Mc Graw – Hill Publications Co Ltd, NewDelhi, First edition Reprint 2010

R5. Ertl, H. Knozinger and J. Weitkamp, "Handbook of Heterogeneous Catalysis" Vol 1-5, Wiley - VCH.

R6. B. Viswanathan, S. Sivasanker , A.V. Ramaswamy, "Catalysis : Principles & Applications" CRC Press, March 2002, Reprint 2011.
R7. D K Chakrabarthy, B. Viswanathan,"Heterogeneous Catalysis" New Age Internatioanl Publishers,2008.
R8. J. Bassett, R.C. Denny, G.H. Jeffery, "Vogels text book of quantitative inorganic analysis",5th Edition
R9. Sunita and Ratan Practical Engineering Chemistry, S.K. Kataria & Sons, 2013.

Course Name: Basic Electronics					
Course Code : EC133P / EC233P					
	L	T	P	Category	ESC
Contact Hrs./Week	3	0	2	CIA Marks	70
Contact Hrs./Sem.	45	0	30	ESE Marks	30
Credits.	3	0	1	Exam Hours	3
Course objectives: This course aims at imparting knowledge about electronic and digital systems, semiconductor theory and operational amplifiers. This course also includes a practical component which allows the students to recognize the different elements used in electronics and digital systems.					
Prerequisites: NIL					

Units	Teaching Hours
Unit-1 Basic Semiconductor And PN Junction Theory	
Atomic Theory – Atom, Electron Orbits and Energy Levels - Conduction in solids – Electron Motion and Hole Transfer, Conventional Current and Electron Flow –Conductors, Insulators and Semiconductors – Energy Band Diagrams – Variation of band gap with temperature. Intrinsic and Extrinsic Semiconductors – Doping, n type and p type material, Majority and minority carriers, Charge Carrier Density, Mass Action Law. Semiconductor Conductivity – Drift Current, Diffusion Current, Charge Carrier Velocity, Condyctivity.The pn Junction – Biased Junctions – Junction Currents and Voltages.VI Characteristics – Static and Dynamic Resistance.Zener diode characteristics, Zener and Avalanche breakdown.	9
Unit-2 Diode Applications	
Diode Approximations – DC Load Line Analysis - DC voltage applied to diodes (Si and zener diodes only). (Simple analysis using KCL and KVL). Rectifiers – Half Wave rectifier – Full Wave Rectifier – Bridge Rectifier : dc load current and voltage, rms load current and voltage, ripple factor, efficiency, PIV. Simple Capacitor Filter(Analysis not expected) – Simple Shunt Zener Voltage Regulator	9
Unit-3 Bipolar Junction Transistor	

Bipolar Junction Transistors: Transistor Construction – Operation – Common Base Configuration – Transistor Amplifying action – Common Collector – Common Emitter. Transistor currents. Common emitter current gain – Common Base Current gain – Relationship. Transistor Biasing : Operating Point – Significance – Fixed Bias and Voltage Divider Bias – Simple analysis.	9
Unit-4 Introduction To Operational Amplifiers	
Block diagram, Op-amp transfer characteristics, Basic Op-amp parameters and its value for IC 741- offset voltage and current, input and output impedance, Gain, slew rate, bandwidth, CMRR, Concept of negative feedback, Inverting and Non-inverting amplifiers, Summing Amplifier, Subtractor, Differential Amplifier, integrator, differentiator, Voltage follower, Introduction to Oscillators, the Barkhausen Criterion for Oscillations, Applications of Oscillator	9
Unit-5 Digital Electronics	
Sampling theorem, Introduction, decimal system, Binary, Octal and Hexadecimal number systems, addition and subtraction, fractional number, Binary Coded Decimal numbers. Boolean algebra, Logic gates, Two Variable and three variable K – maps - Half-adder, Full-adder, Logic Design based on two and three input variables only.	9
List of Experiments:	Practical Hours
Use of basic voltage source and measuring instruments (Power supply, function generator, DSO, Digital Multimeter), familiarization of breadboard. Measurement of Voltage and Frequency using DSO	2
Study of step down transformer. Measuring the secondary voltage waveform on DSO and determination of peak and rms value	2
Identification and testing of electrical/electronic active and passive components	2
Color coding of resistors and capacitor coding	2
Study of Series and Parallel circuits to verify Kirchoff's Voltage Law and Current Law – using breadboard, DMM and DC power supply.	4
Half Wave Rectifier and Full Wave Rectifier : study of waveforms, determination of DC value of rectified wave	4
Study of different types of logic gates – NOT, OR, AND, NAND, NOR and Ex-OR	4
Verification of output of a logical expression using Basic gates/NAND gates/NOR gates	2
Soldering and de-soldering of electronic components on PCB	2
Determination of forward and reverse bias characteristics of silicon diode	4
Application of Zener diode as a basic voltage regulator	2
Self-study : NIL	

Site/Industrial Visits : NIL
Course outcomes: At the end of the course, the student will be able to : CO1: Describe the basic semiconductor principles , working of p-n junction diode and transistors [L2] [PO1] CO2: Demonstrate the operation of diodes in rectifiers, voltage regulator and clipper [L3] [PO1] CO3: Explain the operation of bipolar junction transistor including the amplification and biasing [L2] [PO1, PO6] CO4: Explain the operation and applications of Operational Amplifier [L2] [PO1] CO5: Discuss conversions between binary, decimal, octal and hexadecimal number system [L2] [PO1] CO6: Implement digital logic gates and its application as adders. [L3] [PO1, PO6]
Text Books: T1. David A. Bell, "Electronic Devices and Circuits" – Vth Edition, OUP, 2011 T2. N. P. Deshpande, "Electronic Devices and Circuits – Principles and Applications", TMH, 2017 T3. Robert L Boylestad& Louis Nashelsky, "Electronic Devices and Circuit Theory", 3rd Edition, 2015 T4. Morris Mano, "Digital Logic and Computer Design", PHI, EEE, 2014
Reference Books: R1. Donald A. Neamen, "Electronic Circuits", 3rd Edition, TMH, 2017 R2. Thomas L. Floyd, "Electronic Devices", Seventh Edition, Pearson Education, 2012 R3. Albert Malvino, David. J. Bates, —Electronic Principle, 8th Edition, Tata McGraw Hill, 2015
Online Resources: NIL

Course Name: Computer Programming					
Course Code : CS134P / CS234P					
	L	T	P	Category	ESC
Contact Hrs./Week	3	0	2	CIA Marks	70
Contact Hrs./Sem.	45	0	30	ESE Marks	30
Credits.	3	0	1	Exam Hours	3

Course Objectives:

- To provide exposure to problem-solving through programming.
- To provide a basic exposition to the goals of programming
- To enable the student to apply these concepts in applications which involve

perception, reasoning and learning.	
Units	Teaching Hours
Unit-1 Algorithms and Flowcharts, Constants, Variables And Datatypes, Operators, Managing Input And Output Operations	
Algorithms and flowcharts: Algorithms, Flowcharts, Examples on algorithms and flowcharts. Basic structure of a C program, C Tokens, Data types. Declaration of variables. Operators: Arithmetic operators, Relational operators, Logical operators, Assignment operators, Increment and Decrement operators, Conditional operator, Bitwise operators, Special operators, Arithmetic expressions, Evaluation of expressions, Precedence of Arithmetic operators, Type conversions in expressions, Operator precedence and associatively. Managing input and output operations: Reading a character, writing a character, Formatted Input, Formatted Output	9
Unit-2 Decision Making And Branching, Looping	
Decision making and branching: Decision making with if statement, Simple if statement, The if...else statement, Nesting of if...else statements, The else ... if ladder, The switch statement, The ?: operator, The Goto statement Looping: The while statement, The do statement, The for statement, Jumps in Loops	9
Unit-3 Arrays, User Defined Functions	
Arrays: One-dimensional Arrays, Declaration of one-dimensional Arrays, Initialization of one-dimensional Arrays, Two-dimensional Arrays, Initializing two-dimensional Arrays. User-defined functions: Need for User-defined Functions, A multi-function Program, Elements of user - defined Functions, Definition of Functions, Return Values and their types, Function Calls, Function Declaration, Category of Functions, No Arguments and no Return Values, Arguments but no Return Values, Arguments with Return Values, No Argument but Returns a Value, Functions that Return Multiple Value, recursion –recursive functions, Limitations of recursion.	9
Unit-4 Pointers	

Understanding the pointers, Accessing the Address of a Variable, Declaring Pointer Variables, Initialization of Pointer Variables, Accessing a Variable through its Pointer, Pointer Expressions, Pointer Increments and Scale Factor, Pointers and Arrays, Pointers and Character Strings, Pointers as Function Arguments.	9
Unit-5 Strings, Derived Types, Files	
Strings: String concepts: declaration and initialization, String I/O functions, Array of strings, String manipulation function, Structure: Basic of structures, structures and Functions, Arrays of structures, structure Data types, type definition. Files: Defining, opening and closing of files, Input and output operations, Standard Library Functions for Files	9
List of Experiments :	Practical Hours
1. To understand and realize the use of C tokens, Keywords and Identifiers, Variables, Data types, Declaration of variables, using operators, I/O functions.	4
2. To understand and implement concepts of Decision making statements.	4
3. To understand and implement concepts looping statements.	6
4. To understand and implement concepts of Arrays.	4
5. To understand and implement concepts of Pointers	4
6. To understand and implement concepts of User defined functions.	4
7. To understand and implement concepts of Strings and Structures.	4
Self-study: NA	
Site/Industrial Visits: NA	
Course outcomes: CO1: Solve problems using flowchart and algorithm. (Applying, PO1, PO3) CO2: Exhibit the concept of looping and decision-making statements to solve problems. (Applying, PO1, PO3) CO3: Demonstrate different Operations on arrays and user defined functions. (Applying, PO1, PO3) CO4: Illustrate the appropriate use of pointers. (Applying, PO1, PO3) CO5: Illustrate the appropriate use of strings, files, structures to solve real time problems. (Applying, PO1, PO3)	

Text Books:

T1. Deitel and Deitel, "C How to Program", Prentice Hall 2010 (Reprint).

T2. Herbert Schildt, "C++ : The Complete Reference", McGraw - Hill Osborne Media; 3rd edition 2012 (Reprint).

T3. Yashvant Kanetkar, "Let Us C 13E", BPB Publications – 13th Edition, 2013.

Reference Books:

R1. Shelly and Junt, "Computers and Commonsense", 4th edition, Prentice Hall of India, 2010 (Reprint).

R2. Dennis P. Curtin, Kim Foley, Kunal Sen, Cathleen Morin, "Information Technology: The Breaking wave", Tata MC GrawHill Companies, 2010 (Reprint).

R3. Peter Norton, "Introduction to Computers", 2011 (Reprint).

Online Resources:

W1. V. K. Myalapalli, J. K. Myalapalli and P. R. Savarapu, "High performance C programming," 2015 International Conference on Pervasive Computing (ICPC), Pune, 2015, pp. 1-6

W2. https://users.ece.cmu.edu/~eno/coding/CCodingStandard.html

W3. https://www.w3resource.com/c-programming-exercises/

Course Name: Basic Mechanical Engineering and Nano-science

Course Code : ME 135 / ME 235

	L	T	P	Category	ESC
Contact Hrs./Week	3	0	0	CIA Marks	50
Contact Hrs./Sem.	45	0	0	ESE Marks	50
Credits.	3	0	0	Exam Hours	3

Course objectives:

1. To elucidate and critically demonstrate the Energy sources and basic thermodynamic concepts behind energy transfer.
2. To distinguish and elaborate the different types of prime movers.
3. To describe the functioning of refrigeration and air-conditioning.
4. To evaluate and apply the concepts of nano-science in real engineering applications.
5. To demonstrate and apply the process of machining and metal joining in basic applications.

Prerequisites: Nil

Units	Teaching Hours
Unit-1 Energy Resources, Thermodynamics and Heat transfer	
Energy Resources Conventional Energy resources- Fossil fuel and nuclear fuel, Merits and demerits.	12

Non-conventional energy sources- Solar, Wind, hydraulic, Ocean-thermal, Geo-thermal, Tidal energy and bio mass energy plants working principle. Thermodynamics Basic terms: State, path, process (reversible and irreversible), and cycle, System, surroundings and boundary. Closed system, Open system and Isolated Systems. Laws of Thermodynamics (statements and brief description). Heat engine and Heat pump (Definition). Heat Transfer Modes of Heat transfer and their basic governing equations. Heat exchangers-types. Fins – types and applications.	
Unit-2 I.C. Engine and Turbines	
I.C. Engines Classification, I.C. Engines parts and their function, working of 2 Stroke and 4 stroke engines. Basic terms - Indicated power, brake power frictional power, thermal efficiency, mechanical efficiency (simple problems). Steam Generators Boilers, fire and water tube boilers (Lancashire and Babcock and Will Cox boiler-working with simple sketches). Steam turbines Classifications, Principle of operation of Impulse and reaction turbines. Gas Turbines Open cycle and closed cycle gas turbines working principle. Water Turbines Classification, working principle of Pelton wheel, Francis turbine and Kaplan turbine.	10
Unit-3 Refrigeration and Air-conditioning	
Refrigeration Types of refrigerants and properties of good refrigerant, Refrigerating effect and unit of Refrigeration (definition). Working principle of vapour Compression refrigeration and vapour absorption refrigeration (with sketch). Applications areas of refrigeration system. Air Conditioning Definition, types, Room air-conditioning working principle (with sketch), Applications.	6
Unit-4 Introduction to Nanotechnology	
Introduction to Nanotechnology Introduction to about Nanomaterials, characterization of nanomaterials-SEM, XRD, AFM and Mechanical properties, Advantages, limitations and applications of Nanomaterials.	7

Unit-5 Machine tools and Metal joining processes	
Machine tools Lathe Machine-Types, Parts and different operations like-turning, facing, grooving, parting off, taper turning, and threading (simple sketch) Drilling Machine-Types, Parts and different operations like-drilling, reaming, boring, counter boring, counter sinking and tapping (simple sketch). Milling Machine-Up milling, down milling, Plane milling, End milling, Slot milling and gear cutting (sketches only for following operations) Metal joining Definitions, classification of soldering, Brazing and welding. Differences between soldering, brazing and Welding. Description of Electric Arc welding and Oxy-Acetylene gas welding (Simple sketch).	10
Self-study: Unit-1: Distillation process of crude oil, Harnessing of Ocean-thermal Energy. Unit-2: 4 Stroke Diesel Engine, 2 Stroke petrol engine, Water turbines. Unit-3: Office air-conditioning systems. Unit-4: TEM, UTM techniques for characterization of Nanomaterials. Unit-5: Trepanning operation, Vertical milling machine, brazing and soldering applications.	
Site/Industrial Visits: 1. Heat Transfer Lab. 2. Fluid mechanics and Machinery Lab. 3. Metal Cutting Lab. 4. I.C. Engine Lab.	
Course outcomes: The students will be able to CO1: Classify the energy resources and state the basic laws of the thermodynamics and illustrate with an example modes of heat transfer. [L1, L2] [PO1, PO2]. CO2: List the types of I.C. Engines and turbines, discuss the working principle of I.C. engines and turbines. [L1, L3] [PO1, PO2, PO3]. CO3: Define the terms refrigeration and air-conditioning, identify their application areas. [L1, L2, L3] [PO1, PO2, PO3]. CO4: Explain the fundamental concept of nanotechnology and describe the characterization methods for nanomaterials. [L1, L2] [PO1, PO2]. CO5: Summarize the operations performed by using machine tools and distinguish between welding soldering and brazing process. [L1, L2, L4] [PO1, PO2, PO3, PO4].	

Text Books:

T1. K.R. Gopalkrishna, "A text Book of Elements of Mechanical Engineering", Subhash Publishers, Bangalore, 2008.

T2. S. Trymbaka Murthy, "A Text Book of Elements of Mechanical Engineering", 3rd revised edition, I .K. International Publishing House Pvt. Ltd., New Delhi. 2010.

T3. P.K.Nag, "Engineering Thermodynamics" Tata McGraw-Hill Education, 2005.

T4. B.S. Murthy, P. Shankar, Baldev Raj, B.B. Rath and James Munday, "Nano Science and Nano Technology ", University Press IIM, 2002.

Reference Books:

R1. Dr. R. P. Reddy, "Elements of Mechanical Engineering", 1st Edition, Himalaya Publishing House, New Delhi, 2012.

R2. Hajra Choudhury S K, "Elements of Workshop Technology" 13th Edition, Volume 1,
Machine Tools, India Book Distributing Company Calcutta, 2010.

R3. Hajra Choudhury S K, "Elements of Workshop Technology" 13th Edition, Volume 2,
Machine Tools, India Book Distributing Company Calcutta, 2012.

R4. Charles P. Poole and Frank J. Owens, "Introduction to Nanotechnology", Wiley India
Edition, 2012.

Online Resources:

W1. http://www.hds.bme.hu/letoltesek/targyak/BMEGEVGAG01_ENG/ime.pdf

W2. http://www.nptel.ac.in/downloads/112108148.

HS136 / HS 236 TECHNICAL ENGLISH

(Common for all branches)

Unit-1 Vocabulary Building **8 hours**

Concept of word formation, synonyms , antonyms, homophones, prefixes and suffixes, Misused and confused words.

Unit-2 Basic Writing Skills **8 hours**

Sentence structure, parts of speech, Fragments, Run-on errors, Phrases and clauses, Misplaced and Dangling modifiers, Structure of paragraphs Techniques of writing precisely.

Unit-3 Identifying Common Errors In Writing **9 hours**

Subject verb agreement(concord), articles, prepositions, Tenses, Redundancies, cliché's , Misused and confused words

Unit-4 Essay Writing (Lang. Lab) **10 hours**

ESSAY WRITING (Lang. Lab), Structure of an Academic essay, writing introduction , thesis statement, writing body paragraphs , writing concluding paragraph, unity, support, coherence and sentence skills , Different types of essay.

Unit-5 Oral Communication **10 hours**

(Interactive practical sessions in lang. lab), listening comprehensions, pronunciation, intonation, stress and rhythm, interview and formal presentation skills.

Text Books:

T1. Michael Swan , Practical English Usage, OUP. 1995
T2. F.T. Wood, Remedial English Grammar, Macmillan.2007

Reference Books:

R1. William Zinsser, On Writing Well, Harper Resource Book. 2001
R2. Liz Hamp-Lyons and Ben Heasly, Study Writing, Cambridge University Press. 2006.
R3. Sanjay Kumar and Pushp Lata, Communication Skills, Oxford University Press. 2011.
R4. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press

Course Name: Workshop Practice					
Course Code : ME 151 / ME 251					
	L	T	P	Category	ESC
Contact Hrs./Week	0	0	2	CIA Marks	25
Contact Hrs./Sem.	0	0	30	ESE Marks	25
Credits.	0	0	1	Exam Hours	2
Course objectives: To provide the students with the hands on experience on different trades of engineering like fitting, welding, carpentry & sheet metal.					

List of Experiments:	Practical Hours
1. Safety Precautions and description of workshop tools and equipments.	1
2. Study of fitting tools and equipments.	2
3. Demonstrate and make a square fitting model.	4
4. Demonstrate and make a V fitting model.	2
5. Demonstrate and make a dovetail fitting model.	4
6. Study of electric arc welding tools and equipments.	1
7. Demonstrate and make a Butt Joint welding model.	2
8. Demonstrate and make a Lap Joint welding model.	2
9. Demonstrate and make a T-Joint welding model.	2
10. Demonstrate and make a L-Joint welding model.	2
11. Study of sheet metal tools and equipments.	1
12. Demonstrate and make a rectangular tray.	2

13. Study and demonstration of Carpentry tools, joints and operations.	1
14. Study and demonstration of MIG welding.	2
15. Study and demonstration of TIG welding.	2
Self-study: NA	
Site/Industrial Visits: NA	
Course outcomes: CO1: Demonstrate an understanding of and comply with workshop safety regulations. {L1,L2} {PO1,PO2, PO7, PO10} CO2: Select and perform a range of machining operations to produce a given project. { L1,L2,L3} {PO1,PO6,PO7,PO9,PO10} CO3: Identify and use marking out tools, hand tools, measuring equipment and to work to prescribed tolerances. { L1,L2,L3} {PO1,PO2,PO6,PO9,PO10} CO4: Demonstrate a knowledge of welding process selection and capabilities. { L2,L3} {PO1,PO2,PO7,PO9,PO10} CO5: Demonstrate knowledge of welding, joint design and the application of welding. { L2,L3,L4} {PO1,PO2,PO6,PO7,PO9,PO10}	
Text Books: T1. S. K. H. Choudhury, A. K. H. Choudhury, Nirjhar Roy, "The Elements of Workshop Technology", Vol 1 & 2, Media Propoters and Publishers, Mumbai, 2018.	
Reference Books: R1. P. Kannaiah and K.L. Narayana, "Manual on Workshop Practice", Scitech Publications, (1999). R2. T Jeyapoovan, "Engineering Practices Lab - Basic Workshop Practice Manual," ISBN: 81-259-1800-0 R3. H.S.Bawa, "Workshop Practice", Tata McGraw Hill Publishing Company Limited, (2007)	
Online Resources: W1. https://nptel.ac.in/noc/ W2. http://ecoursesonline.iasri.res.in	

MA231 MATHEMATICS II

(Common for all branches)

Unit-1 Differential Calculus – II 8 Hours

Polar curves and angle between Polar curves. Pedal equations of polar curves, Radius of curvature – Cartesian, parametric, polar and pedal forms.

Unit-2 Integral Calculus – II 14 Hours

Double integrals, Cartesian and polar co – ordinates, change of order of integration, change of variables between cartesian and polar co – ordinates, triple integration, area as a double integral, volume as a triple integral

Unit-3 Differential Equations – II 10 Hours

Linear differential equations of second and higher order with constant coefficients. Method of variation of parameters. Legendre'a and Cauchy's homogeneous differential equations.

Unit-4 Laplace Transforms 10 Hours

Definition - Transforms of elementary functions – Properties, Derivatives and integrals of transforms- Problems. Periodic function. Unit step function and unit impulse function, Inverse transforms, Solutions of linear differential equations.

Unit-5 Vector Calculus – II 7 Hours

Vector Integration - Green's theorem in a plane, Gauss's divergence theorems, Stoke's, (without proof) and simple application.

Text Books:

T1. Dr. B. S. Grewal, "Higher Engineering Mathematics", 39th Edition, Khanna Publishers, July 2005.

