PROCEEDINGS

Fourth Board of Studies Meeting

Department of Electrical Engineering

Islamic University of Science and Technology

Awantipora, J&K, India-192122

9th May, 2019

Contents

Agenda

1. **To vet the course structure and syllabus for B.Tech (Electrical Engineering) course for batch 2018 onwards as per the AICTE Model Curriculum 2018.**

   A Model curriculum prepared for undergraduate courses, including B.Tech courses, is being adopted on the recommendations of the AICTE. The model curriculum is based on Choice-based Credit System (CBCS). CBCS incorporates in curriculum the concept of electives (professional/ functional/open) and emphasizes compulsory internships and induction programs. It reduces credit load of the students and incorporates MOOCS courses in the curriculum. As per the recommendations of the AICTE, the inclusion of an industry expert in the Board of Studies has been mandatory so that the demands of industry are incorporated in the syllabi to make the degrees industry-ready. It being a part of TEQIP-III Project Institutions, MHRD/NPIU too has made it mandatory to revise the curriculum of B.Tech Program from the Academic Session 2018 as per the AICTE guidelines.

2. **To vet PhD/PG (Electrical Engineering) level courses for fulfilling course work requirements of PhD students batch 2018 onwards.**
   The Electrical Engineering Department started PhD program since the year 2018. Some courses are to be introduced at the PhD/PG level to meet the course work credit requirement of the PhD students. A list of such courses along with their syllabus is attached as Annexure VI.

Minutes of the Meeting

The fourth Board of Studies (BoS) meeting of the Department of Electrical Engineering (DoEEE), IUST was held on 9th May 2019. The following members attended the meeting:

1.	Prof. A. H. Moon	Dean SoE&T, IUST	Chairman
2.	Prof. A. H. Bhat	Professor, EE, NIT Srinagar	Subject Expert
3.	Dr. Mashuq-un-Nabi	Associate Professor, EE, IIT Delhi	Subject Expert
4.	MD Masihuzzaman	Team Leader, EE, GE Power, India	Industrial Expert
5.	Mr. Zahoor Ahmad Ganai	I/C Head, EE, IUST	Convener
6.	Mr. Sheikh Asif	Deputy Registrar (Academics)	Member
7.	Dr. S. A. Nahvi	Assistant Professor, EE, IUST	Member
8.	Mr. Javeed Bashir	Assistant Professor, EE, IUST	Member
9.	Dr. MubasharYaqoob	Assistant Professor, EE, IUST	Member
10.	Mr. Rayees Ahmad Lone	Assistant Professor, EE, IUST	Member
11.	Ms. BazigaYousuf	Assistant Professor, EE, IUST	Member
12.	Dr. Ahmed Sharique Anees	Assistant Professor, EE, IUST	Member
13.	Mr. Salman Ahmad	Assistant Professor, EE, IUST	Member
14.	Mr. Pradeep Kumar Patel	Assistant Professor, EE, IUST	Member
15.	Mr. Rahim uddin	Assistant Professor, EE, IUST	Member

At the outset, Mr. Zahoor Ahmad Ganai, I/C Head, Department of Electrical Engineering, welcomed the experts and BoS members. Later Dr. S. A. Nahvi briefed the experts and members about the agenda of the meeting. The members were apprised about the recent decisions of the Academic Council of IUST which included formation of separate Board of Studies for the Departments, approval of Choice Based Credit System (CBCS) policy, inclusion of Massive

Online Open Courses (MOOCS) in the curriculum, etc. The members were briefed about the mandate under TEQIP-III project for up gradation of the curriculum as per All India Council for Technical Education (AICTE) model curriculum and the conduct of BoS meeting thereby. In this regard, it was informed that the revised AICTE syllabus for the 1st year of B.Tech course covering 1st and 2nd semesters shall be uniformly adopted by all the engineering departments of the university and has been already discussed and approved in the BoS meeting of other departments of the School of Engineering and Technology. Dr. S.A. Nahvi also highlighted the importance of designing the curriculum as per the present industry requirements. After threadbare discussions, the following decisions were made:

Agenda-I: To vet the course structure and syllabus for B.Tech (Electrical Engineering) course for batch 2018 onwards as per the AICTE Model Curriculum 2018.

Decisions taken during the BoS meeting:

1. It was recommended by the experts that the lab title for 'Introduction for MATLAB' be changed to 'Introduction to Simulation Software' as other important software are also used in electrical engineering. Likewise 'Wind and Solar energy' course title to be changed to 'Renewable Energy Sources'. It was also recommended that course title 'Control System-I' to be renamed as 'Control Systems'. All the recommendations were discussed and accepted in the meeting. (**Action- Mr. Rayees Lone and Mr. Javed Bashir**)

2. It was recommended that the discipline centric elective courses 'Advanced Power Electronics' and 'Digital Control Systems' be shifted from 7th to 8th semester which was discussed and accepted in the meeting.(**Action- Mr. Rayees Lone and Mr. Javed Bashir**)
3. It was recommended that the courses, Power System Dynamics and Stability, Nonlinear Control System, Optimal Control System and Advanced Electrical Drives be dropped from discipline centric electives for B.Tech program. Experts also recommended to shift the courses 'Power System Dynamics and Stability' and 'Advanced Electrical Drives' to PhD/PG level courses.(**Action- Mr. Rayees Lone and Mr. Javed Bashir**)
4. It was decided to include a Digital Signal Processing (DSP) lab of 1 credit in the 8th semester. (**Action- I/C Head EE in coordination with Head ECE**)

5. It was decided to include the following courses in the B.Tech Program:

- Include a new discipline centric course 'Photo Voltaic Systems' for 7th semester. (**Action – Dr. MubasharZargar in coordination with Mr. Masihuzzaman**).
- Include a new course 'Electricity in Daily Use' as open elective (**Action – Dr. S.A. Nahvi in coordination with Mr. Sheikh Asif**).
- Include the course 'Industrial Management' as core course in 8th semester. (**Action- I/C Head EE in coordination with Head ECE**)

6. A consensus was reached on the evaluation pattern to be followed in lab, Industrial Training and Project (Minor and Major) evaluation for B.Tech course which was accepted by the members of BoS. The said document is attached and would form an Annexure to the Proceedings. (**Action- Mr. Rayees Lone and Mr. Javed Bashir**)

7. It was recommended to assign 'x' credits to the open electives and 'y' credits to generic electives in the course outline such that these credits are reflected in the total credits enrolled for in each semester. (**Action- Mr. Rayees Lone and Mr. Javed Bashir**)

8. It was recommended by the experts to modify the number of hours assigned to minor and major projects such that they correctly reflected the credits of these courses.(**Action- Mr. Rayees Lone and Mr. Javed Bashir**)

9. The syllabus of course 'Signal and Systems' was discussed and the committee experts were of the opinion that the course contents need to be revised. (**Action- Mr. Rahimuddin**)

10. The committee recommended to include modify the syllabus of Basic Electrical Lab and include experiments that involve visualizing current and voltage waveforms on CRO. (**Action- Mr. Javed Bashir**)

11. It was recommended by the industrial expert to include the topic of 'Vector groups' in Unit II of the course 'Electrical Machines-I' and include 'DC motor tests' in the 'Electrical Machines-I' lab. The expert recommendation was accepted in the meeting. (**Action- I/C Head EE**)

12. The syllabus of the course 'Digital Electronics' was discussed in the meeting and it was decided that the topics 'RISC and CISC' should be dropped from Unit-IV of the syllabus. The changes were accepted in the meeting.(**Action- Mr. Rahimuddin in consultation with Head ECE**)

13. The committee decided to modify the syllabus of the course 'Control System' by shifting the topic, *Introduction to State Variable Methods* from Unit-II to Unit-I and *PID controllers with characteristics* from Unit-III to Unit-II. (**Action- Dr. S.A. Nahvi**)

14. It was also recommended by the experts to modify the syllabus of the course 'Electrical Engineering Materials' by shifting the topics from PN-junction onwards to JFET from Unit-IV to Unit-I. The changes were accepted by the members of BoS. (**Action- Mr. Rahimmudin**)

15. The committee recommended to include the experiments on Shift register in the Digital Electronics Lab which was discussed and accepted in the meeting.(**Action- Mr. Rahimuddin in consultation with Head ECE**)

16. It was recommended by the experts to modify the title of last experiment of Control System lab. The matter was discussed and was finally accepted in the meeting. (**Action- Dr. S.A. Nahvi**)

17. The experts recommended to modify the syllabus of course 'Electrical Machines-II' by including the reluctance motor as a topic in Unit-IV of the syllabus. (**Action- Dr. I/C Head EE**)

18. The committee recommended the unitization of the 'Microprocessor and Microcontroller' course. This was accepted in the meeting and will be finalized in consultation with the department of Electronics and Communication engineering.(**Action- Mr. Rahimuddin in consultation with Head ECE**)

19. Experts recommended to modify the syllabus of 'Power Systems-II' lab by including the two more experiments, viz, AC distribution system and study of parts of HT/LT cables. (**Action- Mr. Rayees Lone and Dr. Ahmed Sharique Anees**)

20. It was recommended by the committee to modify the syllabus of course 'Power Systems-II' by interchanging Unit-III with Unit-IV which was accepted by the BoS members. (**Action- Mr. Rayees Lone and Dr. Ahmed Sharique Anees**)