T2. H. K. Das & Rajnish Verma, "Higher Engineering Mathematics", S. Chand & Company Ltd., 2011.

Reference Books:

R1. Erwin Kreyszig, "Advanced Engineering Mathematics", 8th Edition, John Wiley & Sons, Inc, 2005

R2. Thomas and Finney, "Calculus", 9th Edition, Pearson Education, 2004

R3. Peter V. O'Neil, "Advanced Engineering Mathematics", Thomson Publication, Canada, 2007

R4. B. V. Ramana, "Higher Engineering Mathematics", Tata McGraw – Hill, 2009.

R5. George F. Simmons and Steven G. Krantz, "Differential Equation, Theory, Technique and Practice", Tata McGraw – Hill, 2006.

R6. M. D. Raisinghania, "Ordinary and Partial Differential Equation", Chand (S.) & Co. Ltd., India, March 17, 2005.

R7. Paras Ram, "Engineering Mathematics through Applications", 1st Edition, CBS Publisher, 2011

PH132 / PH232 PHYSICS

(Common for all branches)

Unit-1 Modern Physics — 9 hours

Introduction, Planck's theory - Deduction of Wien's displacement law and Rayleigh Jean's law from Planck's law, Compton effect, de Broglie hypothesis – extension to electron particle. Phase velocity, group velocity, expression for group velocity based on superposition of waves, relation between group velocity and particle velocity. Problems.

Unit-2 Quantum Mechanics — 9 hours

Heisenberg's uncertainty principle and its physical significance. Application of uncertainty principle (Non-existence of electron in the nucleus). Wave function. Properties and Physical significance of a wave function Schrodinger - Time independent wave equation – Application: Setting up of a one dimensional Schrödinger wave equation of a particle in a potential well of infinite depth : Probability density and Normalization of wave function – Energy Eigen values and Eigen function. Problems.

Unit-3 Electrical and Thermal Conductivities of metals — 0 hours

Classical free-electron theory. Introduction, assumptions and limitation of classical free-electron theory. Thermal Conductivity. Wiedemann - Franz law, calculation of Lorentz number.

Quantum free-electron theory – Postulates of quantum fee electron theory, Fermi - Dirac Statistics. Fermi-energy – Fermi factor. Density of states. Carrier concentration in metals. Expression for electrical resistivity/conductivity - Merits of Quantum free electron theory. Problems.

Unit-4 Materials Science — 9 hours

Elasticity : Introduction - Bending of beams – Single Cantilever – Application of Cantilever in AFM, Young's modulus-Non uniform bending. Problems.

Dielectrics : Dielectric constant and polarisation of dielectric materials. Types of polarisation. Equation for internal fields in liquids and solids (one dimensional). Clausius – Mossotti equation. Ferro and Piezo – electricity(qualitative). Frequency

dependence of dielectric constant. Important applications of dielectric materials. Problems.

Unit-5 Applied Optics 8 hours

Lasers: Principle and production. Einstein's coefficients (expression for energy density). Requisites of a Laser system. Condition for Laser action. Principle, Construction and working of He-Ne and semiconductor diode Laser. Applications of Laser – Laser welding, cutting and drilling. Measurement of atmospheric pollutants. Problems.

Optical Fibers: Introduction, Principle and Propagation of light in optical fibers. Angle of acceptance. Numerical aperture. Types of optical fibers and modes of propagation. Applications –optical fiber communication system. Problems.

List of Experiments (If any):

1. Basic Measuring Instruments 2 hours
   - Vernier Callipers
   - Screw Gauge
   - Travelling Microscope
2. Verification of Stefan's law 1 hour
3. Planck's Constant (Determination of Planck's constant using LED or using the principle of photoelectric effect) 1 hour
4. Determination of Fermi energy. 1 hour
5. Young's modulus – Non-uniform bending. 1 hour
6. Measurement of Dielectric Constant (Charging & discharging of capacitor) 2 hours
7. Ultrasonic Interferometer. 1 hour
8. Interference at a wedge. 1 hour
9. Laser Diffraction (Determination of grating constant and number of rulings per inch using diffraction grating). 1 hour
10. Frequency determination – Melde's apparatus 2 hours
11. Photo Multiplier Tube – Demonstration only 1 hour

Text Books:

T1. M.N.Avadhanulu and P.G. Kshirsagar, "A Text Book of Engineering Physics", S.Chand & Company Ltd, 9th Edition 2012.

T2. John Wiley "Engineering Physics",Wiley India Pvt. Ltd, 1st Edition 2014.

T3. S.O. Pillai, "Solid State Physics", New Age International, 6th Edition 2009.

T4. S.P. Basavaraju, " Engineering Physics", Revised Edition 2009.

T5. Charles Kittel, "Introduction to Solid State Physics" , 8th Edition.

T6. Arthur Beiser, "Concepts of Modern Physics" , Special Indian Edition 2009.

T7. Ajoy Ghatak, "Optics",4th Edition 2009

Course Name: Basic Electrical Engineering					
Course Code : EE133P /233P					
	L	T	P	Category	ESC
Contact Hrs./Week	3	0	2	CIA Marks	70
Contact Hrs./Sem.	45	0	30	ESE Marks	30
Credits.	3	0	1	Exam Hours	3
Course Objectives: This course is aimed to solve and analyse DC and AC networks. It also covers the fundamental principles of alternator, transformer, motors, renewable energy systems and power converters. It also emphasise the concepts in smart grid and electrical vehicles to cope up with current trends in electrical engineering.					

Prerequisites: NA	
Units	Teaching Hours
Unit-1 : DC circuits	
Basic electrical quantities, KCL, KVL, voltage and current division rules, circuit reduction using series, parallel and star-delta transformation of resistors. Superposition theorem, Thevenin's theorem, Source transformations- Electromagnetism- Faraday's laws, comparison of electric and magnetic circuits.	9
Unit-2: AC circuits	
Comparison of DC and AC , Generation of sinusoidal signal, Representation of AC, inductance and capacitance, behaviour of pure R, L and C in AC circuits, RL, RC and RLC series circuits-derivations, phasor diagrams, real power, reactive power, power factor and resonance. Three phase balanced circuits, voltage and current relations in star and delta connections.	9
Unit-3: Power System Components	
Power system components-overview, Alternator-construction, working and generated voltage equation, Transformer – types, construction, working, emf equation, voltage regulation and efficiency, Switchgears (Fuse, MCB, relay), earthing, electric safety, standards and best practices. DC Motor- construction and working, torque and speed equations of shunt motors, Single phase induction motors - construction and working, BLDC motor and its applications in e-mobility.	9
Unit-4: Power Converters and Renewable Energy	
Power supplies and converters, SCR as a switch single phase rectifiers and inverters, DC power supply. Solar standalone system and its characteristics, Solar PV grid tied system description, Wind energy systems- types, types of renewable	9

systems- stand alone, grid tied systems and hybrid and micro-grids.	
Unit-5: Smart Grid and Electric Vehicles	
Introduction to smart grid, Home automation systems, Application of IoT in electrical systems, smart meters, communication systems in electrical systems, Artificial intelligence in power system. Introduction to electric vehicles- building blocks, charging stations. Different types of batteries and terminologies and BMS applications	9
List of Experiments:	Practical Hours
Verification of superposition theorem	2
Wiring practice – multiple switching and two way switching	2
Phase angle measurement in R, RL and RLC circuits	2
Energy measurement in single phase circuits – with R and RL loads	2
Power factor improvement	2
Regulation and efficiency of single phase transformer.	2
Speed – torque characteristics of a DC shunt motor	2
Speed – torque characteristics of single phase induction motor	2
Characteristics of solar PV Units	2
Electrical appliances control using Arduino	2
Variable DC voltage using DC-DC converter (Demonstration)	2
Power circuit control using relay and a contactor. (Demonstration)	2
Self-study : NA	
Site/Industrial Visits : NA	
Course outcomes: CO1: To solve DC networks CO2: To solve AC networks CO3: To understand working modes of alternator, transformer and motors CO4: To understand renewable energy systems and power converters CO5: To illustrate concepts smart grid and electrical vehicles	
Text Books: T1. D. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010. T2. V K. Mehta, Vivek Mehta, "Principles of Power System", S. Chand, 2005, reprint 2015. T3. D. P. Kothari and K C.Singal, "Renewable Energy Sources and Emerging	

Technologies", PHI, 2011.
T4. James Larminie, John Lowry, 'Electric Vehicle Technology Explained', Wiley , 2015.

Reference Books:
R1. Weedy, Cory, Ekanayake, ' Electric Power Systems', John Wiley & Sons; 5th edition, 2012.
R2. Hina Fathima (Editor), 'Hybrid-Renewable Energy Systems in Microgrids: Integration, Developments and Control', Woodhead Publishing Series in Energy, 2018.
R3. Nikos Hatziargyriou, 'Microgrids: Architectures and Control', Wiley, 2014
D. C. Kulshreshtha, "Basic Electrical Engineering", McGraw Hill, 2009.

Online Resources:
W1. https://nptel.ac.in/courses/108108076/
W2. https://nptel.ac.in/downloads/108105053/

Course Name: Basics of Civil Engineering and Engineering Mechanics					
Course Code : CE134P / CE234P					
	L	T	P	Category	ESC
Contact Hrs./Week	3	0	2	CIA Marks	70
Contact Hrs./Sem.	45	0	30	ESE Marks	30
Credits.	3	0	1	Exam Hours	3

Course objectives:
The students will understand the basics of civil engineering and Engineering Mechanics
The students will understand the basic principles and laws of forces of nature, measurements, calculations and SI units.
The students will understand mechanics that studies the effects of forces and moments acting on rigid bodies that are either at rest or moving with constant velocity along a straight path for static condition only.
The students will understand the basic concepts of forces in the member, centroid, moment of inertia and Kinetics of bodies.

Prerequisites: Nil

Units	Teaching Hours
Unit-1 Introduction To Civil Engineering	
Scope of different fields of Civil Engineering: Surveying, Building Materials, Construction Technology, Structural Engineering, Geotechnical Engineering, Environmental Engineering, Hydraulics, Water Resources Engineering, Transportation Engineering. Role of Civil Engineers in Infrastructure Development.	

Introduction to Engineering Mechanics Basic idealizations-Particle, Continuum, Rigid body and Point force, Newtons laws of motion. Force, classification of force systems, Principle of Physical Independence of forces, Principle of Superposition of forces and Principle of Transmissibilty of forces, Moment, Couple and its characteristics. Composition and resolution of forces, Paralleologram Law of forces, Polygon law. Resultant of coplanar concurrent force systems.	9
Unit-2 Equilibrium of force systems	
Composition of Coplanar Concurrent and Non Concurrent Force System. Resultant of coplanar concurrent force systems. Varignon's Theorem, Resultant of coplanar non concurrent force systems. Equilibrium of force systems Free body Diagram, Lami's Theorem ,Equations of Equilibrium, Equilibrium of coplanar concurrent forces.	9
Unit-3 Support Reactions	
Support Reactions Types of loads and supports, Types of beams, Statically determinate and indeterminate beams, Support Reactions in beams, Numerical Problems on support reactions for statically determinate beams (point load, Uniformly distributed load, Uniformly varying load and moments) .	9
Unit-4 Centroid and Moment of inertia	
Centroid and Moment of inertia Definition of centroid and centre of gravity, Centroid of simple plane figures and built up sections. Moment of inertia / Second Moment of area, Parallel axis theorem and Perpendicular axis theorem, Moment of Inertia of composite areas, Polar Moment of inertia and radius of gyration.	9
Unit-5 Kinematics	
Kinematics Definitions, Displacement, Average velocity, Instantaneous Velocity, Speed, Acceleration, Average Acceleration, Variable Acceleration, Acceleration due to gravity.Types of motion-Rectilinear, Curvilinear and Projectile motion. Relative motion and Motion under Gravity, Numerical Problems. Kinetics: D Alemberts Principle and its application in Plane motion.	9
List of Experiments:	Practical Hours
1.To determine moisture content of fine Aggregates.	2
2.Sieve Analysis of Fine Aggregates.	2
3.Determination of Compressive Strength of Burnt Clay Bricks.	2
4. Determination of Fineness of Cement.	2

5. Setting out of rectangle in the field.	2
6. Setting out of polygon in the field.	2
7. To Verify the Polygon Law of Forces Using Universal Force Table.	2
8. To Verify Parallelogram Law of Forces Using Grave Sand's Apparatus.	2
9. To Determine Weight of Body Using Grave Sand's Apparatus.	2
10. To Verify Triangular law of Forces using Jib Crane Apparatus.	2
11. To determine the reactions for simply supported beam Using Parallel Force Apparatus.	2
12. To determine the center of gravity Using Parallel Force Apparatus.	2
Self-study: NA	
Site/Industrial Visits : Nil	
Course outcomes: After a successful completion of the course, the student will be able to: CO1: Understand basics of Civil Engineering, its scope of study and materials of construction.(L1)(PO1)(PSO1) CO2: Comprehend the action of Forces, Moments and other loads on systems of rigid bodies.(L2)(PO1,PO2)(PSO2) CO3: Compute the reactive forces and the effects that develop as a result of the external loads.(L3)(PO1)(PSO2) CO4: Compute Centroid and Moment of Inertia of regular and built up sections.(L3)(PO1) (PSO1) CO5: Express the relationship between the motion of bodies and equipped to pursue studies in allied courses in Mechanics. (L3) (PO1,PO2) (PSO1)	
Text Books: T1. Bhavikatti S.S. Elements of Civil Engineering, 4th Edition and Engineering Mechanics , 2nd edition, New Delhi, Vikas Publishing House Pvt. Ltd, 2008. T2. Shesh Prakash and Mogaveer, Elements of Civil Engineering and Engineering Mechanics, 1st edition, New Delhi , PHI learning Private Limited,2009. T3. Jagadeesh T.R. and Jay Ram, Elements of Civil Engineering and Engineering Mechanics, 2nd edition, Bangalore, Sapana Book House, 2008.	
Reference Books: R1. Timoshenko, and Young, Engineering Mechanics, Tata McGraw-Hill, New Delhi, 2013. R2. Meriam J. L, and Kraige, L. G, Engineering Mechanics, 5/E, Volume I, Wiley India Edition, India, Feburary 2018 R3. Irvingh H Shames, Engineering Mechanics, 4/E, PHI learning Private Limited, New Delhi, 2008 R4. Ferdinand P. Beer and E. Russel Johnston Jr., Mechanics for Engineers: Statics, McGraw-Hill Book Company, New Delhi. International Edition 2013	

R5. Bansal R. K, Engineering Mechanics, Laxmi Publications (P) Ltd, New Delhi, 2015
Goyal and Raghuvanshi, Engineering Mechanics, New Edition, PHI learning Private Limited, New Delhi. 2011
R6. Rajasekaran, S, Sankarasubramanian, G., Fundamentals of Engineering Mechanics, Vikas Publishing House Pvt., Ltd., 2011.
R7. Kukreja C.B., Kishore K.Ravi Chawla., Material Testing Laboratory Manual, Standard Publishers & Distributors 1996.
R8. Gambhir M.L., Concrete Manual, Dhanpat Rai & Sons, New Delhi, 2014
Duggal S.K., Surveying, Vol-I, Tata McGraw Hill - Publishing Co. Ltd. New Delhi.
R9. Punmia. B.C., Surveying Vol–1, Laxmi Publications, New Delhi.

Online Resources:
W1. https://nptel.ac.in/courses/112103109/
W2. https://nptel.ac.in/courses/122104015/

Course Name: Engineering Graphics					
Course Code : EG 135P / EG 235P					
	L	T	P	Category	ESC
Contact Hrs./Week	2	0	2	CIA Marks	50
Contact Hrs./Sem.	30	0	30	ESE Marks	50
Credits.	2	0	1	Exam Hours	3

Course objectives:
To create an awareness and emphasise the need for Engineering Graphics.
To teach basic drawing standards and conventions.
To develop skills in three-dimensional visualization of engineering components.
To develop an understanding of 2D and 3D drawings using the Solidworks software

Prerequisites: Nil	
Units	Teaching Hours
Unit-1 Introduction to Engineering Drawing& Orthographic Projections	
Introduction to Engineering Drawing Principles of Engineering Graphics and their significance, usage of Drawing instruments, BIS conventions, lettering, Scales – Plain, Diagonal and Vernier Scales. Orthographic Projections (First Angle Projection Only) Principles of orthographic projections, introduction to first angle and third angle projection, projections of points, lines (inclined to both planes) and planes. (No application problems)	14
Unit-2 Introduction of Computer Aided Engineering Drawing	

Introduction of Computer Aided Engineering Drawing (CAED) Introduction and customization of user interface consisting of set up of the drawing page and the printer, including scale settings, setting up of units and drawing limits; ISO and ANSI standards for coordinate dimensioning, orthographic constraints, snap to objects manually and automatically, producing drawings by using various coordinate input entry methods to draw straight lines, applying various ways of drawing circles. Annotations, layering & other functions covering applying dimensions to objects, applying annotations to drawings, setting up and use of layers, layers to create drawings, create, edit and use customized layers, changing line lengths through modifying existing lines.	12
Unit-3 Projections of Regular Solids & Sections of solids	
Projections of Regular Solids Projection of solids inclined to both the Planes, draw simple annotation, dimensioning and scale (both manual and CAD software). Sections of solids Sections and sectional views of right angular solids - Prism, Cylinder, Pyramid, Cone– Auxiliary Views; (both manual and CAD software)	20
Unit-4 Development of surfaces & Isometric Projections	
Development of surfaces Development of surfaces of right regular solids - prism, pyramid, cylinder and cone; draw the sectional orthographic views of geometrical solids. Isometric Projections Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of simple and compound Solids, conversion of Isometric Views to Orthographic Views and Vice-versa, Conventions.	20
Unit-5 Overview of Computer Graphics & Introduction to Modelling and Assembly	
Overview of Computer Graphics Demonstrating knowledge of the theory of CAD software: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line (where applicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.; Projection of solids, Isometric of Simple and compound Solids, sections of solids and development of surfaces. Introduction to Modeling and Assembly Introduction to Computer aided modeling of solid part and assembly using CAD software Parametric and non-parametric solid and wireframe models, part editing and 2D drafting of assembly.	20

Self-study: Three Modelling of Simple Machine Parts
Site/Industrial Visits : Nil
Course outcomes: CO1: Understand the importance of BIS standards and scales and be able to use it in Engineering drawings and be Able to graphically construct geometric 2 Dimensional figures with hand tools and solve numericals related to them. {L1,L2}{PO1} CO2: Use the CAD software and be able to create basic 2D computer geometries like points, lines, and planes. {L1,L2}{PO1,PO2} CO3: Understand the concept of projection and sectioning of solids and be able to create the drawings manually. {L1,L2}{PO1,PO2} CO4: To create Drawings of surfaces of regular solids after development Manually. {L1,L2}{PO1,PO2} CO5: To create isometric drawings from Orthographic projections by using isometric scale Manually and using CAD software. {L1,L2}{PO2,PO5} CO6: To create projection of solids, sectioning development of surface using CAD software and be able to draw basic 3D shapes in CAD. {L1,L2}{PO2,PO5}
Text Books: T1. Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing House T2. N S Parthasarathy and Vela Murali (2015) Engineering Drawing, Oxford University Press T3. Shah, M.B. & Rana B.C. (2009), Engineering Drawing and Computer Graphics, Pearson Education T4. Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication
Reference Books: R1. S. Trymbaka Murthy, "Computer Aided Engineering Drawing", I.K. International Publishing House Pvt. Ltd., New Delhi. R2. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech R3. K.R. Gopalakrishna, "Engineering Graphics", 15th Edition, Subash Publishers Bangalore
Online Resources: Nil

COURSE NAME: BIOSCIENCE					
Course Code : BS 136 / BS 236					
	L	T	P	Course Type	BSC
Contact Hrs./Week	3	0	0	CIA Marks	50

Contact Hrs./Sem.	45	0	0	ESE Marks	50
Total Contact Hrs.	45	0	0	Exam Hours	3
Credits.	3	0	0		

Course objectives:
To introduce biological foundation for engineering students.

Prerequisites: Nil

Units	Teaching Hours
Unit-1 Introduction to Cell structure and biomechanism	
Biological Engineering - Classifications-Taxonomy- Prokaryotes and Eukaryotes- Morphology, NucleusProtein structure and function - Organelles for Protein synthesis and transport- Cell division - mitosis, meiosis- Biochemical pathways - metabolism, energy conversion, TCA cycle, electron transport, ATP, glycolysis, photosynthesis- DNA structure - Replication- Transcription- Translation	9
Unit-2 Biosensors	
General principles - Construction of biosensors, immobilization of receptor components in biosensors- Types –metabolism, semiconductor, optical, piezoelectric, immune-sensors - Applications – lab-on-a-chip, food and beverage, defence, environmental applications, Medical instruments	10
Unit-3 Modern Imaging systems	
X ray, digital radiography – x-ray computed tomography- Nuclear medical imaging systems, Magnetic resonance imaging system, Ultrasonic imaging system, thermal imaging, haemodialysis system, anaesthesia and ventilator systems.	8
Unit-4 Biomechanics	
Key mechanical concepts - 9 fundamentals of biomechanics -Muscle action, Range of motion principle, Force motion principle - Tissue loads - Response of tissue to force -Biomechanics of passive muscle tendon unit- Biomechanics of bone - Biomechanics of ligaments - Mechanical characteristics of muscles- Force time principle - Stretch-shortening cycle	10
Unit-5 Materials for organs and devices	
Materials – polymers, metals, ceramics, hydrogels, degradable biomaterials - Host reaction to biomaterials and their evaluation - Application of biomaterials – heart valves, orthopaedic applications, Cochlear and dental implants, soft tissue replacements, Hard tissue replacements	8
Self-study: Nil	
Site/Industrial Visits: Nil	

Course outcomes:

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

CO1: Discuss the hierarchical of life and the classification of species.

CO2: The student would be able to differentiate between single celled and multi-cellular organisms based on their cell structure.

CO3: Explain about structure, types and functioning of key components as proteins, carbohydrates, fats and DNA/RNA.

CO4: The student will be able to elaborate on the different pathways for energy production, cell division, photosynthesis and genetic transfer.

CO5: Discuss about the construction and working of biosensors for various applications.

CO6: Discuss about the architecture and organization of implantable electronics, which are used to sense and monitor different body functions.

CO7: Discuss the fundamental of the common laboratory equipment, its functioning and the electronics associated with it.

Text Books:

T1. F. Scheller, F. Schubert, (1991) Biosensors, Volume 11 of Techniques and Instrumentation in Analytical Chemistry, Elsevier.