21. It was recommended by the committee to modify the syllabus of course ‘Power electronics’ by including DIAC in Unit-I and RLE load in Unit-II. It was also recommended to include topics pertaining to Silicon Carbide switches. (**Action- Mr. Salman Ahmad**)

22. The experts recommended to include a unit on data communication in Communication System course which was accepted by the BoS members. (**Action- I/C Head EE in consultation with Head ECE**)

23. It was recommended by the committee to replace MATLAB/Simulink by various Simulation software in Power Systems-II lab. (**Action- Mr. Rayees Lone and Mr. Javed Bashir**)

24. It was recommended by the committee to include experiments based on load flow analysis for Modeling and Simulation of Electrical Systems lab. The issue was discussed in the meeting and was accepted by BoS members. (**Action- Mr. Javed Bashir**)

25. It was recommended by the experts to split Unit-I of course 'Computational Electromagnetics' in to two units and to split Unit-IV of course 'Sensors and Transducers' into two units. The issue was discussed and accepted in the meeting. (**Action- Dr. S.A. Nahvi and Mr. Pradeep Kumar Patel**)

26. It was recommended to include more content related to numerical relays and EEF protection of transformers in course 'Switchgear Protection'. (**Action- Dr. Ahmed Sharique Anees**)

27. It was recommended by expert to reframe the syllabus of course 'Advanced Control System'. Is was also recommended to remove Unit-V from the syllabus and include topics, stability and stabilizablity in unit-II. (**Action- Dr. S.A. Nahvi in consultation with Dr. M. Nabi**)

28. It was recommended by the experts to reframe the syllabus of course 'Digital Control system' which was discussed in the meeting and was accepted by the committee. (**Action- Dr. S.A. Nahvi)**

29. The committee also recommended to include the concept of green building in unit-II of course 'Electrical Energy Conservation and Auditing'. (**Action- Dr. Ahmed Sharique Anees**)

Agenda-II: To vet PhD/PG (Electrical Engineering) level courses for fulfilling coursework requirements of PhD students batch 2018 onwards.

Decisions taken during the BoS meeting:

1. It was recommended by the experts that the courses 'Power System Dynamics and Stability' and 'Advanced Electrical Drives' which were dropped from the discipline centric courses of B.Tech program should be shifted as courses in PG program. The recommendation was accepted after discussion in the meeting. (**Action- Mr. Rayees Lone and Mr. Javed Bashir**)

2. The experts were of the opinion to change the title of course 'Approximation of Large Scale systems' by ' Model Order Reduction' and modify its syllabus. (**Action- Dr. S.A. Nahvi**)

3. Dr. M. Nabi recommended some modifications in the in course 'Nonlinear Control systems' which were accepted in the meeting. (**Action- Dr. S.A. Nahvi**)

4. A consensus was reached to split the course 'Smart Grid and Energy management' into two courses as the syllabus of the course was too heavy to be covered in one course. (**Action- Dr. Ahmed Sharique Anees**).

Annexure I

Credit definition, range, distribution, and Course codes

A. Definition of Credit:

1 hr. Lecture (L) per week	1 credit
1 hr. Tutorial (T) per week	1 credit
1 hr. Practical (P) per week	0.5 credit
2 hrs. Practical (P) per week	1 credit

B. Range of Credits:

Credits earned in the range of 169 and above shall be required for a student to be eligible to get Under Graduate Degree in Electrical Engineering. A student will be eligible to get Under Graduate Degree with Honours or additional Minor Engineering, if he/she completes an additional 20 credits. These could also be acquired through MOOCs.

C. Distribution of Credits:

S. No.	*Category*	*Credit Breakup*
1.	*Humanities and Social Science including Management Courses*	*6*
2.	*Basic Science Courses*	*29*
3.	*Engineering Science Courses*	*35*
4.	*Professional Core Courses*	*62*
5.	*Discipline Centric Electives*	*9*
6.	*Generic Electives*	*6 (min)*
7.	*Open Electives*	*8 (min)*
8.	*Project / Seminar / Internship in Industry or Elsewhere*	*14*
Total		*169 (min)*

D. Course Code and Definition:

All courses (except Open Electives) are denoted by a seven digit alphanumeric code (XXXXXXX), three alphabets followed by three numerals, followed by one alphabet.

1. The first three alphabets designate the department teaching the course, i.e., the discipline to which the course belongs, e.g., ELE for Electrical Engineering.
2. The first numeral following the three alphabets indicate the level of the course, 1 to 4 for undergraduate 1st to 4th year; 5 to 7 for postgraduate 1st to 3rd year, and 8, 9 for PhD.
3. The next two numerals are the unique identification numbers for the course. Courses running in odd semesters are labeled from 01 to 49 and courses running in even semesters are labeled from 50 to 99.
4. The last alphabet indicates the nature of the course. It is one amongst four choices, C (Core Course), E (Elective (Discipline Centric)), G (Elective (Generic)), F (Foundation Course).
5. Open Electives have a zero in place of the above level numeral and thereby six digits only.