T2. Vinod Kumar Khanna, (2015) Implantable Medical Electronics: Prosthetics, Drug Delivery, and Health Monitoring, Springer.

T3. Khandpur, (2003) Handbook of Biomedical Instrumentation, Tata McGraw-Hill Education

T4. David A. Winter, (2009) Biomechanics and Motor Control of Human Movement, John Wiley & Sons.

T5. Duane Knudson, (2013) Fundamentals of Biomechanics, Springer Science & Business Media.

T6. Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons, (2012) Biomaterials Science: An Introduction to Materials in Medicine, Academic Press.

Reference Books:

R1. Bansi Dhar Malhotra, Anthony Turner, (2003) Advances in Biosensors: Perspectives in Biosensors, Volume 5 of Advances in Biosensors, Elsevier.

Online Resources:

NPTEL Online courses

III Semester							
Sl.No	Type	Course Name	L (Hrs)	T (Hrs	P (Hrs)	Hrs/ Week	Credits
1	MA331	Mathematics-III	3	0	0	3	3
2	EE332P	Electrical Machines -I	3	0	2	5	4
3	EE333P	Analog & Digital Electronics	3	0	2	5	4
4	EE 334	Electrical Circuit Analysis	3	0	0	3	3
5	EE335	Electromagnetic Fields	3	0	0	3	3
6	HS336	Technical Communication	2	0	0	2	2
7	EEMC1	Cyber Security	2	0	0	2	0
8	EEMC2	Constitution of India	1	0	0	1	0
9	HE371	Holistic Education-III	1	0	0	1	1
		Total	21	0	4	25	20

MA331 MATHEMATICS III

(For EEE branch)

UNIT – I: Coordinate Systems 9 Hours

Curvilinear Coordinate System, Gradient, divergent, curl and Laplacian in cylindrical and Spherical Coordinate system, Cylindrical Coordinates, Spherical Coordinates, Transformation between systems.

UNIT – II: Partial Differential Equation 9 Hours

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Solution of standard types of first order partial differential equations – Lagrange's linear equation – Linear partial differential equations of second and higher order with constant coefficients.

UNIT – III: Fourier Series 9 Hours

Fourier series – Odd and even functions – Half range Fourier sine and cosine series – Complex form of Fourier series – Harmonic Analysis.

UNIT – IV: Fourier Transform 9 Hours

Complex Fourier transform – Sine and Cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity. Solution of equations using Fourier transform.

UNIT – V: Z – Transform and Difference Equations 9 Hours

Z-transform - Elementary properties – Inverse Z – transform – Convolution theorem - Formation of difference equations – Solution of difference equations using Z - transform.

TEXT BOOKS

1. Dr. B. S. Grewal, "Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, June 2014.
2. Kandasamy, P., Thilagavathy, K. and Gunavathy, K., "Numerical Methods", S. Chand Co. Ltd., New Delhi, 2003.

REFERENCE BOOKS

1. Ramana B.V., "Higher Engineering Mathematics", 6th Reprint, Tata McGraw – Hill Publishing Company. New Delhi, 2008.
2. Churchill, R.V. and Brown, J.W., "Fourier Series and Boundary Value Problems", Fourth Edition, McGraw-Hill Book Co., Singapore, 1987.
3. T.Veera Rajan "Engineering Mathematics [For Semester III]. Third Edition. Tata McGraw-Hill Publishing Company. New Delhi, 2007
4. Gerald, C.F, and Wheatley, P.O, "Applied Numerical Analysis", Sixth Edition, Pearson Education Asia, New Delhi, 2002.
5. S. L. Loney, "Plane Trigonometry", Cambridge: University Press.

Course Code: EE332P	Course Name: Electrical Machines - I	
Type of Course: PCC	L:T:P 3:0:2	Credits - 4
Prerequisites :-Basic Electrical Engineering and Electromagnetism	Course : Theory + Lab	Maximum Marks – 100
Course Objectives: To learn working principle, construction, operation and performance of DC rotating machines and transformers.		
Detailed Syllabus		
Unit I	DC GENERATORS	9 hours
Fundamental principles – constructional details- armature windings - single layer winding and double layer winding - lap winding and wave winding -classification - generators, motors– emf equation of generator– Characteristics of series, shunt and compound generators – Armature reaction and commutation – Parallel operation of		

DC shunt and compound generators. Losses and efficiency		
Unit II	DC MOTORS	9 hours
Principle of operation of DC motors – Back emf and torque equation – Characteristics of series, shunt and compound motors - Losses and efficiency, Starting of DC motors – Types of starters – Speed control of DC series and shunt motors		
Unit III	TRANSFORMERS- I	9 hours
Constructional details of core and shell type transformers – Types of windings – Principle of operation – emf equation – Transformation ratio – Transformer on no-load – Parameters referred to HV / LV windings – Equivalent circuit – Transformer on load – Regulation – Parallel operation of single phase transformers,		
Unit IV	TRANSFORMERS- II	9 hours
Three phase transformers – construction and types of connections, phase conversions, cooling methodology of transformers- conservators, breathers, Protection of transformers- Bucholz relay, Auto transformers and tap changing transformers Pulse transformer , isolation transformer ,welding transformer , potential transformer, current transformer.		
Unit V	TESTING OF DC MACHINES AND TRANSFORMERS	9 hours
Testing of DC machines – Losses and efficiency in DC machines ,condition for maximum efficiency , Brake test, Swinburne's test, Retardation test and Hopkinson's test Testing of transformers –Losses and efficiency in transformers, condition for maximum efficiency, All day efficiency, Polarity test, load test, open circuit and short circuit tests , Sumpner's test		
Laboratory Experiments		30 hours
List of experiments 1. Open circuit and load characteristics of D.C separately and self -excited shunt generator 2. Load characteristics of D.C. compound generator with cumulative connection 3. Load characteristics of D.C. shunt motor 4. Load characteristics of DC compound motor 5. Load characteristics of D.C series motor 6. Swinburne's test on D.C shunt motor 7. Hopkinson's test on D.C motor – generator set 8. Load test on single-phase transformer and three phase transformer connections 9. Open circuit and short circuit tests on single phase transformer 10. Sumpner's test on transformers		

Course Outcomes

CO1. Understand the operating principles of a DC generators and analyze the characteristics of self and separately excited DC generators

CO2. Analyze the characteristics and speed control of different types of DC motors and determine the application possibilities of shunt , series and compound motors

CO3. Understand the operational principle of a transformer and analyze the transformer performance on no load and on load.

CO4. Understand the protection methods of transformers and the application of special purpose transformers

CO5. Understand testing methods employed for DC machines and transformers determine the efficiency on no load and on load.

Text Books:

T1. D.P. Kothari and I.J. Nagrath, 'Electric Machines', Tata McGraw Hill Publishing Company Ltd, 2002.

T2. P.S. Bimbhra, 'Electrical Machinery', Khanna Publishers, 2003

Reference Books:

R1. A.E. Fitzgerald, Charles Kingsley, Stephen. D. Umans, 'Electric Machinery', Tata McGraw Hill publishing Company Ltd, 2003.

R2. S. J. Chapman, Electric Machinery Fundamentals, 3rd ed., McGraw-Hill, 1999.

CO-PO/PSO Mapping

COs	POs												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	3		1					2	1			3			
CO2	3	3		1					2	1			3			
CO3	3	3		1					2	1			3			
CO4	3	3		1					2				3			
CO5	3	3		1					2	1			3			

Course Code: EE333P	Course Name: Analog and Digital Electronics	
Type of Course: ESC	L:T:P 3:0:2	Credits - 4
Prerequisites :-Basic Physics, Mathematics and Electromagnetism	Course : Theory + Lab	Maximum Marks – 100

Course Objectives

This course deals electronic devices and their application as switches, amplifiers and

their applications. This course also deals with digital logic systems, combinational and sequential circuits and programmable devices		
Detailed Syllabus		
Unit I	Electronic Switches	9 hours
P-N junction diode, I-V characteristics of a diode, clamping and clipping circuits. BJT Structure, I-V characteristics of BJT, BJT as a switch, MOSFET: Structure and I-V characteristics. MOSFET as a switch. MOSFET as an amplifier: small-signal model and biasing circuits, common-source, common-gate and common-drain amplifiers; small signal equivalent circuits - gain, input and output impedances, transconductance, high frequency equivalent circuit.		
Unit II	Differential, multi-stage and operational amplifiers	9 hours
Differential amplifier; power amplifier; direct coupled multi-stage amplifier; internal Structure of an operational amplifier, ideal op-amp, non-idealities in an op-amp (Output offset voltage, input bias current, input offset current, slew rate, gain bandwidth product). Applications of op-amp: PID controllers, Zero Crossing Detector, Square-wave and triangular-wave generators. Peak detector and monoshot.		
Unit III	Digital systems and logic families	9 hours
Number systems, one's and two's complements arithmetic, codes, error detecting and correcting codes, characteristics of digital lCs, digital logic families, TTL, Schottky TTL and CMOS logic, interfacing CMOS and TTL.		
Unit IV	Combinational and sequential circuits	9 hours
Combinational Circuits: Multiplexer, De-Multiplexer/Decoders, Adders, Subtractors, BCD arithmetic, carry look ahead adder, serial adder, digital comparator, parity checker/generator, code converters, priority encoders, decoders/drivers for display devices, Q-M method of function realization. Sequential Circuits: SR flip flop, J- K-T and D-types flip flops, shift registers, serial to parallel converter, parallel to serial converter, ring counter, sequence generator, ripple(Asynchronous) counters, synchronous counters, special counter IC's,		
Unit V	Converters, memories and Programmable logic devices	9 hours
Digital to analog converters: weighted resistor/converter, R-2R Ladder D/A converter, specifications for D/A converters, examples of D/A converter lCs, sample and hold circuit, analog to digital converters: quantization and encoding, parallel comparator A/D converter, successive approximation A/D converter, dual slope A/D converter. Memory organization and operation, expanding memory size, classification And characteristics of memories, sequential memory, read only memory (ROM), read and write memory(RAM), content addressable memory (CAM), charge de coupled device memory (CCD), commonly used memory chips, ROM as a PLD,		

Programmable logic array, Programmable array logic, Field Programmable Gate Array (FPGA).	
Laboratory Experiments (if any)	30 hours

List of experiments

1. Symbols, identification and checking of electronic components.
2. PN Diode Characteristics, HW and FW rectifiers.
3. Zener Diode characteristics & Regulators.
4. Transistors Characteristics CB, CE and CC configurations.
5. Frequency response of CB, CE and CC amplifier in self bias and fixed bias.
6. Op-Amp Applications.
7. RC & LC Oscillators.
8. Applications of 555 timers.
9. Design & implementation of binary adder/subtract or using basic gates.
10. Design & implementation of application using multiplexers.
11. Design & implementation of synchronous and asynchronous counters.
12. Design & implementation of shift registers.
13. Coding combinational circuits using HDL

Course Outcomes

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

CO1. Understand the characteristics of transistors.

CO2. Design and analyse various operational amplifier circuits.

CO3. Design and implement Combinational and Sequential logic circuits.

CO4. Understand the process of Analog to Digital conversion and Digital to Analog conversion.

CO5. Be able to use PLDs to implement the given logical problem.

CO-PO/PSO Mapping

COs	POs												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	2	2														2
CO2		2	2													2
CO3		2	2								1					2
CO4	2	2														2
CO5		2	2													2

EE334 CIRCUIT ANALYSIS L :T:P 3:1:0

COURSE OBJECTIVES

- *To analyze DC and AC circuits using circuit analysis.*
- *To examine time domain response of first and second order systems*
- *To analyze circuits using Laplace transform.*

- *To discuss the basic concepts of network topology and two port network parameters.*
- *To examine frequency response of electric circuits*

UNIT I DC and AC Circuit Analysis 9+3 hours

Solution for DC circuits using mesh and nodal analysis with dependent sources – super mesh – super node. Circuit theorems - Reciprocity, Substitution, Thevenin's, Norton and maximum power transfer theorems.

AC circuit analysis- Network theorems in ac circuits- Thevenin's, Norton, Maximum Power Transfer theorem, Resonance in series and parallel circuits: Q factor, half-power frequencies and bandwidth of resonant circuits. Transient response in AC circuits.

Three phase circuits- Measurement of 3-phase power in balance and unbalanced circuits.

UNIT II Time Domain Response of Circuits 9+3 hours

Mathematical preliminaries for time domain response – Source free response –DC response of first order circuits – Superposition and linearity – Response Classifications – First order RC Circuits.

Second Order Linear Circuits: Discharging of a Capacitor through an inductor – Source free second order linear networks – second order linear networks with constant inputs.

UNIT III Circuit Analysis Using Laplace Transforms 9+3 hours

Initial conditions in elements, procedure for evaluating initial conditions, Laplace Transform Analysis: Notions of Impedance and Admittance – Manipulation of Impedance and Admittance- Notions of Transfer Function- Equivalent circuits for inductors and capacitors – Nodal and Loop analysis in the s-domain – Switching in RLC circuits- Switched capacitor circuits and conservation of charge.

Poles, Zeros and the s-plane- Classification of Responses – Computation of sinusoidal steady state response for stable networks and systems.

UNIT IV Network Topology & Two Port Network Parameters 9+3 hours

Graph of a network, Concept of tree and co-tree, incidence matrix, tie-set and cut- set schedules Formulation of equilibrium equations in matrix form, solution of resistive networks, principle of duality.

Two Port Networks: z, y, h and transmission parameters, modeling with these parameters, relationship between parameters sets, multiport networks.

UNIT V Frequency Response of Electric Circuits 9+3 hours

Concept of complex frequency – pole – Zero plots – frequency Response of RL,RC and RLC circuits – transient response of RL,RC and RLC series and parallel circuits – free response – step and sinusoidal responses – natural frequency , damped frequency, damping factor and logarithmic decrement – response of circuits for non-sinusoidal periodic inputs.

COURSE LEARNING OUTCOMES

After successfully completing this course, students will be able to:

- Solve DC and AC circuits using basic circuit theorems
- Analyze time domain response of first and second order circuits
- Solve electric circuits using Laplace transforms.
- Apply graph theory to solve electric circuits
- Find the frequency response of electric circuits

TEXT BOOKS

1. William H. Hayt Jr, Jack E. Kemmerly, and Steven M. Durbin, Engineering Circuit Analysis, Tata McGraw Hill Publishing Co Ltd, New Delhi, 2013
2. Mahmood Nahvi, "Electric Circuits", Schaum's Series, Adapted by: Dr. K Uma Rao, Tata McGraw Hill publishing Co. Ltd., New Delhi 2010.

REFERENCE BOOKS

1. De-carlo and Lin, Linear Circuit Analysis 2 ed., Oxford University Press, 2009
2. R.C. Dorf, "Introduction to Electric Circuits, John Wiley & Sons Inc, New York, Second Edition, 2013.
3. Charles K. Alexander, Mathew N.O. Sadiku, Fundamentals of Electric Circuits, McGraw Hill, N.Y, 2006.

Course Code: EE335	Course Name: Electromagnetic Fields	
Type of Course: PCC	L:T:P 3:0:0	Credits - 3
Prerequisites :- Basic Physics, Mathematics and Electromagnetism	Course : Theory	Maximum Marks – 100

Course Objectives

- To analyse fields a potentials due to static changes
- To evaluate static magnetic fields
- To understand how materials affect electric and magnetic fields
- To understand the relation between the fields under time varying situations
- To understand principles of propagation of uniform plane waves.

Detailed Syllabus

Unit I	STATIC ELECTRIC FIELDS	4 hours

Introduction to Co-ordinate System – Rectangular – Cylindrical and Spherical Co-ordinate System – Introduction to line, Surface and Volume Integrals – Definition of Curl, Divergence and Gradient – Meaning of Strokes theorem and Divergence theorem Coulomb's Law in Vector Form – Definition of Electric Field

Intensity – Principle of Superposition – Electric Field due to discrete charges – Electric field due to continuous charge distribution – Electric Field due to charges distributed uniformly on an infinite and finite line – Electric Field on the axis of a uniformly charged circular disc – Electric Field due to an infinite uniformly charged sheet. Electric Scalar Potential – Relationship between potential and electric field - Potential due to infinite uniformly charged line – Potential due to electrical dipole - Electric Flux Density – Gauss Law – Proof of Gauss Law – Applications.		
Unit II	STATIC MAGNETIC FIELD	4 hours
The Biot-Savart Law in vector form – Magnetic Field intensity due to a finite and infinite wire carrying a current I – Magnetic field intensity on the axis of a circular and rectangular loop carrying a current I – Ampere's circuital law and simple applications. Magnetic flux density – The Lorentz force equation for a moving charge and applications – Force on a wire carrying a current I placed in a magnetic field – Torque on a loop carrying a current I – Magnetic moment – Magnetic Vector Potential.		
Unit III	ELECTRIC AND MAGNETIC FIELDS IN MATERIALS	4 hours
Poisson's and Laplace's equation – Electric Polarization-Nature of dielectric materials- Definition of Capacitance – Capacitance of various geometries using Laplace's equation – Electrostatic energy and energy density – Boundary conditions for electric fields – Electric current – Current density – point form of ohm's law – continuity equation for current. Definition of Inductance – Inductance of loops and solenoids – Definition of mutual inductance – simple examples. Energy density in magnetic fields – Nature of magnetic materials – magnetization and permeability - magnetic boundary conditions.		
Unit IV	TIME VARYING ELECTRIC AND MAGNETIC FIELDS	4 hours
Faraday's law – Maxwell's Second Equation in integral form from Faraday's Law – Equation expressed in point form. Displacement current – Ampere's circuital law in integral form – Modified form of Ampere's circuital law as Maxwell's first equation in integral form – Equation expressed in point form. Maxwell's four equations in integral form and differential form. Pointing Vector and the flow of power –Instantaneous Average and Complex Pointing Vector.		
Unit IV	ELECTROMAGNETIC WAVES	4 hours
Derivation of Wave Equation – Uniform Plane Waves – Maxwell's equation in Phasor form – Wave equation in Phasor form – Plane waves in free space and in a homogenous material. Wave equation for a conducting medium – Plane waves in lossy dielectrics – Propagation in good conductors – Skin effect- Problems.		
Course Outcomes: CO1. Discuss different co-ordinate systems, its transformation and the basics of electrostatics.		

CO2. Analyse the magnetic field, magnetic scalar and vector potential.
CO3. Discuss about Ampere's circuital law and analyse the field due to various configurations of loops.
CO4. Express Maxwell's Equation in point form and integral form, propagation of plane wave in free space and lossless dielectric.
CO5. Discuss upon the effect of time varying fields and the modifications required to the Maxwell's equations when subjected to a Dynamic system.

CO-PO/PSO Mapping

COs	POs												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	3		2					1							
CO2	3	3		2					1							
CO3	3	3		2					1							3
CO4	3	3		2					1							
CO5	3	3		2					1							

HS 336 TECHNICAL COMMUNICATION

UNIT I Organization and structure of Technical Documents 6 Hours

Analysing different kinds of technical documents, factors affecting information and document design, Strategies for organization, Information design and writing technical documents.

UNIT II Mechanics of English & Editing 6 Hours

Writing drafts and revising, writing style and language. ,advanced grammar, editing strategies to achieve appropriate technical style. Vocabulary .for professional writing. Idioms and collocations

UNIT III Soft Skills 6 Hours

Personality development. Types of personality. Emotional Intelligence, career planning,

Self-assessment, Perception and Attitudes, Values and belief, Personal goal setting, conflict Resolution.

UNIT IV Oral Communication 6 Hours

Public speaking, Group discussion, Oral presentation, Interviews,, Presentation aids, project proposals

UNIT V: Business Etiquettes 6 Hours

Email etiquettes, Telephone Etiquettes, Engineering ethics, Time Management, Role and responsibility of engineer, Work culture in jobs

TEXT BOOKS

T1: David F. Beer and David McMurrey, Guide to writing as an Engineer, John Willey. New York, 2004

T2: Diane Hacker, Pocket Style Manual, Bedford Publication, New York, 2003. (ISBN 0312406843)

T3: Shiv Khera, You Can Win, Macmillan Books, New York, 2003.

REFERENCE BOOKS

R1: Raman Sharma, Technical Communications, Oxford Publication, London, 2004.

R2: Dale Jungk, Applied Writing for Technicians, McGraw Hill, New York, 2004. (ISBN: 07828357-4) R3: Sharma, R. and Mohan, K. Business Correspondence and Report Writing, TMH New Delhi 2002. R4: Xebec, Presentation Book, TMH New Delhi, 2000. (ISBN 0402213)

IV Semester							
Sl.No	Type	Course Name	L (Hrs)	T (Hrs	P (Hrs)	Hrs/ Week	Credits
1	EE431P	Electrical Machines- II	3	0	2	5	4
2	EE432P	Control Systems	3	0	2	5	4
3	EE433	Signals and Systems	3	0	0	3	3
4	EE434	Generation and Transmission	3	0	0	3	3
5	HS435	Professional Ethics	3	0	0	3	3
6	EE436	Biology for Engineers Lab	0	0	2	2	1
7	EEMC3	Environmental Science	2	0	0	2	0
8	HE471	Holistic Education-IV	0	0	2	1	1
		Total	17	0	8	24	19

Course Code: EE431	Course Name: Electrical Machines - II	
Type of Course: PCC	L:T:P 3:0:2	Credits - 4
Prerequisites :-Basic Electrical Engineering and Electromagnetism	Course : Theory + Lab	Maximum Marks – 100
Course Objectives: To learn working principle, construction, operation and performance of Synchronous and Asynchronous machines		
Detailed Syllabus		
Unit I	SYNCHRONOUS GENERATORS	9 hours
Constructional details – Types of rotors – emf equation – Synchronous reactance – Armature reaction – Voltage regulation – e.m.f, m.m.f, z.p.f and A.S.A methods – Synchronizing and parallel operation – Synchronizing torque - Change of excitation and mechanical input – Two reaction theory – Determination of direct and quadrature axis synchronous reactance using slip test – Operating characteristics - Capability curves		

Unit II	SYNCHRONOUS MOTORS	9 hours
Principle of operation – Torque equation – Operation on infinite bus bars - V-curves – Power input and power developed equations – Starting methods – Current loci for constant power input, constant excitation and constant power developed		
Unit III	THREE PHASE INDUCTION MOTOR	9 hours
Constructional details – Types of rotors – Principle of operation – Slip – Equivalent circuit – Slip-torque characteristics - Condition for maximum torque – Losses and efficiency – Load test - No load and blocked rotor tests - Circle diagram – Separation of no load losses – Double cage rotors – Induction generator – Synchronous induction motor.		
Unit IV	STARTING AND SPEED CONTROL OF THREE PHASE INDUCTION MOTOR	9 hours
Need for starting – Types of starters – Stator resistance and reactance, rotor resistance, autotransformer and star-delta starters – Speed control – Change of voltage, torque, number of poles and slip – Cascaded connection – Slip power recovery scheme.		
Unit V	SINGLE PHASE INDUCTION MOTORS AND GENERALISED MACHINE THEORY	9 hours
Constructional details of single phase induction motor – Double revolving field theory and operation – Equivalent circuit – No load and blocked rotor test – Performance analysis – Starting methods of single-phase induction motors - Generalised machine theory -machine as a circuit -model parameters -conventions - models for dc machines, synchronous machines, induction machines and transformers -introduction to digital simulation of systems comprising of machines.		
Laboratory Experiments		30 hours

1. Regulation of three phase alternator by emf and mmf methods
2. Regulation of three phase alternator by ZPF and ASA methods
3. Regulation of three phase salient pole alternator by slip test
4. Measurements of negative sequence and zero sequence impedance of alternators.
5. V and Inverted V curves of Three Phase Synchronous Motor.
6. Load test on three-phase induction motor.
7. No load and blocked rotor test on three-phase induction motor.
8. Load test on single-phase induction motor
9. No load and blocked rotor test on single-phase induction motor.