Annexure II

Structure of the undergraduate program in Electrical Engineering

1. *Humanities and Social Science including Management Courses:*

S. No.	Course Code	Course Title	Hours Per Week			Semester	Credits
			L	T	P		
1.	ENG101F	Communication Skills	**2**	**0**	**2**	**I**	**3**
2.	DMS-CC-IM-01	Industrial Management and Economics of Marketing	**3**	**0**	**0**	**VIII**	**3**

2. *Basic Science Courses:*

S. No.	Course Code	Course Title	Hours Per Week			Semester	Credits
			L	**T**	**P**		
1.	PHY101C	Physics	**4**	**0**	**0**	**I**	**4**
2.	CHM101C	Chemistry	**4**	**0**	**0**	**I**	**4**
3.	MTH103C	Mathematics-I	**3**	**0**	**0**	**I**	**3**
4.	BIO101F	Environmental Science	**3**	**0**	**0**	**I**	**3**
5.	MTH153C	Mathematics –II	**4**	**0**	**0**	**II**	**4**
6.	PHY150C	Physics Lab	**0**	**0**	**2**	**II**	**1**
7.	CHM150C	Chemistry Lab	**0**	**0**	**2**	**II**	**1**
8.	MTH203C	Applied Mathematics for Engineers	**3**	**0**	**0**	**III**	**3**
9.	STA253C	Probability and Statistics	**3**	**0**	**0**	**IV**	**3**
10.	MTH308C	Numerical Methods in Engineering	**3**	**0**	**0**	**V**	**3**
						Total Credits	**29**

3. Engineering Science Courses:

S. No	Course Code	Course Title	Hours Per Week			Semester	Credits
			L	T	P		
1.	MEC101C	Engineering Graphics and Design	**1**	**0**	**4**	**I**	**3**
2.	CIV150C	Engineering Mechanics	**3**	**0**	**0**	**II**	**3**
3.	CSE150F	Programming for Problem Solving	**3**	**0**	**0**	**II**	**3**
4.	MEC150C	Workshop Practice	**1**	**0**	**4**	**II**	**3**
5.	CSE151F	Programming Lab	**0**	**0**	**2**	**II**	**1**
6.	ELE150C	Basic Electrical Engineering	**3**	**0**	**0**	**II**	**3**
7.	ECE213C	Analog Electronics	**3**	**0**	**0**	**III**	**3**
8.	ECE214C	Analog Electronics Lab	**0**	**0**	**2**	**III**	**1**
9.	ECE263C	Digital Electronics	**3**	**0**	**0**	**IV**	**3**
10.	ECE264C	Digital Electronics Lab	**0**	**0**	**2**	**IV**	**1**
11.	ECE313C	Microprocessors and Microcontrollers	**3**	**0**	**0**	**V**	**3**
12.	ECE314C	Microprocessors and Microcontrollers Lab	**0**	**0**	**2**	**V**	**1**
13.	ECE364C	Communication Systems	**3**	**0**	**0**	**VI**	**3**
14.	ECE462C	Digital Signal Processing	**3**	**0**	**0**	**VIII**	**3**
15.	ECE463C	Digital Signal Processing Lab	**0**	**0**	**2**	**VIII**	**1**
Total Credits							**35**