Course Outcomes
CO1: Understand the operating principles of synchronous generators and determine the regulation of athe generator under lagging, leading and upf loads CO2: Analyze the effect of changing load and excitation on the performance of a synchronous motor CO3: Understand the operational principle and analyse the performance characteristic of a three phase induction machine. CO4: Examine the speed control and starting methods of three phase induction motors CO5: Determine the performance characteristics of a single phase induction motor on load
Text Books: T1. D.P. Kothari and I.J. Nagrath, 'Electric Machines', Tata McGraw Hill Publishing Company Ltd, 2002. T2. P.S. Bimbhra, 'Electrical Machinery', Khanna Publishers, 2003
Reference Books: R1. A.E. Fitzgerald, Charles Kingsley, Stephen. D. Umans, 'Electric Machinery', Tata McGraw Hill publishing Company Ltd, 2003. R2. M.G. Say , The Performance and Design of Alternating Current Machines, CBS Publications, Dec 2005

CO-PO/PSO Mapping

COs	POs												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	3		1					2	1			Y			
CO2	3	3		1					2	1			Y			
CO3	3	3		1					2	1			Y			
CO4	3	3											Y			
CO5	3	3		1					2	1			Y			

Course Code: EE432	Course Name: Control Systems	
Type of Course: PCC	L:T:P 3:0:2	Credits - 4
Prerequisites :- Circuits analysis, Mathematics	Course : Theory + Lab	Maximum Marks – 100
Course Objectives: The course aims to write the different methods of representation of systems and getting their transfer function models, to illustrate		

time response of systems and its analysis, to explain the open loop and closed–loop frequency responses of systems, to describe the concept of stability of control system and methods of stability analysis, to design compensation for a control system, to explain of state space analysis, to model and test the performance of controllers and system on MATLAB, to analyze the performance a few given systems by finding the transfer functions

Detailed Syllabus

Unit I	INTRODUCTION TO CONTROL SYSTEMS	9 hours

Introduction to Control Systems: Types of Control Systems, Effect of Feedback Systems, Differential equation of Physical Systems – Mechanical Systems, Electrical Systems, Analogous Systems. Block diagrams and signal flow graphs: Transfer functions, Block diagram algebra and Signal Flow graphs.

Unit II	TIME RESPONSE OF FEED BACK CONTROL SYSTEMS	9 hours

Time Response of feedback control systems: Standard test signals, Unit step response of First and Second order Systems. Time response specifications, Time response specifications of second order systems, steady state errors and error constants. Introduction to PI, PD and PID Controllers.

Unit III	STABILITY ANALYSIS	9 hours

Stability analysis: Concepts of stability, Necessary conditions for Stability, Routh stability criterion, Relative stability analysis: more on the Routh stability criterion, Introduction to Root-Locus Techniques, The root locus concepts, Construction of root loci.

Unit IV	FREQUENCY DOMAIN ANALYSIS AND STABILITY	9 hours

Frequency domain analysis and stability: Correlation between time and frequency response, Bode plot, polar plots Nyquist Stability criterion, Design of lag, lead and lead lag compensators.

Unit V	STATE SPACE ANALYSIS	9 hours

State space representation, Advantages of state space analysis over transfer unction method, Canonical forms, Solution of state equation, Stability, Controllability and Observability of the system.

Laboratory Experiments	30 hours

PROGRAMMING EXPERIMENTS

1. Design and implementation of compensators.
2. Design of P, PI and PID controllers.
3. Stability analysis of linear systems.
4. State space modelling of electronic circuit and comparison of stability analysis of state space modelling and transfer function modelling.
5. Digital simulation of linear systems.

HARDWARE EXPERIMENTS

6. Determination of transfer function parameters of a DC servo motor.
7. Determination of transfer function parameters of AC servo motor.
8. Study of synchros.
9. Analog simulation of type-0 and type-1 system.
10. Real-time hybrid data acquisition and control.

SIMULINK EXPERIMENTS

11. Analysis and Design of Aircraft Pitch Controller
12. Analysis of Vehicle Suspension System

Course Outcomes

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

CO1: Define basic principles and techniques in designing linear control systems.

CO2: Apply knowledge of control theory for practical implementations in engineering and network analysis

CO3: Explain the basic concepts of state space modelling and analysis.

CO4: Model and test the performance of controllers and system on MATLAB

CO5: Analyze the performance a few given systems by finding the transfer functions.

Text Books:

T1. K. Ogata, 'Modern Control Engineering', 4th edition, Pearson Education, New Delhi, 2013 / PHI.

T2. I.J. Nagrath & M. Gopal, 'Control Systems Engineering', New Age International Publishers, 2013.

Reference Books:

R1. J.C. Doyle, B.A. Francis and A.R. Tannenbaum, Feedback Control Theory, Maxwell Macmilan International edition. 1992.

R2. C.L. Phillips and R.D. Harbour, Feedback Control Systems, Prentice Hall, 1985

R3. B.C. Kuo, 'Automatic Control Systems', Prentice Hall of India Ltd., New Delhi, 1995.

R4. M. Gopal, 'Control Systems, Principles & Design', Tata McGraw Hill, New Delhi, 2002.

R5. Norman S. Nise, Control Systems Engineering, 4th edition, New York, John Wiley, 2013. (Indian edition)

R6. M.N. Bandyopadhyay, 'Control Engineering Theory and Practice', Prentice Hall of India, 2013.

CO-PO/PSO Mapping

COs	POs												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	3		1					2	1			Y			

CO2	3	3		1					2	1			Y			
CO3	3	3		1					2	1			Y			
CO4	3	3											Y			
CO5	3	3		1					2	1			Y			

Course Code: EE433	Course Name: SIGNALS AND SYSTEMS	
Type of Course: PCC	L:T:P 3:1:0	Credits - 4
Prerequisites :- Basic Physics, Mathematics and Electromagnetism	Course : Theory	Maximum Marks – 100

Course Objectives

- To understand the properties and representation of continuous and discre time signals.
- To understand the sampling process and analysis of discrete systems using transforms.
- To understand the analysis and synthesis of discrete time systems.

Detailed Syllabus

Unit I	REPRESENTATION OF SIGNALS AND SYSTEMS	9 hours

Continuous and discrete time signals: Classification of Signals – Periodic & Aperiodic, Even& Odd, and Energy& Power signals, Deterministic & Random signals, Transformation in independent variable of signals: time scaling, time shifting, time reversal. Complex exponential and Sinusoidal signals, Periodicity of continuous and discrete signals, Basic/Elementary functions: unit impulse, unit step functions, Basic system properties.

Unit II	LINEAR TIME-INVARIANT CONTINUOUS TIME SYSTEMS	9 hours

Introduction, Convolution Integral, Properties of Linear Time Invariant Systems. Differential Equations representation of Systems, Solving Differential Equations, Natural and Forced Response of the system, Block Diagram Representation.

Unit III	FOURIER ANALYSIS OF CONTINUOUS AND DISCRETE TIME SIGNALS AND SYSTEMS	9 hours

Introduction, Frequency response of LTI systems, Fourier representation of Four Classes of signals, Fourier series, Fourier Transform, Discrete Time Fourier Series, Discrete Time Fourier Transform, Properties of Fourier Representations, Continuous time Fourier Transform and Laplace Transform analysis with examples, convolution in time and frequency domains.

Unit IV	SAMPLING THEOREM AND z-TRANSFORMS	9 hours

Representation of continuous time signals by its sample - Sampling theorem – Reconstruction of a Signal from its samples, aliasing – discrete time processing of continuous time signals, sampling of band pass signals. Basic principles of z-transform - z-transform definition – region of convergence – properties of ROC – Properties of z-transform – Poles and Zeros – inverse z-transform.

Unit IV	LINEAR TIME-INVARIANT DISCRETE TIME SYSTEMS	9 hours

Introduction, Convolution sum, Properties of Linear Time Invariant Systems. Difference Equations representation of Systems, Solving Difference Equations, Natural and Forced Response of the system, Block Diagram Representation.

Course Outcomes

CO1: Discuss classification of signals into Continuous and discrete signals based on various criteria.

CO2: Analyse of LTI systems based on Convolution Integral operation.

CO3: Discuss about frequency response of LTI systems and analysis using Fourier and Laplace transformations.

CO4: Discuss Sampling theorem and processing of samples to reconstruct the signals from samples.

CO5: Analyse of LTI systems based on Convolution Sum operation.

Text Books:

T1. Alan V.Oppenheim, Alan S.Willsky with S.Hamid Nawab, Signals & Systems, 2nd edn., Pearson Education, 2012.

Reference Books:

R1. Simon Haykin and Barry Van Veen, Signals and Systems, John Wiley, 1999

R2. John G.Proakis and Dimitris G.Manolakis, Digital Signal Processing, Principles, Algorithms and Applications, 3rd edn., PHI, 2000.

R3. M.J.Roberts, Signals and Systems Analysis using Transform method and MATLAB, TMH 2013.

R4. K.Lindner, "Signals and Systems", McGraw Hill International, 1999

R5. Moman .H. Hays," Digital Signal Processing ", Schaum's outlines, Tata McGraw-Hill Co Ltd., 2004.

R6. Ashok Amhardar, "Analog and Digital Signal Processing", 2ndEdition Thomson 2002.

CO-PO/PSO Mapping

COs	POs												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	3		2					1							
CO2	3	3		2					1							
CO3	3	3		2					1							

CO4	3	2		2					1							1
CO5	3	3		2					1							

Course Code: EE434	Course Name: GENERATION AND TRANSMISSION	
Type of Course: PCC	L:T:P 3:1:0	Credits - 4
Prerequisites :- Basic electrical engineering, Electrical circuit analysis	Course : Theory	Maximum Marks – 100

Course Objectives

To introduce conventional and non-conventional energy generation principl economics of generation, transmission system parameters and characteristics.

Detailed Syllabus

Unit I	CONVENTIONAL POWER GENERATION	9 hours

Importance of Electrical Energy - Generation of Electrical Energy – Sources of Energy – Comparison of Energy Sources – Conventional Power Generation: Steam Power Station – Hydro Electric Power Station – Diesel Power Station – Nuclear Power Station – Gas Turbine Power Plant.

Unit II	NON-CONVENTIONAL POWER GENERATION	9 hours

Need of non-conventional power generation - Solar Energy - Wind Energy - Tidal Energy -Geothermal Energy – Biomass; comparisons of all types of non-conventional power generation sources with their advantages and disadvantages

Unit III	ECONOMICS OF POWER GENERATION	9 hours

Economics of generation: definitions – load curves – number and size of units – cost of electrical energy – tariff. Economics of power factor improvement: design for improvement of power factor using power capacitors

Unit IV	TRANSMISSION SYSTEM PERFORMANCE	9 hours

Calculation of inductance and capacitance of single phase and three phase for balanced and unbalanced circuits; Classification of Transmission Lines – Performance (voltage regulation and efficiency) assessment for short, medium (Nominal-T, Nominal-Pie) and long transmission lines – ABCD Parameters of short. medium and long transmission lines

Unit V	METHODS TO IMPROVE TRANSMISSION SYSTEM	9 hours

	PERFORMANCE	

Causes of low p.f - Methods of improving p.f - phase advance and generation of reactive KVAR using static Capacitors - most economical p.f. for constant KW load and constant KVA type loads, Numerical Problems. Dependency of Voltage on Reactive Power flow - Methods of Voltage Control: Shunt Capacitors, Series Capacitors, Synchronous Capacitors, Tap changing and Booster Transformers.

Course Outcomes

CO1: To explain conventional energy conversion methods.
CO2: To explain nonconventional energy conversion methods.
CO3: To analyse economics of power generation
CO4: To analyse transmission system using system parameters
CO5: To discuss the transmission line performance improvement techniques.

Text Books:

T1. Electrical power systems - by C. L. Wadhwa, New Age International (P) Limited, Publishers, 1998.
T2. Electrical Power Generation, Transmission and Distribution by S. N. Singh., PHI, 2013.

Reference Books:

R1. Luces M.Fualkenberry ,Walter Coffer, 'Electrical Power Distribution and Transmission', Pearson Education, 2012.
R2. Hadi Saadat, 'Power System Analysis,' Tata McGraw Hill Publishing Company', 2013.
R3. Central Electricity Authority (CEA), 'Guidelines for Transmission System Planning', New Delhi.
R4. A Text Book on Power System Engineering by M.L.Soni, P.V.Gupta, U.S.Bhatnagar, A.Chakrabarthy, Dhanpat Rai & Co Pvt. Ltd.
R5. Electric Energy systems Theory – by O.I.Elgerd, Tata Mc Graw-hill Publishing Company Ltd., Second edition.
R6. Modern Power System Analysis by I.J.Nagaraj and D.P.Kothari, Tata McGraw Hill, 2nd Edition.

CO-PO/PSO Mapping

COs	POs												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	2	3											3			
CO2	2	3											3			
CO3	1	2	2										3			
CO4		2	2										3			
CO5	1	2	1										3			

HS435 PROFESSIONAL ETHICS III

UNIT I Introduction to Ethics 9 Hours

Introduction to Profession, Engineering and Professionalism, Three types of Ethics / Morality, Positive and Negative faces of Engineering Ethics.

Human Values : Morals, Values and Ethics – Integrity – Work Ethic – Service Learning – Civic Virtue – Respect for Others – Living Peacefully – caring – Sharing – Honesty – Courage – Valuing Time – Co-operation – Commitment – Empathy – Self-Confidence – Character – Spirituality

UNIT II Responsibility in Engineering and Engineering Ethics 9 Hours

Introduction, Engineering Standards, Blame – Responsibility and Causation, Liability, Design Standards, The Range of Standards of Practise, The Problem of many hands.

Senses of 'Engineering Ethics' - variety of moral issued - types of inquiry - moral dilemmas - moral autonomy - Kohlberg's theory - Gilligan's theory - consensus and controversy – Models of Professional Roles - theories about right action - Self-interest - customs and religion - uses of ethical theories.

UNIT III Social and value Dimensions in Technology 9 Hours

Technology – The Promise and Perils, Computer Technology – Privacy and Social Policy, Ownership of Computer Software and public Policy, Engineering Responsibility in Democratic Deliberation on Technology Policy, The Social Embeddedness of Technology. Gender equity, women in engineering

UNIT IV Engineers and Business 9 Hours

Ethics in Business – HR, Marketing, Finance and Accounting, Production and Operation Risks, Approaches to risk, Engineers liability for Risks

Ethics in Global Business – Ethical principles governing global business, ethical relations to adapting host countries, culture and norms, avoiding sanctions, protection of intellectual properties.

Pressures for ethical convergence

UNIT V: Ethics and Environment 9 Hours

Environment in Law and Court Decisions, Criteria for “Clean Environment”, The progressive Attitude towards the Environment, Going beyond the Law, Respect for nature, Scope of Professional Engineering obligations to Environment.

TEXT BOOKS

T1. Mike Martin and Roland Schinzinger, "Ethics in Engineering", McGraw-Hill, New York 1996.

T2. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2004.

REFERENCE BOOKS

R1. Charles D. Fleddermann, "Engineering Ethics", Pearson Education / Prentice Hall, New Jersey,
2004 (Indian Reprint)

R2. Charles E Harris, Michael S. Protchard and Michael J Rabins, "Engineering Ethics – Concepts and Cases", Wadsworth Thompson Learning, United States, 2000 (Indian Reprint now available)

R3. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi, 2003.

R4. Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, Oxford, 2001.

Course Code: EE451	Course Name: Biology for Engineers Lab	
Type of Course: HSMC	L:T:P 0:0:2	Credits – 1
Prerequisites : Biology for Engineers	Course : Lab	Maximum Marks – 50
Course Objectives: To train students in applications of biology in engineering domain. The course will deal with problems specific to the circuit branches		
Detailed Syllabus		
List of Experiments		Total hours 30
1. Experiment on biological sensors and their characteristics 2. Development of a biomedical instrument using sensors and signal processors 3. Imaging technology for biological signals 4. Integration and testing of the biomedical instrumentation systems 5. Measurement of air quality		
Course Outcomes CO1: To measure biological signals CO2: To implement signal processing in the biomedical instrument CO3: To test imaging technique CO4: To integrate and test an air quality test instrument		
Text Books: T1. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2006. T2. Gilbert M. Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.		

Reference Books:

R1. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India Pvt Ltd, New Delhi, 2007.

R2. Erach Bharucha, "Textbook of Environmental Studies", Universities Press(I) Pvt, Ltd,
Hydrabad, 2015.

R3. G. Tyler Miller and Scott E. Spoolman, "Environmental Science", Cengage Learning India PVT, LTD, Delhi, 2014.

R4. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, 2005.

Course Code: MC03	Course Name: ENVIRONMENTAL SCIENCE	
Type of Course: HSMC	L:T:P 3:0:0	Credits – 3
Prerequisites : Nil	Course : Theory	Maximum Marks – 100

Course Objectives: To create awareness on professional ethics and Human Values, To create awareness on Engineering Ethics providing basic knowledge about engineering Ethics, Variety of moral issues and Moral dilemmas, Professional Ideals and Virtues.

Detailed Syllabus

Unit I	Renewable and non-renewable resources	9 hours

Forest resources : Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. b) Water resources : Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. c) Mineral resources : Use and exploitation, environmental effects of extracting and using mineral resources, case studies. d) Food resources : World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. e) Energy resources : Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. Case studies. f) Land resources : Land as a resource, land degradation, man induced landslides, soil erosion and desertification. • Role of an individual in conservation of natural resources. • Equitable use of resoureces for sustainable lifestyles.

Unit II	Ecosystems	9 hours

Concept of an ecosystem. Structure and function of an ecosystem. • Producers, consumers and decomposers. • Energy flow in the ecosystem. • Ecological succession. • Food chains, food webs and ecological pyramids. • Introduction, types, characteristic features, structure and function of the following ecosystem :- a. Forest ecosystem b. Grassland ecosystem c. Desert ecosystem d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Unit III	Biodiversity and its conservation	9 hours
Introduction – Definition : genetic, species and ecosystem diversity. • Biogeographical classification of India • Value of biodiversity : consumptive use, productive use, social, ethical, aesthetic and option values • Biodiversity at global, National and local levels. • India as a mega-diversity nation V • Hot-sports of biodiversity. • Threats to biodiversity : habitat loss, poaching of wildlife, man-wildlife conflicts. • Endangered and endemic species of India • Conservation of biodiversity : In-situ and Ex-situ conservation of biodiversity.		
Unit IV	Environmental Pollution	9 hours
Definition • Cause, effects and control measures of :- a. Air pollution b. Water pollution c. Soil pollution d. Marine pollution e. Noise pollution f. Thermal pollution g. Nuclear hazards • Solid waste Management : Causes, effects and control measures of urban and industrial wastes. • Role of an individual in prevention of pollution. • Pollution case studies. • Disaster management : floods, earthquake, cyclone and landslides.		
Unit V	Social Issues and the Environment	9 hours
From Unsustainable to Sustainable development • Urban problems related to energy • Water conservation, rain water harvesting, watershed management • Resettlement and rahabilitation of people; its problems and concerns. Case Studies • Environmental ethics : Issues and possible solutions. • Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies. • Wasteland reclamation. • Consumerism and waste products. • Environment Protection Act. • Air (Prevention and Control of Pollution) Act. • Water (Prevention and control of Pollution) Act • Wildlife Protection Act • Forest Conservation Act • Issues involved in enforcement of environmental legislation. • Public awareness.		
Course Outcomes CO1: To explain importance of environmental protection CO2: To explain sustainable development		
Text Books: T1. Erach Bharucha, 'Text book for Environmental Studies', UGC		

CO-PO/PSO Mapping

COs	POs												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1			1				2	3				2			1	
CO2			1				2	3				2			1	

V Semester							
Sl.No	Type	Course Name	L (Hrs)	T (Hrs	P (Hrs)	Hrs/ Week	Credits
1	EE531P	Power Electronics	3	0	2	5	4
2	EE532P	Microprocessors and Microcontrollers	3	0	2	5	4
3	EE533	Power Systems - I	3	0	0	3	3
5	EE534	Advanced Computer programming	3	0	0	3	3
6	EE535X	Program Elective – 1	3	0	0	3	3
7	OE01	Open Elective - 1	3	0	0	3	3
		Total	18	0	4	22	20

EE534 POWER ELECTRONICS

L:T:P - 2:1:1

COURSE OBJECTIVES

- To compare characteristics of switching devices.
- To evaluate the performance of phase controlled converters for different types of loads.
- To design DC-DC converters with given characteristics.
- To analyze and evaluate the operation of inverters.
- To identify different power quality issues due power electronic devices in the circuit and study of compensating devices to mitigate that.
- To experimentally verify the performance of various switching devices and circuits like rectifiers, voltage controller, choppers and inverters.

UNIT I POWER SEMI-CONDUCTOR DEVICES, FIRING, COMMUTATION AND PROTECTION CIRCUITS . 6+3 hours

Structure, operation and characteristics of SCR, power transistor, MOSFET and IGBT.Two transistor analogy of SCR, Merits, Demerits and application of SCR ,Turn on and turn off methods of SCR, Turn on and turn off dynamic characteristics of SCR, Thyristor gate characteristics, Thyristor ratings, SCR firing circuits, UJT

firing circuit, di/dt and dv/dt protection, snubber circuit and its numerical problems. Switching losses.