4.Professional Core Courses

S. No	Course Code	Course Title	Hours Per Week			Semester	Credits
			L	T	P		
1.	ELE201C	Electromagnetic Field Theory	**3**	**0**	**0**	**III**	**3**
2.	ELE202C	Network Analysis	**3**	**1**	**0**	**III**	**4**
3.	ELE203C	Basic Electrical Engineering Lab	**0**	**0**	**2**	**III**	**1**
4.	ELE204C	Introduction to Simulation Software	**0**	**0**	**2**	**III**	**1**
5.	ELE205C	Signals and Systems	**3**	**0**	**0**	**III**	**3**
6.	ELE251C	Electrical Machines-I	**3**	**1**	**0**	**IV**	**4**
7.	ELE252C	Control Systems	**3**	**1**	**0**	**IV**	**4**
8.	ELE253C	Electrical Engineering Materials	**3**	**0**	**0**	**IV**	**3**
9.	ELE254C	Electrical Machines-I Lab	**0**	**0**	**2**	**IV**	**1**
10.	ELE255C	Control Systems Lab	**0**	**0**	**2**	**IV**	**1**
11.	ELE302C	Electrical Machines-II	**3**	**1**	**0**	**V**	**4**
12.	ELE303C	Power Systems-I	**3**	**1**	**0**	**V**	**4**
13.	ELE304C	Electrical Measurement & Instrumentation	**3**	**0**	**0**	**V**	**3**
14.	ELE305C	Electrical Machines-II Lab	**0**	**0**	**2**	**V**	**1**
15.	ELE306C	Power Systems-I Lab	**0**	**0**	**2**	**V**	**1**
16.	ELE307C	Electrical Measurement & Instrumentation Lab	**0**	**0**	**2**	**V**	**1**
17.	ELE351C	Power Systems-II	**3**	**1**	**0**	**VI**	**4**
18.	ELE352C	Power Electronics	**3**	**1**	**0**	**VI**	**4**
19.	ELE353C	Electrical Machine Design	**3**	**0**	**0**	**VI**	**3**
20.	ELE354C	Power Systems-II Lab	**0**	**0**	**2**	**VI**	**1**
21.	ELE355C	Power Electronics Lab	**0**	**0**	**2**	**VI**	**1**
22.	ELE356C	Modeling and Simulation of Electrical Systems	**0**	**0**	**2**	**VI**	**1**
23.	ELE401C	Electric Drives	**3**	**1**	**0**	**VII**	**4**
24.	ELE402C	Switchgear and Protection	**3**	**1**	**0**	**VII**	**4**
25.	ELE403C	Switchgear and Protection Protection Lab	**0**	**0**	**2**	**VII**	**1**
Total Credits							**62**

5. Electives (Discipline Centric)

S. No	Course Code	Course Title	Hours Per Week			Semester	Credits
			L	T	P		
1.	ELE350E	Utilization of Electrical Energy	**3**	**0**	**0**	**VI**	**3**
2.	ELE351E	Special Electrical Machines	**3**	**0**	**0**	**VI**	**3**
3.	ELE352E	Computational Electromagnetics	**3**	**0**	**0**	**VI**	**3**
4.	ELE353E	Sensors and Transducers	**3**	**0**	**0**	**VI**	**3**
5.	ELE401E	Advanced Control Systems	**3**	**0**	**0**	**VII**	**3**
6.	ELE402E	Power Station Practice	**3**	**0**	**0**	**VII**	**3**
7.	ELE403E	Power System Operation and Control	**3**	**0**	**0**	**VII**	**3**
8.	ELE404E	High Voltage Engineering	**3**	**0**	**0**	**VII**	**3**
9.	ELE450E	Advanced Power Electronics	**3**	**0**	**0**	**VIII**	**3**
10.	ELE451E	Digital Control Systems	**3**	**0**	**0**	**VIII**	**3**
11.	ELE452E	Flexible AC Transmission System (FACTS)	**3**	**0**	**0**	**VIII**	**3**
12.	ELE453E	EHV AC &DC Transmission	**3**	**0**	**0**	**VIII**	**3**
13.	ELE454E	Electrical Energy Conservation and Auditing	**3**	**0**	**0**	**VIII**	**3**

6. Generic Electives:

S. No.	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	ELE350G	Renewable Energy systems	**3**	**0**	**0**	**VI**	**3**
2.	ELE351G	Fuzzy Logic and Artificial Neural Networks	**1**	**0**	**4**	**VI**	**3**
3.	ELE352G	Biomedical Engineering	**3**	**0**	**0**	**VI**	**3**
4.	ELE353G	Applied Linear Algebra	**3**	**0**	**0**	**VI**	**3**
5.	ELE401G	Optimization for Engineering Design	**3**	**0**	**0**	**VII**	**3**
6.	ELE402G	Electric Hybrid Vehicles	**3**	**0**	**0**	**VII**	**3**
7.	ELE403G	Virtual Instrumentation Lab	**0**	**0**	**2**	**VII**	**1**

Annexure III

Course Outline for B. Tech. Electrical Engineering, Batch 2018 Onwards

1st Semester

S. No	Course Code	Course Title	Hours Per Week			Credits
			L	T	P	
1.	PHY101C	Physics	4	0	0	4
2.	CHM101C	Chemistry	4	0	0	4
3.	MTH103C	Mathematics-I	3	0	0	3
4.	BIO101F	Environment Science	3	0	0	3
5.	MEC101C	Engineering Graphics and Design	1	0	4	3
6.	ENG 101F	Communication Skills	2	0	2	3
7.	-	Induction Program	-	-	-	-
Total Credits						20

2nd Semester

S. No	Course Code	Course Title	Hours Per Week			Credits
			L	T	P	
1.	CIV150C	Engineering Mechanics	3	0	0	3
2.	MTH153C	Mathematics-II	4	0	0	4
3.	CSE150F	Programming for Problem Solving	3	0	0	3
4.	MEC150C	Workshop Practice	1	0	4	3
5.	ELE150C	Basic Electrical Engineering	3	0	0	3
6.	CSE151F	Programming Lab	0	0	2	1
7.	PHY150C	Physics Lab	0	0	2	1
8.	CHM150C	Chemistry Lab	0	0	2	1
Total Credits						19

Semester III

S. No	Course Code	Course Title	Hours Per Week			Credits
			L	T	P	
1.	ELE201C	Electromagnetic Field Theory	3	0	0	3
2.	ELE202C	Network Analysis	3	1	0	4
3.	ECE213C	Analog Electronics	3	0	0	3
4.	ELE205C	Signals and Systems	3	0	0	3
5.	MTH203C	Applied Mathematics for Engineers	3	0	0	3
6.	ECE214C	Analog Electronics Lab	0	0	2	1
7.	ELE203C	Basic Electrical Engineering Lab	0	0	2	1
8.	ELE204C	Introduction to Simulation Softwares	0	0	2	1
9.	XXX0xx	Open Elective	-	-	-	Y
Total Credits						19+Y

Semester IV

S. No	Course Code	Course Title	Hours Per Week			Credits
			L	T	P	
1.	ELE251C	Electrical Machines-I	3	1	0	4
2.	STA253C	Probability and Statistics	3	0	0	3
3.	ECE263C	Digital Electronics	3	0	0	3
4.	ELE252C	Control Systems	3	1	0	4
5.	ELE253C	Electrical Engineering Materials	3	0	0	3
6.	ELE254C	Electrical Machines-I Lab	0	0	2	1
7.	ECE264C	Digital Electronics Lab	0	0	2	1
8.	ELE255C	Control Systems Lab	0	0	2	1
9.	XXX0xx	Open Elective	-	-	-	Y
Total Credits						20+Y

Semester V

S. No	Course Code	Course Title	Hours Per Week			Credits
			L	T	P	
1.	ELE302C	Electrical Machines-II	3	1	0	4
2.	ELE303C	Power Systems-I	3	1	0	4
3.	MTH308C	Numerical Methods in Engineering	3	0	0	3
4.	ECE313C	Microprocessors and Microcontrollers	3	0	0	3
5.	ELE304C	Electrical Measurements& Instrumentation	3	1	0	4
6.	ELE305C	Electrical Machines-II Lab	0	0	2	1
7.	ELE306C	Power Systems-I Lab	0	0	2	1
8.	ELE307C	Electrical Measurements& Instrumentation Lab	0	0	2	1
9.	ECE314C	Microprocessor and Microcontroller Lab	0	0	2	1
10.	XXX0xx	Open Elective	-	-	-	Y
Total Credits						22+Y

Semester VI

S. No	Course Code	Course Title	Hours Per Week			Credits
			L	T	P	
1.	ELE351C	Power Systems-II	3	1	0	4
2.	ELE352C	Power Electronics	3	1	0	4
3.	ELE353C	Electrical Machine Design	3	0	0	3
4.	ECE364C	Communication Systems	3	0	0	3
5.	ELE354C	Power Systems-II Lab	0	0	2	1
6.	ELE355C	Power Electronics Lab	0	0	2	1
7.	ELE356C	Modeling and Simulation of Electrical Systems	0	0	2	1
8.	XXX3xxG	Generic Elective	X	0	0	X
9.	ELE3xxE	Elective (Discipline Centric)	3	0	0	3
10.	XXX0xx	Open Elective	-	-	-	Y
Total Credits						20+X+Y

Semester VII

S. No	Course Code	Course Title	Hours Per Week			Credits
			L	T	P	
1.	ELE401C	Electric Drives	3	1	0	4
2.	ELE402C	Switchgear and Protection	3	1	0	4
3.	ELE404C	Project (Minor)	0	0	8	4
4.	ECE403C	Switchgear and Protection Protection Lab	0	0	2	1
5.	XXX3xxG	Elective (Generic)	X	0	0	X
6.	ELE4xxE	Elective (Discipline Centric)	3	0	0	3
7.	XXX0xx	Open Elective	-	-	-	Y
8.	ELE405C	Seminar on Industrial Training	(4 weeks)			2
Total Credits						18+X+Y

Semester VIII

S. No	Course Code	Course Title	Hours Per Week			Credits
			L	T	P	
1.	ECE462C	Digital Signal Processing	3	0	0	3
2.	ELE450C	Project (Major)	0	0	20	10
3.	DMS-CC-IM-01	Industrial Management and Economics of Marketing	3	0	0	3
4.	ELE4xxE	Elective (Discipline Centric)	3	0	0	3
5.	ECE463C	Digital Signal Processing Lab	0	0	2	1
6.	XXX0xx	Open Elective	-	-	-	Y
Total Credits						20+Y

Electives (Discipline Centric)