UNIT II PHASE-CONTROLLED CONVERTERS 6+3 hours

2-pulse, 3-pulse and 6-pulse converters – Their operation with R, RL and RLE and the effect of free wheeling diode, derivation of average and rms load voltage and its numerical problems - Effect of source inductance - Distortion and displacement factor – Ripple factor - Single phase AC voltage controllers ON-OFF control and phase control.

UNIT III DC TO DC CONVERTERS 6+3 hours

Chopper- Time ratio control and current limit control strategy, classification based on voltage and current flow-class A, B, C, D, E types of chopper. Step up chopper and step down chopper –derivation of average and rms load voltage and load current Performance parameters of chopper and regenerative operation of step up chopper. Operation and design considerations of Buck, boost, buck-boost converters.

UNIT IV INVERTERS 6+3 hours

Single phase and three phase (both 120^0mode an d 180^0mode) inverters - PWM techniques: Sinusoidal PWM, modified sinusoidal PWM and multiple PWM - Voltage and harmonic control - Series resonant inverter - Current source inverters.

UNIT V APPLICATIONS 6+3 hours

Uninterrupted power supply topologies - Flexible AC transmission systems - Static VAr compensators(SVC)-TCR,TSR,TSC, static synchronous compensators(STATCOM), comparison of shunt compensators, Static series compensators-TSSC, TCSC, GCSC, SSSC. Comparison of series compensators. Comparison of series and shunt compensators, IPFC and UPFC.

LIST OF EXPERIMENTS 30 hours

1. Characteristics of SCR
2. Characteristics of TRIAC
3. Characteristics of MOSFET and IGBT
4. Transient characteristics of SCR and MOSFET
5. AC to DC fully controlled converter
6. AC to DC half-controlled converter
7. Step down and step up MOSFET based choppers
8. IGBT based single-phase PWM inverter
9. IGBT based three-phase PWM inverter
10. Resonant dc-to-dc converter

COURSE LEARNING OUTCOMES

By the end of this course students should be able

- To describe the construction, design and characteristics of semiconductor devices.
- To describe the modes of operation of power electronic converters and inverters.
- To design and apply power electronic circuit for generalized requirement.
- To apply the knowledge of power electronics in power quality domain particularly for compensation.
- To experimentally verify the performance of various switching devices and circuits like rectifiers, voltage controller, choppers and inverters.

TEXT BOOKS

1. Muhammad H. Rashid, "Power Electronics: Circuits, Devices and Applications",
2. Pearson Education, Third edition, 2004 / PHI.
3. Ned Mohan, Tore.M.Undeland, William. P. Robbins, "Power electronic converters, Application and Design" John Wiley and sons, third edition, 2013.

REFERENCE BOOKS

1. Bimal K. Bose, " Modern power electronics and ac drives", Pearson Edeucation.2013.
2. Mr.Jaganathan, " Introduction to power electronics", Prentice Hall of India,2004.
3. Bimbra P.S, " Khanna Publishers", Fifth edition.
4. M.D Singh and Khanchandani, " Power electronics" , Tata Mc-grow hill publication, New Delhi, 2002.

Course Code: EE532P	Course Name: Microprocessors and Microcontrollers	
Type of Course: PCC	L:T:P 3:0:2	Credits – 4
Prerequisites :- Analog and Digital electronics	Course : Theory	Maximum Marks – 100
Course Objectives: This course covers assembly level and high level programming for both ARM processors and controllers. This course also facilitates the concepts of system synthesis using embedded operating system and component interfacing.		
Detailed Syllabus		
Unit I	Arm Processor Fundamentals	9 hours
Microcomputer System – Harward and Von Neumann architecture - Evolution of microprocessor and microcontrollers – Features of microprocessor 8085 and 8086 - Features of microprocessor 8051 and 8052- Philosophy of RISC and CISC design– RISC advantages and drawbacks – Introduction to ARM - ARM Architecture - Operation and control – ARM Processor and Microcontroller Families - List and comparison of ARM cores and ARM cortex – Embedded system hardware and		

software		
Unit II	Arm Assembly Level Programming	9 hours
Programming model - Memory organization - Addressing modes – ARM Instruction set – Thumb instruction set - Exception and interrupt handling		
Unit III	ARM C AND PYTHON PROGRAMMING	9 hours
Embedded C and Python - ARM cross-development toolkit – Data types – Statements - Functions and procedures – Pointers – Register allocation - Address space model		
Unit IV	Embedded and Real Time Operating Systems	9 hours
Operating system support - Embedded system - Real-time operating system - Abstraction in hardware design - Firmware and bootloader – Simple little operating system - Memory hierarchy and cache memory – Virtual memory – I/O peripherals - System Control Coprocessor - Mobile device operating systems - Desktop/server operating systems – Coprocessor – Power consumption		
Unit V	Interfacing and System Design	9 hours
Single Board Computer - Interfacing LED Display - Interfacing LCD Display – Keypad Interfacing - Generation of Gate signals for converters and Inverters - Motor Control – Controlling AC appliances - Programmable Peripheral Interface - Interfacing of memory chips, ADC/DAC, Multiplexers – Bluetooth and Zigbee interfacing		
Laboratory Experiments (if any)		30 hours

List of experiments:

Assembly Programming

1. Assembly Level Programs to copy data from one memory location to other memory location.
2. Assembly Level Programs to find sum of n numbers in external/internal memory.
3. Assembly Level Programs to implement simple calculator to perform basic arithmetic operations.

C Programming

4. C Programs for finding largest and smallest in an array.
5. C Programs for Sorting and Searching.

External Interfacing

6. Counters: Up/down counters in decimal/hexadecimal.
7. LCD interfacing: Digital clock
8. LED interfacing: Blinking and scrolling words
9. Speed control of DC/Stepper motor.
10. Generation Signals.
11. ADC/DAC Interfacing: Current Sensor
12. Serial communication: Transmission from Kit and reception from PC using

Serial Port.

Course Outcomes

CO1: Comparison of basic microcontroller with the ARM processors

CO2: Execute assembly programs for memory mapped input-output.

CO3: Execute high level language programs for memory mapped input-output.

CO4: Recognition of embedded operating system in digital devices.

CO5: Construct and execute component interfacing with ARM.

TEXT BOOKS

1. ARM Architecture Reference Manual, Second Edition, Published 2011, edited by David Seal. Addison-Wesley. The definitive reference for the ARM architecture definition.
2. ARM System-on-Chip Architecture, Second Edition, Published 2000, by Steve Furber. Addison-Wesley. Covers the hardware aspects of ARM processors and SOCdesign.
3. Real-Time Operating Systems for ARM Cortex-M Microcontrollers, Jonathan W. Valvano, third edition, 2012.

REFERENCE BOOKS

1. ARM Assembly Language, Fundamentals and Techniques, William Hohl, CRC Press.
2. Real-Time Interfacing to ARM Cortex-M Microcontrollers, Jonathan W. Valvano, third edition, 2011.
3. ARM system developer's guide : Designing and optimizing software, Sloss, Andrew N; Symes, Dominic.
4. Modern Operating Systems, 2nd edition (2001) by Andrew Tanenbaum. Prentice-Hall.
5. Computer Architecture: A Quantitative Approach, by John L. Hennessy et al. MorganKaufmann. 2nd edition (2012).
6. The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors, Joseph Yiu, Newnes, 2013.
7. Computer Organization and Design: The Hardware/Software Interface, by David A. Pattersonet al. 2012. Morgan Kaufmann
8. Muhammad Ali Mazidi, Rolin D. Mckinlay, Danny Causey '8051 Microcontroller and Embedded Systems using Assembly and C Programming'.
9. Hall D. V., "Microprocessor and Interfacing-Programming and Hardware", 3rdedition., Tata McGraw-Hill Publishing Company Limited, 2008.
10. Ramesh S. Gaonkar, "Microprocessor - Architecture, Programming and Applications with the 8085", Penram International publishing private limited, fifth edition.

CO-PO/PSO Mapping

COs	POs												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	✓															
CO2	✓				✓											✓
CO3	✓				✓											✓
CO4	✓				✓											✓
CO5	✓				✓											✓

EE533 POWER SYSTEM – 1

UNIT – 1

DC AND AC DISTRIBUTION SYSTEM

Classification of Distribution Systems - Comparison of DC vs AC and Under-Ground vs Over- Head Distribution Systems- Requirements and Design features of Distribution Systems- Voltage Drop Calculations (Numerical Problems) in D.C Distributors for the following cases: Radial D.C Distributor fed one end and at the both the ends (equal/unequal Voltages) and Ring Main Distributor. Voltage Drop Calculations (Numerical Problems) in A.C. Distributors for the following cases: Power Factors referred to receiving end voltage and with respect to respective load voltages.

UNIT – 2

SUBSTATIONS

Air insulated substations (AIS) - Indoor & Outdoor substations: Substations layout showing the location of all the substation equipment. Bus bar arrangements in the Sub-Stations: Simple arrangements like single bus bar, sectionalized single bus bar, main and transfer bus bar system with relevant diagrams.

Gas insulated substations (GIS) – Advantages of Gas insulated substations, different types of gas insulated substations, single line diagram of gas insulated substations, bus bar, construction aspects of GIS, Installation and maintenance of GIS, Comparison of Air insulated substations and Gas insulated substations. Mobile Substations

UNIT – 3

MODELING OF POWER SYSTEM COMPONENTS

Modeling of Generator: Description of Simplified Network Model of a Synchronous Machine (Classical Model)

Modeling of Governor: Mathematical Modeling of Speed Governing System Modeling of Turbine: First order Turbine model, Block Diagram representation of Steam Turbines and Approximate Linear Models.

Modeling of Excitation System: Fundamental Characteristics of an Excitation system, Transfer function, Block Diagram Representation of IEEE Type-1 Model, Modeling of Loads: Frequency dependent and non-dependent.

UNIT – 4

FAULT STUDIES

Introduction – Balanced three phase fault – short circuit capacity – systematic fault analysis using bus impedance matrix – algorithm for formation of the bus impedance matrix.

Introduction – Fundamentals of symmetrical components – sequence impedances – sequence networks – single line to ground fault – line fault - Double line to ground fault – Unbalanced fault analysis using bus impedance matrix.

UNIT – 5

ELECTRIC HEATING, WELDING AND ILLUMINATION

Advantages and methods of electric heating, resistance heating induction heating and dielectric heating; Electric welding: resistance and arc welding, electric welding equipment, comparison between A.C. and D.C. Welding; Illumination - terms used in illumination, laws of illumination, polar curves, photometry, integrating sphere, sources of light. Types and design of lighting and flood lighting

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EE534 ADVANCED COMPUTER PROGRAMMING

COURSE OVERVIEW:

The course provides the opportunity to the student to extend their programming skill to the industrial and product oriented level. The course presents the advanced concepts in the computer engineering using python programming. The course also demonstrates the integration of allied tools and technologies with python to understand end-to-end scenario. The course will follow practical approach in every concept through programming.

COURSE OUTCOMES:

CO #	Description	RBT
1	Implement basic building blocks using python programming	L3
2	Extend and demonstrate utilization of advanced packages in python	L2
3	Operate data and exhibit user interfaces	L3
4	Demonstrate web and mobile applications	L2
5	Execute the consumption of cloud services from python program	L3

SYLLABUS

UNIT I: Python Programming
Data types, Statements, Functions, File handling, Classes and Objects
UNIT II: Python Libraries and packages
Numpy, Scikit-Learn, Pandas, Matplotlib, Scipy, PyTorch, Tensorflow,
UNIT III: Data access and Graphical User Interface
SQL and NonSQL databases, MySQL, MangoDB, Postgresql, Tkinter, wxPython
UNIT IV: Web and Mobile programming
REST Webservices, Djongo, Flask, Javascript, NodeJS, Cordova, Kivy
UNIT V: Cloud computing
Cloud services, Automation using IoT, Raspberry Pi programming, Case studies

TEXT BOOKS

1. Martin C. Brown, Python: The Complete Reference, McGraw Hill Education; Forth edition, 2018.
2. Sebastian Raschka Vahid Mirjalili, Python Machine Learning, Second Edition, 2017
3. Antonio Mele, Django 2 by Example: Build powerful and reliable Python web applications from, Packt Publishing, 2018
4. Burkhard A. Meier, Python GUI Programming Cookbook, Packt Publishing Limited, 2015.
5. Raschka Sebastian, Python Machine Learning, Packt Publishing Limited, 2018.

ONLINE REFERENCE

1. https://nptel.ac.in/courses/106/106/106106182/
2. https://nptel.ac.in/courses/106/106/106106212/

3. https://www.python.org/

V Semester Electives	
A	Wind and Solar Energy Systems
B	Electrical Machine Design
C	Power System Protection
D	Internet of Things
E	Utilization of Electrical Energy
F	Object Oriented Programming

	Wind and Solar Energy Systems	3L:0T:0P	3 credits

Course Outcomes:

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

- Understand the energy scenario and the consequent growth of the power generation from renewable energy sources.
- Understand the basic physics of wind and solar power generation.
- Understand the power electronic interfaces for wind and solar generation.
- Understand the issues related to the grid-integration of solar and wind energy systems.

Unit 1: Physics of Wind Power: (5 Hours)

History of wind power, Indian and Global statistics, Wind physics, Betz limit, Tip speed ratio, stall and pitch control, Wind speed statistics-probability distributions, Wind speed and power-cumulative distribution functions.

Unit 2: Wind generator topologies: (12 Hours)

Review of modern wind turbine technologies,Fixed and Variable speed wind turbines, Induction Generators, Doubly-Fed Induction Generators and their characteristics, Permanent- Magnet Synchronous Generators, Power electronics converters. Generator-Converter configurations, Converter Control.

Unit 3: The Solar Resource: (3 Hours)

Introduction, solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability.

Unit 4: Solar photovoltaic: (8 Hours)

Technologies-Amorphous, monocrystalline, polycrystalline; V-I characteristics of a PV cell, PV Unit, array, Power Electronic Converters for Solar Systems, Maximum Power Point Tracking (MPPT) algorithms.Converter Control.

Unit 5: Network Integration Issues: (8 Hours)

Overview of grid code technical requirements. Fault ride-through for wind farms - real and reactive power regulation, voltage and frequency operating limits, solar PV and wind farm behavior during grid disturbances. Power quality issues. Power system interconnection experiences in the world. Hybrid and isolated operations of solar PV and wind systems.

Unit 6: Solar thermal power generation: (3 Hours)

Technologies, Parabolic trough, central receivers, parabolic dish, Fresnel, solar pond, elementary analysis.

	Electrical Machine Design	3L:0T:0P	3 credits

Course Outcomes:

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

- Understand the constructionand performance characteristics of electrical machines.
- Understand the various factors which influence the design: electrical, magnetic and thermal loading of electrical machines
- Understand the principles of electrical machine design and carry out a basic design of an ac machine.
- Use software tools to do design calculations.

Unit 1: Introduction

Major considerations in electrical machine design, electrical engineering materials, space factor, choice of specific electrical and magnetic loadings, thermal considerations, heat flow, temperature rise, rating of machines.

Unit 2: Transformers

Sizing of a transformer, main dimensions, kVA output for single- and three-phase transformers, window space factor, overall dimensions, operating characteristics, regulation, no load current, temperature rise in transformers, design of cooling tank, methods for cooling of transformers.

Unit 3: Induction Motors

Sizing of an induction motor, main dimensions, length of air gap, rules for selecting rotor slots of squirrel cage machines, design of rotor bars & slots, design of end rings, design of wound rotor, magnetic leakage calculations, leakage reactance of polyphase machines, magnetizing current, short circuit current, circle diagram, operating characteristics.

Unit 4: Synchronous Machines

Sizing of a synchronous machine, main dimensions, design of salient pole machines, short circuit ratio, shape of pole face, armature design, armature parameters, estimation of air gap length, design of rotor, design of damper winding, determination of full load field mmf, design of field winding, design of turbo alternators, rotor design.

Unit 5: Computer aided Design (CAD):

Limitations (assumptions) of traditional designs, need for CAD analysis, synthesis and hybrid methods, design optimization methods, variables, constraints and objective function, problem formulation. Introduction to FEM based machine design. Introduction to complex structures of modern machines-PMSMs, BLDCs, SRM and claw-pole machines.

Text / References:

1. A. K. Sawhney, " A Course in Electrical Machine Design", Dhanpat Rai and Sons, 1970.
2. M.G. Say, "Theory & Performance & Design of A.C. Machines", ELBS London.
3. S. K. Sen, " Principles of Electrical Machine Design with computer programmes", Oxford and IBH Publishing, 2006.
4. K. L. Narang, " A Text Book of Electrical Engineering Drawings", SatyaPrakashan, 1969.
5. A. Shanmugasundaram, G. Gangadharan and R. Palani, " Electrical Machine Design Data Book" , New Age International, 1979.
6. K. M. V. Murthy, " Computer Aided Design of Electrical Machines", B.S. Publications, 2008.
7. Electrical machines and equipment design exercise examples using Ansoft's Maxwell 2D machine design package.

	Power System Protection	3L:0T:0P	3 credits

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

- Understand the different components of a protection system.

- Evaluate fault current due to different types of fault in a network.
- Understand the protection schemes for different power system components.
- Understand the basic principles of digital protection.
- Understand system protection schemes, and the use of wide-area measurements.

Unit 1: Introduction and Components of a Protection System (4 hours)
Principles of Power System Protection, Relays, Instrument transformers, Circuit Breakers

Unit 2: Faults and Over-Current Protection (8 hours)
Review of Fault Analysis, Sequence Networks. Introduction to Overcurrent Protection and overcurrent relay co-ordination.

Unit 3: Equipment Protection Schemes(8 hours)
Directional, Distance, Differential protection. Transformer and Generator protection. Bus bar Protection, Bus Bar arrangement schemes.

Unit 4: Digital Protection (8 hours)
Computer-aided protection, Fourier analysis and estimation of Phasors from DFT. Sampling, aliasing issues.

Unit 5: Modeling and Simulation of Protection Schemes (8 hours)
CT/PT modeling and standards, Simulation of transients using Electro-Magnetic Transients (EMT) programs. Relay Testing.

Unit 6: System Protection (4 hours)
Effect of Power Swings on Distance Relaying. System Protection Schemes. Under-frequency, under-voltage and df/dt relays, Out-of-step protection, Synchro-phasors, Phasor Measurement Units and Wide-Area Measurement Systems (WAMS). Application of WAMS for improving protection systems.

Text/References

1. J. L. Blackburn, " Protective Relaying: Principles and Applications" , Marcel Dekker, New York, 1987.
2. Y. G.Paithankar and S. R. Bhide, " Fundamentals of power system protection" , Prentice Hall, India, 2010.
3. A. G. Phadke and J. S. Thorp, " Computer Relaying for Power Systems", John Wiley & Sons, 1988.
4. A. G. Phadke and J. S. Thorp, "Synchronized Phasor Measurements and their Applications" , Springer, 2008.

5. D. Reimert, " Protective Relaying for Power Generation Systems", Taylor and Francis, 2006.

INTERNET OF THINGS L:T:P 2:1:0

COURSE OBJECTIVES

• Understand the building blocks of IoT technology and explore the vast spectrum of IoT applications

• Design and implement IoT applications and platform that manage physical data.

UNIT I INTRODUCTION TO IOT 6 hours

Features - Hardware and Data Ecosystem - Challenges - Market perspective - Sensors -Actuators - Signal Processing- Embedded System - Communication System – Research Opportunities

UNIT II IOT TECHNOLOGIES 6 hours

Database management system - Data acquisition- Communication Protocols- Cloud Services - Single Board Computers - Crypto System

UNIT III IOT PLATFORMS 6 hours

Open source IoT platforms - Eclipse IoT projects - Internet of Everything Platforms

UNIT IV IOT APPLICATION 6 hours

Smart meter - Home automation - Security Systems - Industrial process control - Electric Vehicles

UNIT V IOT IMPLEMENTATION 6 hours

Hardware and Data Model - Java, Javascript, Scilab and Python programming language - Web services - Web application - Mobile application - Case studies in Agriculture or in Healthcare.

INFORMAL LABORATORY EXPERIMENTS 15 hours

1. No-SQL/SQL and Python CRUD programming
2. Raspberry Pi GPIO programming
3. NI MyDAQ Data acquisition using Matlab/Scilab
4. Web application development – REST API example
5. Mobile application development – Controller and Monitoring System
6. Demonstration of Home Automation and Smart Meter
7. Demonstration of IoT platform.

COURSE LEARNING OUTCOMES

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

• Select appropriate hardware and software components for IoT applications

• Design and implement IoT client software on mobile devices including user interface, database access, event handling and communication.

• Design server-side/ cloud-end of the IoT application.

• Design and implement primitive IoT platform

TEXT BOOKS

1. Adrian McEwen and Hakim Cassimally, Designing the Internet of Things 1st Edition,

2. Maneesh Rao, Internet of Things with Raspberry Pi 3, 2018

3. PeterWaher, "Learning Internet of Things", 2015

UTILIZATION OF ELECTRICAL ENERGY L:T:P - 3:0:0

COURSE OBJECTIVES

- To understand the principles of electric drives
- To design illumination systems
- To apply design techniques in heating and welding.
- To understand Electric traction systems and their performance.
- To examine Industrial applications of electric drives.

UNIT I ELECTRIC DRIVES 9 hours

Type of electric drives, choice of motor, starting and running characteristics, speed control, temperature rise, particular applications of electric drives, types of industrial loads, continuous, intermittent and variable loads, load equalization.

UNIT II ELECTRIC HEATING & WELDING 9 hours

Advantages and methods of electric heating, resistance heating induction heating and dielectric heating. Electric welding, resistance and arc welding, electric welding equipment, comparison between A.C. and D.C. Welding.

UNIT III ILLUMINATION ENGINEERING 9 hours

Introduction, terms used in illumination, laws of illumination, polar curves, photometry, integrating sphere, sources of light. Discharge lamps, MV and SV lamps – comparison between tungsten filament lamps and fluorescent tubes, Basic principles of light control, Types and design of lighting and flood lighting.

UNIT IV ELECTRIC TRACTION – I 9 hours

System of electric traction and track electrification. Review of existing electric traction systems in India. Special features of traction motor, methods of electric braking-plugging rheostat braking and regenerative braking. Mechanics of train movement. Speed-time curves for different services – trapezoidal and quadrilateral speed time curves.