S. No	Course Code	Course Title	Hours Per Week			Semester	Credits
			L	T	P		
1.	ELE350E	Utilization of Electrical Energy	3	0	0	VI	3
2.	ELE351E	Special Electrical Machines	3	0	0	VI	3
3.	ELE352E	Computational Electromagnetics	3	0	0	VI	3
4.	ELE353E	Sensors and Transducers	3	0	0	VI	3
5.	ELE401E	Advanced Control Systems	3	0	0	VII	3
6.	ELE402E	Power Station Practice	3	0	0	VII	3
7.	ELE403E	Power System Operation and Control	3	0	0	VII	3
8.	ELE404E	High Voltage Engineering	3	0	0	VII	3
9.	ELE450E	Advanced Power Electronics	3	0	0	VIII	3
10.	ELE451E	Digital Control Systems	3	0	0	VIII	3
11.	ELE452E	Flexible AC Transmission System (FACTS)	3	0	0	VIII	3
12.	ELE453E	EHV AC &DC Transmission	3	0	0	VIII	3
13.	ELE454E	Electrical Energy Conservation and Auditing	3	0	0	VIII	3

Note:

1. *Discipline Centric electives are offered to the students of the Department of Electrical Engineering only.*
2. *The students of the Department of Electrical Engineering have to choose Discipline Centric electives from the above list.*

Electives (Generic)

S. No.	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	ELE350G	Renewable Energy Systems	3	0	0	VI	3
2.	ELE351G	Fuzzy Logic and Neural Networks	1	0	4	VI	3
3.	ELE352G	Biomedical Engineering	3	0	0	VI	3
4.	ELE353G	Applied Linear Algebra	3	0	0	VI	3
5.	ELE401G	Optimization for Engineering Design	3	0	0	VII	3
6.	ELE402G	Electric Hybrid Vehicles	3	0	0	VII	3
7.	ELE403G	Virtual Instrumentation Lab	0	0	2	VII	1

Note:

1. *Generic Electives are School Level electives and are offered to the students of the School of Engineering and Technology including the students of the Department of Electrical Engineering.*
2. *The students of the Department of Electrical Engineering have to choose Generic Electives from the list of Generic Electives offered by all the Departments of School of Engineering and Technology.*

Annexure IV

Syllabus for B. Tech. Electrical Engineering, Batch 2018 onwards.

PHY101C Physics L=4, P=0

Vectors: Vector Analysis, Rotation of coordinate axis and Transformation of vectors, Gradient of scalar field, divergence and curl of vector field in Cartesians, Spherical polar and Cylindrical Coordinate systems, line , surface & volume integrals, Gauss's divergence theorem, Stokes's theorem.

Mechanics: Newton's laws of motion, rigid body, centre of mass, conservation of linear momentum, moment of inertia, conservation of angular momentum, Central forces, Keplers laws for planetary motion. SHM, Damped, undamped and forced Oscillations (no derivation): Equation of motion, solution, amplitude resonance, velocity resonance, quality factor.

Special theory of Relativity: Frame of reference, Michelson-Morley experiment, Galilian transformations, basic postulates of special relativity, Lorentz transformations, length contraction and time dilation, mass energy relation.

Optics: Electromagnetic theory of light, Interference: Conditions for Interference of light, Young's double slit experiment, Newton's rings, diffraction: Single Slit diffraction pattern, Diffraction grating, Grating spectra, Polarization: Malus Law, Phenomena of double refraction.
Lasers: Properties of laser light, Main components of laser, absorption, spontaneous and stimulated emission, CW and pulsed lasers, Examples and applications: He-Ne laser, Ruby laser.

Quantum Theory: Need of Quantum theory, Photoelectric effect, Compton Effect, Heisenberg's uncertainty principle, de Broglie's hypothesis. Basic postulates of quantum mechanics, Wave function and its properties, Schrodinger's equation and its application to particle in 1-D box.
Nuclear physics: Structure of nucleus. Basic properties of nucleus (size, charge, and density), Binding energy, nuclear fission & fusion, Radioactivity, Gas detectors: GM counter.

Elementary Solid State Physics: Crystal lattice, Crystal structure, Unit cells, Miller Indices, Bravais lattice, Bragg's Law, Photographic crystal X-ray diffraction techniques, Laue's method. Free electron theory of metals, Classification of solids, formation of energy bands in metals, semiconductors and insulators, intrinsic and extrinsic semiconductors.

Recommended Text/Reference Books:

1. Griffiths D. J., Introduction to electrodynamics, Pearson Education (India).
2. Murray R. Speigel, Schaum's Outline on Vector Analysis, McGraw Hill Education India.
3. Upadhaya J. C., Classical Mechanics, Himalaya Publishing House.
4. Ghatak A., Optics, McGraw Hill Education India.
5. Besier A., Mahajan S., Choudhary S. R., Concepts of Modern Physics, McGraw Hill Education India.
6. Omar M. A., Elementary Solid State Physics, Prentice Hall of India.