UNIT V ELECTRIC TRACTION-II 9 hours

Calculations of tractive effort, power, specific energy consumption for given run, effect of varying acceleration and braking retardation, adhesive weight and braking retardation adhesive weight and coefficient of adhesion. Maglev.

COURSE LEARNING OUTCOMES

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

- Understand the principles of electric drives
- Apply design principles in illumination systems
- Apply design techniques in heating and welding.
- Differentiate Electric traction systems and their performance.
- Understand systems in Industrial applications of electric drives.

TEXT BOOKS

1. E. Openshaw Taylor, „Utilization of Electrical Energy in SI Units", Orient Longman Pvt.Ltd, 2013.

2. B.R. Gupta, „Generation of Electrical Energy", Eurasia Publishing House (P) Ltd, New Delhi, 2013.

REFERENCE BOOKS

1. H. Partab, „Art and Science of Utilisation of Electrical Energy", Dhanpat Rai and Co, New Delhi, 2004. Bengaluru 72
2. Gopal.K.Dubey, „Fundamentals of Electrical Drives", Narosa Publishing House, New Delhi, 2002.
3. C.L. Wadhwa, „Generation, Distribution and Utilization of Electrical Energy", New Age International Pvt.Ltd, 2013. 4. J.B. Gupta, „Utilization of Electric Power and Electric Traction", S.K.Kataria and Sons, 2002.

OBJECT ORIENTED PROGRAMMING L:T:P – 3:0:0

COURSE DESCRIPTION

To present the concept of object oriented programming and discuss briefly the important elements of object oriented analysis and design of systems.

COURSE OBJECTIVES

- To study the object oriented programming principles, tokens, expressions, control structures and functions.
- To introduce the classes, objects, constructors and Destructors.
- To introduce the operator overloading, inheritance and polymorphism concepts in C++.
- To introduce constants, variables, data types, operators, classes, objects, methods, arrays and strings in Java.
- To introduce the programming approach in Java, interfaces and packages, multithreading, managing errors and exceptions and Applet programming.

UNIT I OBJECT ORIENTED PROGRAMMING AND BASICS OF C++ 9 Hours

Software crisis – Software evolution – A look at procedure oriented programming – Object oriented programming paradigm – Basic concepts of object oriented programming – Benefits of OOP – Object-oriented languages – Applications of OOP - What is C++? – A simple C++ program – More C++ statements – Structure of C++ Program. Tokens – Keywords – Identifiers and constants – Basic data types – User defined data types – Derived data types – Symbolic constants – Declaration of variables – Dynamic initialization of variables – Reference variables – Operators in C++ – Scope resolution operator – Manipulators – Type cast operator – Expressions and their types – Special assignment expressions – Control structures - The main function – Function prototyping – Call by reference – Return by reference – Inline functions – Default arguments – Function overloading.

UNIT II CLASSES AND OBJECTS 9 Hours

Specifying a class – Defining member functions – Private member functions –Arrays within a class – Memory allocation for objects – Static data members – Static member functions – Arrays of objects – Objects as function arguments –Friendly functions – Returning objects. Constructors: Parameterized constructors – Multiple

constructors in a class – Constructors with default arguments – Dynamic initialization of objects – Copy constructor – Dynamic constructors – Destructors.

UNIT III OPERATOR OVERLOADING, INHERITANCE AND POLYMORPHISM 9 Hours

Defining operator overloading: Overloading unary, binary operators. Manipulation of strings using operators – Rules for overloading operators – Type Conversions - Defining derived classes – Single inheritance – Multilevel inheritance – Multiple inheritance – Hierarchical inheritance – Hybrid inheritance – Virtual base classes – Abstract classes - Introduction to pointers to objects: This pointer – Pointers to derived classes – Virtual functions – Pure virtual functions.

UNIT IV JAVA EVOLUTION, CONSTANTS, VARIABLES, DATA TYPES, OPERATORS, CLASSES, OBJECTS, METHODS, ARRAYS AND STRINGS 9 Hours

Java features: How Java differs from C and C++ - Simple Java program – Java program structures – Java tokens – Java statements – Implementing a Java program – Java virtual machine – Command line arguments - Constants – Variables – Data types – Scope of variables – Operators in Java. Defining a class – Adding variables and methods – Creating objects – Accessing class members – Constructors – Method overloading – Static members – Inheritance: Extending a class – Overriding methods – Final variables and methods – Final classes – Abstract methods and classes – Visibility control - Arrays – One dimensional array – Creating an array – Two-dimensional arrays – Strings – Vectors.

UNIT V PROGRAMMING USING INTERFACES, PACKAGES, ULTITHREADING, MANAGING ERRORS AND EXCEPTIONS AND APPLETS 9 hours

Defining interfaces – Extending interfaces – Implementing interfaces – Accessing interface variables – Java API packages – Using system packages – Creating, accessing and using a package – Adding a class to a package - Creating threads – Extending the thread class – Stopping and blocking a thread – Thread exceptions – Thread priority – Synchronization – Life cycle of a thread – Using thread methods. Types of errors: Exceptions – Syntax of exception handling code – Multiple catch statements – Using finally statements – Throwing our own exceptions – Using exceptions for debugging. Preparing to write applets – Applet lifecycle – Creating an executable applet – Designing a web page – Applet tag – Adding applet to HTML file – Running the Applet.

ESSENTIAL READINGS

1. E.Balagurusamy, „Object Oriented Programming with C++", Second edition, Tata McGraw Hill, 2013.

2. E.Balagurusamy, „Programming with JAVA – A Primer", Second edition, Tata McGraw Hill, 2013.

RECOMMENDED READINGS

1. Herbert Schildt, „C++ - The Complete Reference", Tata McGraw Hill, 2012.

2. Bjarne Stroustrup, „The C++ Programming Language", Addison Wesley, 2012.

3. John .R .Hubbard, „Schaums Outline Programming with C++", Tata McGraw Hill, 2013.
4. Kris Jasma, „Java Programming – A Complete Reference", Galgotia publication, 1994

VI Semester							
Sl.No	Type	Course Name	L (Hrs)	T (Hrs	P (Hrs)	Hrs/ Week	Credits
1	EE631P	High Voltage Engineering and Protection	3	0	2	5	4
2	EE632P	Power Systems - II	3	0	2	5	4
3	EE633P	Digital Signal Processing	3	0	0	3	3
4	HS634	Project Management & Finance	3	0	0	3	3
5	OE02	Open Elective - 2	3	0	0	3	3
6	OE03	Open Elective - 3 (Global Elective)	3	0	0	3	3
		Total	18	0	4	22	20

EE631P HIGH VOLTAGE ENGINEERING & PROTECTION

COURSE OBJECTIVES

- *To understand the various types of over voltages in power system and protection methods, generation and measurement of over voltages in laboratories.*
- *To learn the nature of Breakdown mechanism in solid, liquid and gaseous dielectrics – discussion on commercial insulates.*
- *To testing various power apparatus as per IEEE/IEC standards*
- *To explain on various faults, its identification and its analysis.*
- *To explain the method of circuit breaking various arc theories arcing phenomena.*

SYLLABUS

Unit I Over Voltages in Electrical Power Systems 9+3 Hours

Causes of over voltages and its effect on power system – Lightning and its classification switching surges and temporary over voltages - protection against over voltages. breakdown mechanisms in solid, liquid, gas and composite dielectrics.

Unit II	Generation & Measurement of High Voltages and High Currents	9+3 Hours

Generation of High DC, AC, impulse voltages and currents. Tripping and control of impulse generators. Measurement of High voltages and High currents – digital techniques in high voltage measurement.

Unit III	Testing of electrical apparatus	9+3 Hours

High voltage testing of electrical power apparatus – power frequency, impulse voltage and DC testing – International and Indian standards – Insulation Coordination. - Biomedical Applications-Electrostatic spinning, pumping, propulsion - Hazards of Electrostatic electricity in industry Processing of juices, milk, egg, meat and fish products

Unit IV	Protection of High voltage equipment	9+3 Hours

Principles and need for protective schemes – Nature and causes of faults – Types of faults – Fault current calculation using symmetrical components – Power system Earthing - Zones of protection and essential qualities of protection – Protection scheme

Unit IV	Circuit breakers & Relays	9+3 Hours

Operating principles of relays, Electromagnetic Relays, Overcurrent, Directional, Distance, Differential, Negative sequence and under frequency relays. Circuit breakers – air, oil and vacuum.

COURSE LEARNING OUTCOMES

1. *To have an idea about the conduction and breakdown of dielectrics.*
2. *To explain about generation & measurement of high voltages & currents.*
3. *To test the electrical apparatus with high voltage*
4. *To Write the basic construction and working principles of relays and circuit breakers.*
5. *To explain relays and circuit breaker deployed in the power system*

TEXT BOOKS

1. M.S. Naidu and V. Kamaraju, 'High Voltage Engineering', Tata McGraw Hill, 5th Edition, 2012
2. G.V. Barbosa –Canovas, "Pulsed electric fields in food processing: Fundamental aspects and applications" CRC Publisher Edition March 2008
3. John D.Kraus, Daniel A.Fleisch, "Electromagnetics with Applications" McGrawHill International Editions, 2011.
4. Dieter Kind and Kurt Feser "High Voltage Testing Techniques" Technology Engineering Edition 2004.
5. Badri Ram, Vishwakarma, 'Power System Protection and Switchgear', Tata McGraw hill, 2011.

REFERENCE BOOKS

1. E. Kuffel and W.S. Zaengl, 'High Voltage Engineering Fundamentals', Pergamon press, Oxford, London, 1986.
2. E. Kuffel and M. Abdullah, 'High Voltage Engineering', Pergamon press, Oxford, 1970.
3. M.L. Soni, P.V. Gupta, V.S. Bhatnagar, A. Chakrabarti, 'A Text Book on Power System Engineering', Dhanpat Rai & Co., 2012.
4. Y.G. Paithankar and S.R. Bhide, 'Fundamentals of Power System Protection', Prentice Hall of India Pvt. Ltd., New Delhi – 110001, 2010

LIST OF EXPERIMENTS 15 hours

1. High voltage measurement using Capacitive Dividers & using Impulse Generators
2. Study of break down phenomena in air and solid dielectrics.
3. Study of break down phenomena in oil dielectrics.
4. Power Frequency flashover test on 11kV Pin Type Insulator
5. Measurement of Soil Resistivity by Wenners Four Point Method &
6. Measurement of Earth Pit Resistance by Fall of Potential Method and E.B Curt's Method.
7. Impulse Withstand & Flashover Test on 11kV Pin Type Insulator.
8. Study of overcurrent and under voltage relay working
9. Study of differential relay and its phenomenon of working.
10. Study of Electromechanical directional over current relay test kit

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EE632P Power Systems – II

Course Outcomes:

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

- Use numerical methods to analyse a power system in steady state.
- Understand stability constraints in a synchronous grid.
- Understand methods to control the voltage, frequency and power flow.
- Understand the monitoring and control of a power system.

- Understand the basics of power system economics.

Unit I: Power Flow Analysis

Review of the structure of a Power System and its components. Analysis of Power Flows: Formation of Bus Admittance Matrix. Real and reactive power balance equations at a node.

Load and Generator Specifications. Application of numerical methods for solution of nonlinear algebraic equations – Gauss Seidel and Newton-Raphson methods for the solution of the power flow equations. Computational Issues in Large-scale Power Systems.

Unit 2: Stability Constraints in synchronous grids

Swing Equations of a synchronous machine connected to an infinite bus. Power angle curve. Description of the phenomena of loss of synchronism in a single-machine infinite bus system following a disturbance like a three--phase fault. Analysis using numerical integration of swing equations (using methods like Forward Euler, Runge-Kutta 4th order methods), as well as the Equal Area Criterion. Impact of stability constraints on Power System Operation.

Effect of generation rescheduling and series compensation of transmission lines on stability.

Unit 3: Control of Frequency and Voltage

Turbines and Speed-Governors, Frequency dependence of loads, Droop Control and Power Sharing. Automatic Generation Control. Generation and absorption of reactive power by various components of a Power System. Excitation System Control in synchronous generators, Automatic Voltage Regulators. Shunt Compensators, Static VAR compensators and STATCOMs. Tap Changing Transformers.

Power flow control using embedded dc links, phase shifters and

Unit 4: Monitoring and Control

Overview of Energy Control Centre Functions: SCADA systems. Phasor Measurement Units and Wide-Area Measurement Systems. State-estimation. System Security Assessment.

Normal, Alert, Emergency, Extremis states of a Power System. Contingency Analysis.

Preventive Control and Emergency Control.

Unit 5: Power System Economics and Management

Basic Pricing Principles: Generator Cost Curves, Utility Functions, Power Exchanges, Spot Pricing. Electricity Market Models (Vertically Integrated, Purchasing Agency, Whole-sale competition, Retail Competition), Demand Side-management, Transmission and Distributions charges, Ancillary Services. Regulatory framework.

Text/References:

1. J. Grainger and W. D. Stevenson, “Power System Analysis”, McGraw Hill Education,
1994.
2. O. I. Elgerd, “Electric Energy Systems Theory”, McGraw Hill Education, 1995.

3. A. R. Bergen and V. Vittal, "Power System Analysis", Pearson Education Inc., 1999.
4. D. P. Kothari and I. J. Nagrath, "Modern Power System Analysis", McGraw Hill Education,
2003.
5. B. M. Weedy, B. J. Cory, N. Jenkins, J. Ekanayake and G. Strbac, "Electric Power Systems",
Wiley, 2012.

EE633	Digital Signal Processing	3L:0T:0P	3 credits

Course Outcomes:

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

- Represent signals mathematically in continuous and discrete-time, and in the frequency domain.
- Analyse discrete-time systems using z-transform.
- Understand the Discrete-Fourier Transform (DFT) and the FFT algorithms.
- Design digital filters for various applications.
- Apply digital signal processing for the analysis of real-life signals.

Unit 1: Discrete-time signals and systems (6 hours)

Discrete time signals and systems: Sequences; representation of signals on orthogonal basis; Representation of discrete systems using difference equations, Samplingand reconstruction of signals - aliasing; Sampling theorem and Nyquist rate.

Unit 2: Z-transform (6 hours)

z-Transform, Region of Convergence, Analysis of Linear Shift Invariant systems using z- transform, Properties of z-transform for causal signals, Interpretation of stability in z-domain, Inverse z-transforms.

Unit 2: Discrete Fourier Transform (10 hours)

Frequency Domain Analysis, Discrete Fourier Transform (DFT), Properties of DFT, Connvolution of signals, Fast Fourier Transform Algorithm, Parseval's Identity, Implementation of Discrete Time Systems.

Unit 3:Designof Digital filters (12 hours)

Designof FIR Digital filters: Windowmethod,Park-McClellan's method. Design of IIR Digital Filters: Butterworth, Chebyshev and Elliptic Approximations;Low-pass, Band-pass, Band- stop and High-pass filters.

Effect of finite register length in FIR filter design. Parametric and non-parametric spectral estimation. Introduction to multi-rate signalprocessing.

Unit 4: Applications of Digital Signal Processing (6 hours)

Correlation Functions and Power Spectra, Stationary Processes, Optimal filtering using ARMA Model, Linear Mean-Square Estimation, Wiener Filter.

Text/Reference Books:

1. S. K. Mitra, "Digital Signal Processing: A computer based approach", McGraw Hill, 2011.
2. A.V. Oppenheim and R. W. Schafer, "Discrete Time Signal Processing", Prentice Hall, 1989.
3. J. 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. DeFatta, J. G. Lucas andW. S. Hodgkiss, " Digital Signal Processing" , John Wiley & Sons, 1988.

HS 631 PROJECT MANAGEMENT AND FINANCE

UNIT I Introduction to Project Management 9 Hours

Importance, Objectives & Functions of Management , Principles of Management, Importance of organizational Structure in Management- Authority / Responsibility Relation, Management by objectives

Introduction to Project Management ,Categories of Project, Project Failure, Project---- Life Cycle Concept and Cost Components.

UNIT II Project Planning and Scheduling Activity Duration, Resource Requirements, & Cost 9 Hours

Duration: Resource Loading versus Activity Duration, Variation in Activity Duration, Methods for Estimating Activity Duration, Estimation Precision; Resources; Estimating Cost, JPP Session to Estimate Activity Duration & Resource Requirements, Determining Resource Requirements

Fundamentals of Project Network Diagram: Project Network Diagram, Benefits to Network- Based Scheduling, Building the Network Diagram Using the PDM, Analysing the Initial Project Network Diagram.

UNIT III Planning Tools 9 Hours

WBS – Work Breakdown Structure, Gantt/Bar chart & its Limitations, Network Planning, Network analysis, C. P. M.- . Activity on Arrow (A.O.A.), Critical path and type of Floats, Precedence network analysis (A.O.N.), Types of precedence relationship, P. E. R.T. Analysis. Applications, advantages and limitations of PERT & CPM.

UNIT IV: Introduction to Finance 9 Hours

Concepts, Business, Finance, Corporate Finance, Functions of Finance Manger, Objectives of Financial Management Finance, and Strategies to improve the wealth of the owners.

Meaning, Types of Working Capital, Operating Cycle, Estimation of Working Capital Requirements. Approaches in Working Capital

Importance of Time Value of Money, Techniques of Capital Budgeting: Pay Back, Discounted Payback Period, Net Present Value, and Internal Rate of Return, Profitability Index, and Modified Internal Rate of Return. Advantages and Disadvantages of Techniques of Capital Budgeting.

UNIT V: Financial Management & Capital Structure 9 Hours

Meaning of capital structure and financial structure, principles of capital structure, optimum capital structure, determinants of capital structure, capital structure and EPS Point of indifference, Capital gearing.

Approaches to Capital Structure: Net Income Approach, Net Operating Income Approach, M M Hypothesis without Tax Theories of capital structure- concepts, – practical problems

TEXT BOOKS

T1. Mike Martin and Roland Schinzinger, “Ethics in Engineering”, McGraw-Hill, New York 1996.

T2. Govindarajan M, Natarajan S, Senthil Kumar V. S, “Engineering Ethics”, Prentice Hall of India, New Delhi, 2004.

REFERENCE BOOKS

R1. Charles D. Fleddermann, “Engineering Ethics”, Pearson Education / Prentice Hall, New Jersey,
2004 (Indian Reprint)

R2. Charles E Harris, Michael S. Protchard and Michael J Rabins, "Engineering Ethics – Concepts and

Cases", Wadsworth Thompson Learning, United States, 2000 (Indian Reprint now available)

R3. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi, 2003.

R4. Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers",

Oxford University Press, Oxford, 2001.

VII Semester							
Sl.No	Type	Course Name	L (Hrs)	T (Hrs	P (Hrs)	Hrs/ Week	Credits
1	EE731X	Program Elective – 2	3	0	0	3	3
2	EE732X	Program Elective – 3	3	0	0	3	3
3	EE733X	Program Elective – 4	3	0	0	3	3
4	OE04	Open Elective - 4	3	0	0	3	3
5	EE771	Project Stage-I	0	0	6	6	3
6	EE772	Service Learning	0	0	4	4	2
7	EE773	Internship	0	0	4	4	2
		Total	12	0	14	26	19

VII Semester Electives	
A	Industrial Drives
B	Electrical and Hybrid Vehicles
C	Power System Dynamics and Control
D	Digital Control Systems
E	Control Systems Design
F	Electric Mobility
G	Advanced Converter Design
H	Programmable Logic Controllers
I	Mobile Communication Networks
J	Digital Communication
K	Wireless Sensor Networks

INDUSTRIAL DRIVES

L:T:P 3:0:0

COURSE OBJECTIVES

- To study and understand the different types of drives and selection of drive and power converter.
- To study and analyze the operation of the converter / chopper fed dc drive and to solve simple problems.
- To study and understand the operation of both classical and modern induction motor drives.
- To study special machines stepper motor, servo motor and brushless motor drives and their control.
- To analyze and design controllers for closed loop operation.

UNIT I AN INTRODUCTION TO ELECTRICAL DRIVES & ITS DYNAMICS
9 hours

Electrical drives. Advantages of electrical drives. Parts of electrical drives, choice of electrical drives, status of dc and ac drives, Dynamics of electrical drives, Fundamental torque equation, speed torque conventions and multiquadrant operation. Equivalent values of drive parameters, components of low torques, nature and classification of load torques, calculation of time and energy loss in transient operations, steady state stability, load equalization.

UNIT II MOTOR RATING AND DRIVES 9 hours

Selection of motor power rating

Thermal model of motor for heating and cooling, Classes of motor duty, determination of motor rating.

Industrial Drives

Rolling mill drives, cement mill drives, paper mill dries and textile mill drives.

UNIT III D C MOTOR DRIVES 9 hours

Starting braking, transient analysis, single phase fully controlled rectifier, control of dc separately excited motor, Single-phase half controlled rectifier control of dc separately excited motor. Three phase fully controlled rectifier control of dc separately excited motor, three phase half controlled controlled rectifier control of dc separately excited motor, multiquadrant operation of dc separately excited motor fed form fully controlled rectifier. Rectifier control of dc series motor, chopper controlled dc drives, chopper chopper control of separately excited dc motor. Chopper control of series motor.

UNIT IV INDUCTION MOTOR DRIVES 9 hours

Operation with unbalanced source voltage and single phasing, operation with unbalanced rotor impedances, analysis of induction motor fed from non-sinusoidal voltage supply, starting braking, transient analysis. (b) Stator voltage control variable voltage frequency control from voltage sources , voltage source inverter control, closed loop control, current source inverter control, current regulated voltage source inverter control, rotor resistance control, slip power recovery, speed control of single phase induction motors.

UNIT V SYNCHRONOUS MOTOR DRIVES 9 hours

Operation form faced frequency supply, synchronous motor variable speed drives, variable frequency control of multiple synchronous motors. Self-controlled synchronous motor drive employing load commutated thruster inverter.

COURSE LEARNING OBJECTIVES

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

- To compare construction and working of various special machines
- To differentiate the applications of special machines
- To select drive systems for the special machines
- To analyse the special machine drives

TEXT BOOKS

1. R. Krishnan, 'Electric Motor and Drives: Modelling Analysis and Control', Pearson Education, 2001.
2. G.K. Pubey, 'Fundamentals of Electrical Drives', Narosa Publication, 2012.

REFERENCE BOOKS

1. BimalK. Bose, 'Power Electronics and Motor drives' , Elsevier, 2011.
2. Chesmond, Wilson and Lepla, 'Advanced Control System Technology', Viva low priced student edition, 2014.

Electrical and Hybrid Vehicles

3L:0T:0P 3 credits

Course Outcomes:

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

- Understand the models to describe hybrid vehicles and their performance.
- Understand the different possible ways of energy storage.
- Understand the different strategies related to energy storage systems.

Unit 1: Introduction (10 hours)

Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance.

Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

Unit 3: Electric Trains (10 hours)

Electric Drive-trains: Basic concept of electric traction, introduction to various electric drivetrain topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives,

Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

Unit 4: Energy Storage (10 hours)

Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy

storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems

Unit 5: Energy Management Strategies (9 hours)

Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management

strategies.

Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

Text / References:

1. C. Mi, M. A. Masrur and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2011.

2. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies", Springer, 2015.

3. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel

Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.

4. T. Denton, "Electric and Hybrid Vehicles", Routledge, 2016.

Power System Dynamics and Control

3L:0T:0P 3 credits

Course Outcomes:

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

- Understand the problem of power system stability and its impact on the system.
- Analyse linear dynamical systems and use of numerical integration methods.
- Model different power system components for the study of stability.
- Understand the methods to improve stability.

Unit 1: Introduction to Power System Operations

Introduction to power system stability. Power System Operations and Control. Stability problems in Power System. Impact on Power System Operations and control.

Unit 2 : Analysis of Linear Dynamical System and Numerical Methods

Analysis of dynamical System, Concept of Equilibrium, Small and Large Disturbance Stability. Modal Analysis of Linear System. Analysisusing Numerical Integration Techniques. Issues in Modeling: Slow and Fast Transients, Stiff System.

Unit 3 : Modeling of Synchronous Machines and Associated Controllers

Modeling of synchronous machine: Physical Characteristics. Rotor position dependent model. D-Q Transformation. Model with Standard Parameters. Steady State Analysis of Synchronous Machine. Short Circuit Transient Analysis of a Synchronous Machine.

Synchronization of Synchronous Machine to an Infinite Bus. Modeling of Excitation and Prime Mover Systems. Physical Characteristics and Models. Excitation System Control.

Automatic Voltage Regulator. Prime Mover Control Systems. Speed Governors.

Unit 4 : Modeling of other Power System Components

Modeling of Transmission Lines and Loads. Transmission Line Physical Characteristics.

Transmission Line Modeling. Load Models - induction machine model. Frequency and Voltage Dependence of Loads. Other Subsystems – HVDC and FACTS controllers, Wind Energy Systems.

Unit 5 : Stability Analysis

Angular stability analysis in Single Machine Infinite Bus System. Angular Stability in multimachine systems – Intra-plant, Local and Inter-area modes. Frequency Stability: Centre of Inertia Motion. Load Sharing: Governordroop. Single Machine Load Bus System: Voltage Stability. Introduction to Torsional Oscillations and the SSR phenomenon. Stability Analysis Tools:Transient Stability Programs, Small Signal Analysis Programs.

Unit 6 : Enhancing System Stability

Planning Measures. Stabilizing Controllers (Power System Stabilizers). Operational Measures-Preventive Control. Emergency Control.

1. K.R. Padiyar, “Power System Dynamics, Stability and Control”, B. S. Publications,

2002.
2. P. Kundur, "Power System Stability and Control", McGraw Hill, 1995.
3. P. Sauer and M. A. Pai, "Power System Dynamics and Stability", Prentice Hall, 1997.

Digital Control Systems

3L:0T:0P 3 credits

Course Outcomes:

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

- Obtain discrete representation of LTI systems.
- Analyse stability of open loop and closed loop discrete-time systems.
- Design and analyse digital controllers.
- Design state feedback and output feedback controllers.

Unit 1: Discrete Representation of Continuous Systems (6 hours)

Basics of Digital Control Systems. Discrete representation of continuous systems. Sample and hold circuit. Mathematical Modelling of sample and hold circuit. Effects of Sampling and Quantization. Choice of sampling frequency. ZOH equivalent.

Unit 2: Discrete System Analysis (6 hours)

Z-Transform and Inverse Z Transform for analyzing discrete time systems. Pulse Transfer function. Pulse transfer function of closed loop systems. Mapping from s-plane to z plane.

Solution of Discrete time systems. Time response of discrete time system.

Unit 3: Stability of Discrete Time System (4 hours)

Stability analysis by Jury test. Stability analysis using bilinear transformation. Design of digital control system with dead beat response. Practical issues with dead beat response

design.

Unit 4: State Space Approach for discrete time systems (10 hours)

State space models of discrete systems, State space analysis. Lyapunov Stability.

Controllability, reach-ability, Reconstructibility and observability analysis. Effect of pole

zero cancellation on the controllability & observability.

Unit 5: Design of Digital Control System(8 hours)

Design of Discrete PID Controller, Design of discrete state feedback controller. Design of set point tracker. Design of Discrete Observer for LTI System. Design of Discrete compensator.

Unit 6: Discrete output feedback control (8 hours)

Design of discrete output feedback control. Fast output sampling (FOS) and periodic output feedback controller design for discrete time systems.

Text Books :

1. K. Ogata, "Digital Control Engineering", Prentice Hall, Englewood Cliffs, 1995.
2. M. Gopal, "Digital Control Engineering", Wiley Eastern, 1988.
3. G. F. Franklin, J. D. Powell and M. L. Workman, "Digital Control of Dynamic

Systems", Addison-Wesley, 1998.
4. B.C. Kuo, "Digital Control System", Holt, Rinehart and Winston, 1980. ----------
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Control Systems Design

3L:0T:0P 3 credits

Course Outcomes:

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

- Understand various design specifications.
- Design controllers to satisfy the desired design specifications using simple controller structures (P, PI, PID, compensators).
- Design controllers using the state-space approach.

Unit 1: Design Specifications (6 hours)

Introduction to design problem and philosophy. Introduction to time domain and frequency domain design specification and its physical relevance. Effect of gain on transient and steady

state response. Effect of addition of pole on system performance. Effect of addition of zero on system response.

Unit 2: Design of Classical Control System in the time domain (8 hours)

Introduction to compensator. Design of Lag, lead lag-lead compensator in time domain.

Feedback and Feed forward compensator design. Feedback compensation. Realization of compensators.

Unit 3: Design of Classical Control System in frequency domain (8 hours)

Compensator design in frequency domain to improve steady state and transient response.

Feedback and Feed forward compensator design using bode diagram.

Unit 4: Design of PID controllers (6 hours)

Design of P, PI, PD and PID controllers in time domain and frequency domain for first, second and third order systems. Control loop with auxiliary feedback – Feed forward control.

Unit 5: Control System Design in state space (8 hours)

Review of state space representation. Concept of controllability & observability, effect of pole zero cancellation on the controllability & observability of the system, pole placement design through state feedback. Ackerman's Formula for feedback gain design. Design of Observer. Reduced order observer. Separation Principle.

Unit 6: Nonlinearities and its effect on system performance (3 hours)

Various types of non-linearities. Effect of various non-linearities on system performance.

Singular points. Phase plot analysis.

Text and Reference Books :

1. N. Nise, "Control system Engineering", John Wiley, 2000.
2. I. J. Nagrath and M. Gopal, "Control system engineering", Wiley, 2000.
3. M. Gopal, "Digital Control Engineering", Wiley Eastern, 1988.

4. K. Ogata, "Modern Control Engineering", Prentice Hall, 2010.
5. B. C. Kuo, "Automatic Control system", Prentice Hall, 1995.
6. J. J. D'Azzo and C. H. Houpis, "Linear control system analysis and design (conventional and modern)", McGraw Hill, 1995.
7. R. T. Stefani and G. H. Hostetter, "Design of feedback Control Systems", Saunders College Pub, 1994.

ELECTRIC MOBILITY

L:T:P 2:1:0

COURSE OBJECTIVES

- *Understand the global moves on electrical mobility*
- *Understand the opportunities in electrical domain with the introduction of new vehicles.*
- *Design algorithms for energy management*

UNIT I INTRODUCTION 9 hours

Introduction to EV, HEV, PHEV, REEV, Electric Scooters, Electric Bus, Trucks, Power chairs - Challenges and Opportunities, Global Initiatives

UNIT II POWER SYSTEM DYNAMICS 9 hours

Energy Forcast, Generation and Load Scheduling - Smart grid - V2V - V2G - IoT EVs – DGs

UNIT III SMART CHARGING STATION AND SOLAR CHARGING STATION 9 hours

Energy Storage Technologies, BMS, Tariff Policy, Supply Side and Demand Side Incentives, AC and DC Chargers, Solar PV System, Smart Charging Station Architecture, Technologies, Features, Functions, Solar Charging Station,Battery swapping.

UNIT IV ENERGY MANAGEMENT SYSTEM 9 hours

Artificial Intelligence Based EMS, Power Optimization, Monitoring and Control Applications

UNIT V CASE STUDY 9 hours

Design, Simulation and Prototyping of Power train - Motors and drives - ECU for EV/HEV

COURSE LEARNING OUTCOMES

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

- *Understand the importance of electrical mobility on various aspects*
- *Understand the future opportunities in electric vehicle and allied technological sector.*

- *Build intelligent algorithms for energy management for large load dynamics.*

TEXT BOOKS

1. Miao Wang, Ran Zhang and Xuemin (Sherman) Shen, "Mobile Electric Vehicles", Springer

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PROGRAMMABLE LOGIC CONTROLLERS

L:T:P - 3:0:0

COURSE OBJECTIVES

The course aims to give the fundamentals of PLC and its programming. The course also aims to give an overview of PLC functions and the operation of Analog PLC

UNIT I PLC BASICS AND PROGRAMMING 9 hours

PLC Basics: PLC system, I/O Units and interfacing, CPU processor, programming equipment, programming formats, construction of PLC ladder diagrams, Devices connected to I/O Units. PLC Programming: Input instructions, outputs, operational procedures, programming examples using contacts and coils.

UNIT II LADDER DIAGRAMS 9 hours

Digital logic gates, programming in the Boolean algebra system, conversion examples Ladder Diagrams for process control: Ladder diagrams & sequence listings, ladder diagram construction and flowchart for spray process system. PLC Registers: Characteristics of Registers, Unit addressing, holding registers, Input Registers, Output Registers.

UNIT III PLC FUNCTIONS 9 hours

PLC Functions: Timer functions & Industrial applications, counters, counter function industrial applications, Arithmetic functions, Number comparison functions, number conversion functions

UNIT IV DATA HANDLING FUNCTIONS 9 hours

Data Handling functions: SKIP, Master control Relay, Jump, Move, FIFO, FAL, ONS, CLR & Sweep functions and their applications. Bit Pattern and changing a bit shift register, sequence functions and applications, controlling of two-axis & three axis Robots with PLC, Matrix functions.

UNIT V ANALOG PLC 9 hours

Analog PLC operation: Analog Units& systems, Analog signal processing, Multi bit Data Processing, Analog output Application Examples, PID principles, position indicator with PID control, PID Units, PID tuning, PID functions.

COURSE LEARNING OUTCOMES

By the end of the course student will be able to

- *Understand the basic operations of PLC*
- *Development of ladder diagrams*
- *Principles of PLC programming*
- *Various functions and function handling in PLC*
- *Operation of analog PLC*

TEXT BOOKS

1. John W. Webb & Ronald A. Reiss, 'Programmable Logic Controllers- Principles and Applications', Fifth Edition, PHI, 2009
2. J R. Hackworth & F.D Hackworth Jr., 'Programmable Logic Controllers- Programming Method and Applications', Pearson, 2006

REFERENCE BOOKS

1. W. Bolton, 'Programmable Logic Controllers', 5th edition, Elsevier, 2011
2. Garry Dunning, 'Introduction to Programmable Logic Controllers', Delmar Cengage, 2007

MOBILE COMMUNICATION NETWORKS

L:T:P – 3:0:0

COURSE OBJECTIVES

- *To expose the students to the basic mobile networking terminologies and concepts.*
- *To understand the practical realities of mobile voice and data transmissions and their implications.*
- *To teach the concepts of addressing and routing of data packets.*
- *To be able to implement basic networking applications and internetworking of heterogeneous systems.*

UNIT I WIRELESS TRANSMISSION 9 Hours

Frequencies for radio transmission, signals, antennas, signal propagation, multiplexing, modulation, OSI Model, Layers in OSI model

UNIT II MEDIUM ACCESS CONTROL 9 Hours

Motivation for a specialized MAC, SDMA, FDMA, TDMA, fixed TDM, Classical aloha, carrier sense multiple access, multiple access with collision avoidance, polling inhibit sense multiple access, CDMA Comparison.

UNIT III TELECOMMUNICATIONS SYSTEMS 9 Hours

GSM, mobile services, system architecture, radio interface, protocols, localization and calling, handover, security, new data services, DECT, system architecture TETRA, UMTS and IMT-2012, radio interface, UTRAN

UNIT IV SATELLITE SYSTEMS 9 Hours

Basics of GEO, LEO, MEO, Routing, localization, and handover. BROADCAST SYSTEMS: Cyclic repetition of data, digital audio broadcasting, digital video broadcasting, convergence of broadcasting and mobile communications.

UNIT V WIRELESS LAN AND MOBILE LAYERS 9Hours

Infrared vs radio transmission, infrastructure and ad-hoc network, IEEE802.11, Blue tooth. Mobile IP, Goals, assumptions and requirements, IP packet delivery,

agent discovery, registration, encapsulation, IP micro-mobility support, Congestion control , TCP over 2.5/3G wireless networks .

TEXT BOOK

1. Mobile Communications - 2nd Edition, JOCHEN SCHILER, Pearson Education.2013.

REFERENCE BOOKS

1. Mobile Communications Engineering, Theory and applications-2nd Edition, WILLIM C.Y. LEE, McGraw-Hill, 2012, Singapore.
2. Introduction to wireless and Mobile Systems- Second edition, Dharma Prakash Agarwal, Qing An Zeng, 2nd Edition, THOMSON, 2007.
3. .Electronic Communications systems Fundamentals through advanced-5th Edition, Wayne Tomasi, Pearson Education 2007.

DIGITAL COMMUNICATION

L:T:P – 3:0:0

COURSE OBJECTIVES

- *To provide adequate knowledge of digital transmission and the basics of modulation .*
- *To teach students concepts of radio wave propagation and applications*
- *To introduce the students to Spread Spectrum concepts.*

UNIT I RADIO WAVE PROPAGATION 9 Hours

Introduction, EM wave basics, Ground wave propagation, ree space propagation, ground reflection, surface wave, diffraction, Troposcopic scatter,Ionosphere propagation, electrical properties of the ionosphere, effects of earth's magnetic field

UNIT II SAMPLING 9 Hours

Sampling Principles, Sampling Theorem, ,Practical aspects of sampling and signal recovery. PAM, TDM. Waveform Coding Techniques, PCM, Quantization noise and SNR

UNIT III TRANSMISION 9 Hours

DPCM, DM, applications. Base-Band Shaping for Data Transmission, Discrete PAM signals, power spectra of discrete PAM signals. ISI, Nyquist's criterion for distortion less base-band binary transmission, correlative coding

UNIT IV MODULATION TECHNIQUES 9 Hours

Base-band M-ary PAM systems, adaptive equalization for data transmission, Digital Modulation formats,Coherent binary modulation techniques, Coherent quadrature modulation techniques. Non-coherent binary modulation techniques

UNIT V RADIO WAVE PROPAGATION 9 Hours

Spread Spectrum Modulation: Pseudo noise sequences, notion of spreadspectrum, direct sequence spread spectrum, coherent binary PSK, frequencyhop spread spectrum, applications.

TEXT BOOK

1. Digital communications, Simon Haykin, John Wiley India Pvt. Ltd,2008.

REFERENCE BOOKS

1. Digital and Analog communication systems, Simon Haykin, JohnWildy India Lts, 2008
2. An introduction to Analog and Digital Communication, K. SamShanmugam, John Wiley India Pvt. Ltd, 2008.
3. Digital communications - Bernard Sklar: Pearson education 2007

WIRELESS SENSOR NETWORKS

L:T:P – 3:0:0

COURSE OBJECTIVES

- *To expose the students to wireless sensor networks (WSNs) .*
- *To enable the students to learn how to cope with complete systems, starting with hardware design and low-level programming throughout applications and data processing.*
- *To teach the students to build set of skills and expertise in WSNs by designing and implementing*

UNIT I OVERVIEW OF WIRELESS SENSOR NETWORKS 9 hours

Challenges for Wireless Sensor Networks, Enabling Technologies for Wireless Sensor Networks, Gateway Concepts.

UNIT II ARCHITECTURES 9 hours

Single-Node Architecture - Hardware Components, Energy Consumption of Sensor Nodes , Operating Systems and Execution Environments, Network Architecture - Sensor Network Scenarios, optimization Goals and Figures of Merit

UNIT III NETWORKING SENSORS 9 hours

Physical Layer and Transceiver Design Considerations, MAC Protocols for Wireless Sensor Networks, Low Duty Cycle Protocols And Wakeup Concepts - S-MAC , TheMediation Device Protocol, Wakeup Radio Concepts, Address and Name Management, Assignment of MAC Addresses, Routing Protocols- Energy-Efficient Routing, Geographic Routing.

UNIT IV INFRASTRUCTURE ESTABLISHMENT 9 hours

Topology Control , Clustering, Time Synchronization, Localization and Positioning, Sensor Tasking and Control.

UNIT V SENSOR NETWORK PLATFORMS AND TOOLS 9 hours

Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level software platforms, Node-level Simulators, State-centric programming.

TEXT BOOKS

1. Holger Karl & Andreas Willig, " Protocols And Architectures for Wireless Sensor Networks" John Wiley, 2005.
2. Feng Zhao & Leonidas J. Guibas, “Wireless Sensor Networks- An Information Processing Approach", Elsevier, 2007.

REFERENCE BOOKS

1. Kazem Sohraby, Daniel Minoli, & Taieb Znati, “Wireless Sensor Networks- Technology, Protocols, And Applications”, John Wiley, 2007.
2. Anna Hac, “Wireless Sensor Network Designs”, John Wiley, 2013.

VIII Semester							
Sl.No	Type	Course Name	L (Hrs)	T (Hrs	P (Hrs)	Hrs/ Week	Credits
1	EE831X	Program Elective –5	3	0	0	3	3
2	EE832X	Program Elective –6	3	0	0	3	3
3	EE871	Project Stage-II	0	0	16	16	8
		Total	6	0	16	22	14

VIII Semester Electives	
A	HVDC Transmission Systems
B	Power Quality and FACTS
C	Electrical Energy Conservation and Auditing
D	Computer Architecture
E	Energy Storage systems
F	Special Electrical Machines
G	Embedded Control Systems
H	Robotics and Automation
I	Computer Communication Networks
J	Optical Fiber Communication

HVdc Transmission Systems

3L:0T:0P 3 credits

Course Outcomes:

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

- Understand the advantages of dc transmission over ac transmission.
- Understand the operation of Line Commutated Converters and Voltage Source
- Converters.
- Understand the control strategies used in HVdc transmission system.
- Understand the improvement of power system stability using an HVdc system.

Unit 1:dc Transmission Technology (4 hours)

Comparison of AC and dc Transmission (Economics, Technical Performance and Reliability). Application of DC Transmission. Types of HVdc Systems. Components of a HVdc system. Line Commutated Converter and Voltage Source Converter based systems.

Unit 2: Analysis of Line Commutated and Voltage Source Converters (10 hours)

Line Commutated Converters (LCCs): Six pulse converter, Analysis neglecting commutation overlap, harmonics, Twelve Pulse Converters. Inverter Operation.

Effect of Commutation Overlap. Expressions for average dc voltage, AC current and reactive power absorbed by the converters. Effect of Commutation Failure, Misfire and Current Extinction in LCC links.
Voltage Source Converters (VSCs): Two and Three-level VSCs. PWM schemes: Selective
Harmonic Elimination, Sinusoidal Pulse Width Modulation. Analysis of a six pulse converter.
Equations in the rotating frame. Real and Reactive power control using a VSC.
Unit 3:Control of HVdc Converters: (10 hours)
Principles of Link Control in a LCCHVdc system. Control Hierarchy, Firing Angle Controls - Phase-Locked Loop, Current and Extinction Angle Control, Starting and Stopping of a Link. Higher level Controllers Power control, Frequency Control, Stability Controllers.
Reactive Power Control. Principles of Link Control in a VSC HVdc system: Power flow and dc Voltage Control. Reactive Power Control/AC voltage regulation.
Unit 3:Components of HVdc systems: (8 hours)
Smoothing Reactors, Reactive Power Sources and Filters in LCC HVdc systems DC line:
Corona Effects. Insulators, Transient Over-voltages. dc line faults in LCC systems. dc line faults in VSC systems. dc breakers. Monopolar Operation. Ground Electrodes.
Unit 4:Stability Enhancement using HVdc Control (4 hours)
Basic Concepts: Power System Angular, Voltage and Frequency Stability. Power Modulation: basic principles – synchronous and asynchronous links. Voltage Stability Problem in AC/dc systems.
Unit 5:MTdc Links (4 hours)
Multi-Terminal and Multi-Infeed Systems. Series and Parallel MTdc systems using LCCs. MTdc systems using VSCs. Modern Trends in HVdcTechnology. Introduction to Modular Multi-level Converters.
Text/References:
1. K. R. Padiyar, "HVDC Power Transmission Systems", New Age International Publishers, 2011.
2. J. Arrillaga, "High Voltage Direct Current Transmission", Peter Peregrinus Ltd., 1983.
3. E. W. Kimbark, "Direct Current Transmission", Vol.1, Wiley-Interscience, 1971.

Power Quality and FACTS

3L:0T:0P 3 credits

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

- Understand the characteristics of ac transmission and the effect of shunt and series
- reactive compensation.
- Understand the working principles of FACTS devices and their operating
- characteristics.
- Understand the basic concepts of power quality.

- Understand the working principles of devices to improve power quality.

Unit 1: Transmission Lines and Series/Shunt Reactive Power Compensation (4 hours)

Basics of AC Transmission. Analysis of uncompensated AC transmission lines. Passive Reactive Power Compensation. Shunt and series compensation at the mid-point of an AC line. Comparison of Series and Shunt Compensation.

Unit 2: Thyristor-based Flexible AC Transmission Controllers (FACTS) (6 hours)

Description and Characteristics of Thyristor-based FACTS devices: Static VAR Compensator (SVC), Thyristor Controlled Series Capacitor (TCSC), Thyristor Controlled Braking Resistor and Single Pole Single Throw (SPST) Switch. Configurations/Modes of Operation, Harmonics and control of SVC and TCSC. Fault Current Limiter.

Unit 3: Voltage Source Converter based (FACTS) controllers (8 hours)

Voltage Source Converters (VSC): Six Pulse VSC, Multi-pulse and Multi-level Converters, Pulse-Width Modulation for VSCs. Selective Harmonic Elimination, Sinusoidal PWM and Space Vector Modulation. STATCOM: Principle of Operation, Reactive Power Control:

Type I and Type II controllers, Static Synchronous Series Compensator (SSSC) and Unified Power Flow Controller (UPFC): Principle of Operation and Control. Working principle of Interphase Power Flow Controller. Other Devices: GTO Controlled Series Compensator.

Fault Current Limiter.

Unit 4: Application of FACTS (4 hours)

Application of FACTS devices for power-flow control and stability improvement. Simulation example of power swing damping in a single-machine infinite bus system using a TCSC. Simulation example of voltage regulation of transmission mid-point voltage using a STATCOM.

Unit 5: Power Quality Problems in Distribution Systems (4 hours)

Power Quality problems in distribution systems: Transient and Steady state variations in voltage and frequency. Unbalance, Sags, Swells, Interruptions, Wave-form Distortions:

harmonics, noise, notching, dc-offsets, fluctuations. Flicker and its measurement. Tolerance of Equipment: CBEMA curve.

Unit 6: DSTATCOM (8 hours)

Reactive Power Compensation, Harmonics and Unbalance mitigation in Distribution Systems using DSTATCOM and Shunt Active Filters. Synchronous Reference Frame Extraction of Reference Currents. Current Control Techniques in for DSTATCOM.

Unit 6: Dynamic Voltage Restorer and Unified Power Quality Conditioner (6 hours)

Voltage Sag/Swell mitigation: Dynamic Voltage Restorer – Working Principle and Control Strategies. Series Active Filtering. Unified Power Quality Conditioner (UPQC): Working Principle. Capabilities and Control Strategies.

Text/References

1. N. G. Hingorani and L. Gyugyi, "Understanding FACTS: Concepts and Technology of

FACTS Systems", Wiley-IEEE Press, 1999.
2. K. R. Padiyar, "FACTS Controllers in Power Transmission and Distribution", New Age
International (P) Ltd. 2007.
3. T. J. E. Miller, "Reactive Power Control in Electric Systems", John Wiley and Sons, New
York, 1983.
4. R. C. Dugan, "Electrical Power Systems Quality", McGraw Hill Education, 2012.
5. G. T. Heydt, "Electric Power Quality", Stars in a Circle Publications, 1991

Electrical Energy Conservation and Auditing

3L:0T:0P 3 credits

Course Outcomes:

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

- Understand the current energy scenario and importance of energy conservation.
- Understand the concepts of energy management.
- Understand the methods of improving energy efficiency in different electrical
- systems.
- Understand the concepts of different energy efficient devices.

Unit 1: Energy Scenario (6 Hours)

Commercial and Non-commercial energy, primary energy resources, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario, energy pricing, energy sector reforms, energy and environment, energy security, energy conservation and its importance, restructuring of the energy supply sector, energy strategy for the future, air pollution, climate change. Energy Conservation Act-2001 and its features.

Unit 2: Basics of Energy and its various forms (7 Hours)

Electricity tariff, load management and maximum demand control, power factor improvement, selection & location of capacitors, Thermal Basics-fuels, thermal energy contents of fuel, temperature & pressure, heat capacity, sensible and latent heat, evaporation,
condensation, steam, moist air and humidity & heat transfer, units and conversion.

Unit 3: Energy Management & Audit (6 Hours)

Definition, energy audit, need, types of energy audit. Energy management (audit) approach understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments. Material and Energy balance: Facility as an energy system, methods for preparing process flow, material and energy balance diagrams.

Unit 4: Energy Efficiency in Electrical Systems (7 Hours)

Electrical system: Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors, performance assessment of PF capacitors, distribution and transformer

losses. Electric motors: Types, losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors.

Unit 5: Energy Efficiency in Industrial Systems (8 Hours)

Compressed Air System: Types of air compressors, compressor efficiency, efficient compressor operation, Compressed air system components, capacity assessment, leakage test, factors affecting the performance and savings opportunities in HVAC, Fans and blowers: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. Pumps and Pumping System: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities.

Cooling Tower: Types and performance evaluation, efficient system operation, flow control strategies and energy saving opportunities, assessment of cooling towers.

Unit 6: Energy Efficient Technologies in Electrical Systems (8Hours)

Maximum demand controllers, automatic power factor controllers, energy efficient motors, soft starters with energy saver, variable speed drives, energy efficient transformers, electronic ballast, occupancy sensors, energy efficient lighting controls, energy saving potential of each technology.

Text/Reference Books

1. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, General Aspects (available online)

2. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-3, Electrical Utilities (available online)

3. S. C. Tripathy, "Utilization of Electrical Energy and Conservation", McGraw Hill, 1991.

4. Success stories of Energy Conservation by BEE, New Delhi (www.bee-india.org)

Computer Architecture

3L:0T:0P 3 credits

Course Outcomes:

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

- Understand the concepts of microprocessors, their principles and practices.
- Write efficient programs in assembly language of the 8086 family of microprocessors.
- Organize a modern computer system and be able to relate it to real examples.
- Develop the programs in assembly language for 80286, 80386 and MIPS processors inreal and protected modes.
- Implement embedded applications using ATOM processor.

Unit 1: Introduction to computer organization (6 hours)

Architecture and function of general computer system, CISC Vs RISC, Data types, Integer Arithmetic - Multiplication, Division, Fixed and Floating point representation and arithmetic, Control unit operation, Hardware implementation of CPU with Micro instruction, microprogramming, System buses, Multi-bus organization.

Unit 2: Memory organization (6 hours)

System memory, Cache memory - types and organization, Virtual memory and its implementation, Memory management unit, Magnetic Hard disks, Optical Disks.
Unit 3: Input – output Organization (8 hours)
Accessing I/O devices, Direct Memory Access and DMA controller, Interrupts and Interrupt Controllers, Arbitration, Multilevel Bus Architecture, Interface circuits - Parallel and serial port. Features of PCI and PCI Express bus.
Unit 4: 16 and 32 microprocessors (8 hours)
80x86 Architecture, IA – 32 and IA – 64, Programming model, Concurrent operation of EU and BIU, Real mode addressing, Segmentation, Addressing modes of 80x86, Instruction set of 80x86, I/O addressing in 80x86
Unit 5: Pipelining(8 hours)
Introduction to pipelining, Instruction level pipelining (ILP), compiler techniques for ILP, Data hazards, Dynamic scheduling, Dependability, Branch cost, Branch Prediction, Influence on instruction set.
Unit 6: Different Architectures (8 hours)
VLIW Architecture, DSP Architecture, SoC architecture, MIPS Processor and programming

Text/Refence Books
1. V. Carl, G. Zvonko and S. G. Zaky, "Computer organization", McGraw Hill, 1978.
2. B. Brey and C. R. Sarma, "The Intel microprocessors", Pearson Education, 2000.
3. J. L. Hennessy and D. A. Patterson, "Computer Architecture A Quantitative Approach", Morgan Kauffman, 2011.
4. W. Stallings, "Computer organization", PHI, 1987.
5. P. Barry and P. Crowley, "Modern Embedded Computing", Morgan Kaufmann, 2012.
6. N. Mathivanan, "Microprocessors, PC Hardware and Interfacing", Prentice Hall, 2004.
7. Y. C. Lieu and G. A. Gibson, "Microcomputer Systems: The 8086/8088 Family", Prentice Hall India, 1986.
8. J. Uffenbeck, "The 8086/8088 Design, Programming, Interfacing", Prentice Hall, 1987.
9. B. Govindarajalu, "IBM PC and Clones", Tata McGraw Hill, 1991.
10. P. Able, "8086 Assembly Language Programming", Prentice Hall India.

ENERGY STORAGE SYSTEMS

L:T:P 3:0:0

COURSE OBJECTIVES

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

- *Emphasize basic physics, chemistry, and engineering issues of energy storage devices, such as Batteries, thermoelectric convertors, fuel cells, supercapacitors*
- *An understanding about batteries and thermoelectric in detail*

- *A Knowledge about supercapacitors and fuel cells.*

UNIT I ENERGY USE SCENARIO 9 hours

Prospect for both traditional and renewable energy sources - detailed analysis of Indian energy market and future need through 2020. Energy, economic growth and the environment, implications of the Kyoto Protocol, and structural change in the electricity supply industry.

UNIT II BATTERIES 9 hours

Batteries - performance, charging and discharging, storage density, energy density, and safety issues. Classical batteries - Lead Acid, Nickel-Cadmium, Zinc Manganese dioxide, and modern batteries -Zinc-Air, Nickel Hydride, Lithium Battery.

UNIT III MATERIALS AND MEASUREMENT 9 hours

Thermoelectric - electron conductor and phonon glass, classical thermoelectric materials four-probe resistivity measurement. Seebeck coefficient measurement, and thermal conductivity measurement.

UNIT IV SUPERCAPACITORS 9 hours

Supercapacitors - types of electrodes and some electrolytes, Electrode materials – high surface area activated carbons, metal oxide, and conducting polymers. Electrolyte - aqueous or organic, disadvantages and advantages of supercapacitors - compared to battery systems, applications.

UNIT V FUEL CELLS 9 hours

Fuel cells - direct energy conversion - maximum intrinsic efficiency of an electrochemical converter, physical interpretation - carnot efficiency factor in electrochemical energy convertors. Types of fuel cells - hydrogen oxygen cells, hydrogen air cell, alkaline fuel cell, and phosphoric fuel cell.

COURSE LEARNING OUTCOMES

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

- to analyse Indian energy market and future need
- gain a knowledge about batteries and fuel cells
- obtain ideas about thermoelectric; familiarised with superconductors and its applications.

TEXT BOOKS:

1. Tetsuya Osaka, Madhav Datta, 'Energy Storage Systems in Electronics', Gordon and Breach Science Publishers, 2000.
2. R. M. Dell, D.A.J. Rand, 'Understanding Batteries', RSC Publications, 2001.

REFERENCE BOOKS:

1. James Larminie, Andrew Dick, 'Fuel Cell System Explained', J. Wiley, 2003.

EE734B SPECIAL ELECTRICAL MACHINES

L:T:P - 3:0:0

COURSE OBJECTIVES

- *To understand the construction, principle of operation and performance of synchronous reluctance motors.*
- *To analyse the operation and performance of stepping motors.*
- *To understand the construction, principle of operation and performance of switched reluctance motors.*
- *To understand the construction, principle of operation and performance of permanent magnet brushless D.C. motors.*
- *To understand the construction, principle of operation and performance of permanent magnet synchronous motors.*

UNIT I SYNCHRONOUS RELUCTANCE MOTORS 9 hours

Constructional features – Types – Axial and radial air gap motors – Operating principle – Reluctance – Phasor diagram - Characteristics – Vernier motor.

UNIT II STEPPING MOTORS 9 hours

Constructional features – Principle of operation – Variable reluctance motor – Hybrid motor – Single and multi-stack configurations – Theory of torque predictions – Linear and non-linear analysis – Characteristics – Drive circuits.

UNIT III SWITCHED RELUCTANCE MOTORS 9 hours

Constructional features – Principle of operation – Torque prediction – Power controllers – Non-linear analysis – Microprocessor based control - Characteristics – Computer control.

UNIT IV PERMANENT MAGNET BRUSHLESS D.C. MOTORS 9 hours

Principle of operation – Types – Magnetic circuit analysis – EMF and torque equations – Power controllers – Motor characteristics and control.

UNIT V PERMANENT MAGNET SYNCHRONOUS MOTORS 9 hours

Principle of operation – EMF and torque equations – Reactance – Phasor diagram – Power controllers - Converter - Volt-ampere requirements – Torque speed characteristics - Microprocessor based control.

COURSE LEARNING OUTCOMES

Upon completion of this course, the students will be

- *Familiar with the construction, principle of operation and performance of different fractional horse power motors.*
- *Have the competence to choose the motors based on application specifications*

TEXT BOOKS

1. T.J.E. Miller, 'Brushless Permanent Magnet and Reluctance Motor Drives', Clarendon Press, Oxford, 1989.
2. P.P. Aearnley, 'Stepping Motors – A Guide to Motor Theory and Practice', Peter Perengrinus, London, 1982.

REFERENCE BOOKS

1. T. Kenjo, 'Stepping Motors and Their Microprocessor Controls', Clarendon Press London, 2012.
2. T. Kenjo and S. Nagamori, 'Permanent Magnet and Brushless DC Motors', Clarendon Press, London, 1988.

EMBEDDED CONTROL SYSTEMS

L:T:P - 3:0:0

COURSE OBJECTIVES

- To explain the peripherals interface basics and operation.
- To explain interfacing and programming input-output devices.
- To demonstrate in case studies.

UNIT I INTRODUCTION 9 hours

Controlling the hardware with software - Data lines - Numbering systems - Address lines - Ports - Schematic representation - Bit masking - Programmable peripheral interface - Switch input detection – Sampling

UNIT II INPUT-OUTPUT DEVICES AND SIGNAL PROCESSING 9 hours

Keyboard basics - Keyboard scanning algorithm - Multiplexed LED displays - character LCD Units- LCD Unit display – Configuration - Time of day clock - Timer manager -Interrupts – Interrupt service routines - Interrupt vector or dispatch table multiple point - Interrupt driven pulse width modulation - D/A and A/D converters and its working principles - Interrupts in analog signal measurement

UNIT III CONTROL AND PROGRAMMING 9 hours

Networking - Model Based Embedded Control Software Development – Haptic Interface - RTOS - Rapid Prototyping Tools – Modeling, Analysis and Design of

control strategy – Digital simulation – Digital redesign - Adaptive Control – PID controller design

UNIT IV ASYNCHRONOUS SERIAL COMMUNICATION 9 hours

Asynchronous serial communication - RS 232 - RS 485 - Sending and receiving data – Serial ports on PC - Low level PC serial I/O Unit - Buffered serial I/O - Multi channel data acquisition. - Auto port detection - recording and playing back voice

UNIT V CASE STUDIES 9 hours

Controlling motors - Bi-directional - control of motors - H bridge - Telephonic systems – Burger alarms - Fire alarms - Adaptive cruise control - Fuel and ignition control - Control of hybrid-electric power trains – Applications – Load Controllers

COURSE LEARNING OUTCOMES

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

- *Explain the peripherals interfacing with practical applications.*
- *Demonstrate the case studies involving interfacing of input-output devices.*

REFERENCE BOOKS

1. Jean J Labrosse, "Embedded System Building Blocks: Complete and Ready to use Units in C" , the publisher , Paul Temme, 2010
2. Ball SR "Embedded microprocessor system - Real world design, Prentice Hall , 1996
3. Hermann. K "Real Time systems- Design for distributed Embedded Application", kluwerAcdemic , 2012
4. Daniel W Lewis, "Fundamentals of Embedded software where C and Assembly meet" PHI 2012.

ROBOTICS AND AUTOMATION

L:T:P - 3:0:0

COURSE OBJECTIVES

- *To define the concepts in kinematics and dynamics of robotic system.*
- *To discuss the control strategies of simple robotic system.*
- *To illustrate the applications of computer based control to integrated automation systems.*

UNIT I INTRODUCTION 9 hours

Robot definitions - Laws of robotics - Robot anatomy - History - Human systems and Robotics - Specifications of Robots - Flexible automation versus Robotic technology - Classification applications

UNIT II ROBOTIC SYSTEMS 9 hours

Basic structure of a robot – Robot end effectors - Manipulators - Classification of robots – Accuracy - Resolution and repeatability of a robot - Drives and control systems – Mechanical components of robots – Sensors and vision systems - Transducers and sensors - Tactile sensors – Proximity sensors and range sensors - Vision systems - RTOS - PLCs - Power electronics

UNIT III ROBOT KINEMATICS, DYNAMICS AND PROGRAMMING 9 hours

Matrix representation - Forward and reverse kinematics of three degree of freedom – Robot Arm – Homogeneous transformations – Inverse kinematics of Robot – Robo Arm dynamics - D-H representation of forward kinematic equations of robots - Trajectory planning and avoidance of obstacles - Path planning - Skew motion - Joint integrated motion – Straight line motion - Robot languages- Computer control and Robot programming/software

UNIT IV CONTROL SYSTEM DESIGN 9 hours

Open loop and feedback control - General approach to control system design - Symbols and drawings - Schematic layout - Travel step diagram, circuit and control modes - Program control - Sequence control - Cascade method - Karnaugh-Veitch mapping - Microcontrollers - Neural network - Artificial Intelligence - Adaptive Control – Hybrid control

UNIT V ROBOT APPLICATIONS 9 hours

Material handling - Machine loading, Assembly, inspection, processing operations and service robots - Mobile Robots - Robot cell layouts - Robot programming languages

COURSE LEARNING OUTCOMES

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

- *Define the basic concept of robotics and automation.*
- *State the mechanical requirements and design of control system for robot.*
- *Illustrate the applications of robots in various domains.*

TEXT BOOKS

1. Nagrath and Mittal, “Robotics and Control”, Tata McGraw-Hill, 2013.

2. Spong and Vidhyasagar, “Robot Dynamics and Control”, John Wiley and sons, 2008.
3. S. R. Deb and S. Deb, ‘Robotics Technology and Flexible Automation’, Tata McGraw Hill Education Pvt. Ltd, 2010.

REFERENCE BOOKS

1. Saeed B. Niku, ‘Introduction to Robotics’,Prentice Hall of India, 2013.
2. Mikell P. Grooveret. al., "Industrial Robots - Technology, Programming and Applications", McGraw Hill, New York, 2008.
3. Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Eastern Economy Edition, Prentice Hall of India P Ltd., 2006.
4. Fu K S, Gonzalez R C, Lee C.S.G, "Robotics : Control, Sensing, Vision and Intelligence", McGraw Hill, 1987

COMPUTER COMMUNICATION NETWORKS

L:T:P – 3:0:0

COURSE OBJECTIVES

- *To develop an understanding of basic computer networking terminologies and concepts.*
- *To expose the students to the practical realities of data transmissions and their implications in computer networks.*
- *To teach concepts of addressing and routing of data packets.*
- *Students should be able to implement basic networking applications such as client-server communication, email and web browsing services.*

UNIT I INTRODUCTION AND PHYSICAL LAYER 9 Hours

OSI Model, Layers in OSI model, Addressing, Network Hardware, Network Software , Guided Transmission Media, wireless Transmission, Physical Layer Design Issues.

UNIT II THE DATA LINK LAYER 9 Hours

Date Link Layer Design Issues, Error Detection and Correction, Elementary data Link Protocols, Sliding window Protocols, Protocol Verification, Data Link Protocols. THE MEDIUM ACCESS CONTROL SUB LAYER: Multiple Access protocols, Ethernet, Wireless LANS, Broadband wireless, Bluetooth, Data Link Layer Switching.

UNIT III THE NETWORK LAYER 9 Hours

Network layer design issues, Routing Algorithms, Congestion Control Algorithms, and Quality of Service, Network Layer in the Internet

UNIT IV THE TRANSPORT LAYER 9 Hours

The Transport Service, Elements of Transport protocols, A simple transport protocol, the internet transport protocols (TCP and UDP), Performance issues

UNIT IV THE APPLICATION LAYER AND OTHER NETWORKS 9 Hours

Domain name System (DNS), electronic mail, worldwide web, multimedia. Telephone and cable networks for data transmission, Telephone networks, Dial up modem, DSL, Cable TV for data transmission ,Uses of computer Networks, Communication Satellites.

TEXT BOOK

1. Computer Networks: Andrews S. Tanenbaum, 4th Edition, Pearson Education 2012.

REFERENCE BOOKS

1. ATM Protocol concepts - Hondel and Fluber, Addison Wesley 2011.
2. Data and computer networks – W Stallings 5th Edition, Prentice Hall of India 2014.

OPTICAL FIBER COMMUNICATION

L:T:P – 3:0:0

COURSE OBJECTIVES

- *To expose the students to benefits of Optical fibers extensively for data transmission systems and their large information-carrying capacity.*
- *To teach the students how optical fibres are deployed in local, metropolitan, or wide-area applications to connect thousands of users having a wide range of transmission capacities and speeds.*
- *The expose students concept of WDM*

UNIT I OVERVIEW OF OPTICAL FIBER COMMUNICATION 9 Hours

Introduction, Historical development, general system, advantages, disadvantages, and applications of optical fiber communication, optical fiber waveguides, Ray theory, types of fibers, fiber materials, fiber optic cables, Attenuation, absorption, scattering losses, bending loss, dispersion, Intra model dispersion, Inter model dispersion

UNIT II OPTICAL SOURCES, DETECTORS, COUPLERS AND CONNECTORS 9 Hours

Introduction, LED's, LASER diodes, Photo detectors, Photo detector noise, Response time, Photo diodes, comparison of photo detectors, fiber alignment and joint loss, single mode fiber joints, fiber splices, fiber connectors and fiber couplers

UNIT III OPTICAL RECEIVER AND DIGITAL LINKS 9 Hours

Introduction, Optical Receiver Operation, receiver sensitivity, quantum limit, eye diagrams, coherent detection, burst mode receiver, operation, Analog receivers, analog links, CNR, multichannel transmission techniques, RF over fiber, Radio over fiber links, microwave photonics ,

UNIT IV DIGITAL LINKS 9 Hours

Digital links – Introduction, point–to–point links, System considerations, link power budget, nodal noise and chirping. WDM concepts, overview of WDM operation principles, WDM standards, multiplexer, Isolators and circulators, direct thin film filters, active optical components, variable optical attenuators, chromatic dispersion compensators, tunable light sources.

UNIT IV OPTICAL AMPLIFIERS 9 Hours

Optical Amplifiers and Networks – optical amplifiers, basic applications and types, semiconductor optical amplifiers, OPTICAL NETWORKS: Introduction, SONET / SDH, Optical Interfaces, SONET/SDH rings, High speed light waveguides.

TEXT BOOKS

1. "Optical Fiber Communication", Gerd Keiser, 4th Ed., MGH,2008.
2. "Optical Fiber Communications", John M. Senior, Pearson Education. 3rd Impression, 2007.

REFERENCE BOOK

1. Fiber Optic Communication - Joseph C Palais: 4th Edition,Pearson Education.