CHM101C Chemistry L=4, P=0

Chemical Thermodynamics: Introduction and Importance, First Law of Thermodynamics, Work done in Isothermal and Adiabatic Conditions, Heat capacities, Relation between Cp and Cv relations, Second Law of Thermodynamics, Concept of Entropy, Carnot engine, Gibbs free energy. Free Energy Changes as Criteria of Reversible and Irreversible process, Gibbs-Helmholtz's equation, Clausius– Clapeyron equation.

Electro-Chemistry and Corrosion: Introduction, Conductivity of Electrolytes, Kohlrausch's Law of Independent Migration of Ions and its Application, Debye Huckel Theory of Strong Electrolytes. Electrochemical cells, Electrode-Potential, Standard Electrode Potential, Fuel Cells, Batteries, Introduction, Effects of Corrosion, Dry Corrosion and Wet Corrosion, mechanisms, Types of Corrosion (Pitting Corrosion, Crevice Corrosion, Galvanic Corrosion and Stress corrosion), Factors Effecting Corrosion (Nature of the Metal and Nature of the Environment), Corrosion Protection and Inhibition (Cathodic Protection, Anodic Protection, Protective Coatings).

Nano-Technology and Polymers: Nano-scale and Its Significance, Properties at Nano-scale: Optical, Electrical, and Magnetic. General Methods of Preparation of Nano-materials viz Top Down (Ball Milling, Lithography) and Bottom up Methods (Sol-Gel, Solution Based Method), Advantages of Polymers over other Engineering Materials, Functionality, Degree of Polymerization, Concept of Molecular Weight, Polymerization (Addition, Condensation and Copolymerization), Polymerization Techniques (Bulk, Solution, Suspension and Emulsion polymerizations), Preparation, Properties and Engineering application of some Important Polymers, Polythene (LDPE and HDPE), Polyvinyl Chloride, Polystyrene, Teflon, Phenol Formaldehyde, urea-formaldehyde resin.

Lubricants: Introduction, Function of Lubricants, Mechanism of Lubrication, Classification of Lubricants (Liquid, Semisolid, Solid), Properties of Lubricants (Flash Point and Fire Point, Viscosity, Aniline Point Acid value).

Instrumental Techniques: Introduction, Advantages and Disadvantages of Instrumental and Non-Instrumental Methods, Electromagnetic Radiation, Electromagnetic Spectrum, Light Absorption (Beers-Lambert Law) UV-Vis spectroscopy (Types of Transition, Chromophors, Auxo-chromes and Applications), Infrared Spectroscopy (Modes of vibration, IR bands corresponding to different functional groups and Applications), Nuclear Magnetic Resonance: Principle, shielding mechanism, chemical shift, number of Signals, Application of Nuclear Magnetic Resonance to Simple Organic Molecules.

Recommended Text/Reference Books:

1. Chemistry in Engineering and Technology Volumes I & II, J. Kuriacose, R. Rajaram, 2001, TMH publishing company Limited, New Delhi.
2. Engineering Chemistry, P.C. Jain, 16th Edition, Dhanpat Rai & Sons, NaiSarak; New Delhi.
3. Chemistry of Engineering Materials, C.V. Agarwal, 9th Edition.
4. Chemistry in Engineering, L. A. Munro, 1964, Prentice Hall, New York.

5. Applied Chemistry for Engineers, R. M. E. Diamant, 3rd Revised Edition, Pitman Publishing.
6. Principles of Physical Chemistry – Puri, Sharma and Pathania, 2017, 4th Edition, Vishal Publishing Co.
7. Physical Chemistry by Peter Atkins, Julio de Paula, 8th Edition, 2006, WH Freeman.
8. Concise Inorganic Chemistry by J.D. Lee, 5th Edition, 2008, Oxford University Press.
9. Electrochemistry and Corrosion Science by N. Perez, 2nd Edition, 2016, Springer.
10. Polymer Science, V.R. Goowriker, N.V Viswanathan and Jayadev Sreedhar, 2nd Edition, 2015, New Age International Publishers.
11. Nanotechnology Fundamentals and Applications, Manasi Karkare, Rajni Bahuguna, 2013, I K international.
12. Nanotechnology Importance And Application, Fulekar, 2010, K International Publishing house.

MTH103C Mathematics-I L=3, P=0

Brief Review of Differential Calculus: Limit, continuity and differentiability of functions of several variables, Chain rule, Jacobi theorem. Taylor's theorem of one and two variables, extrema of functions, two or more variables using method of Lagrange's multipliers.

Ordinary Differential Equations: Exact ordinary differential equations and Ordinary differential equations reducible to exact differential equations. Linear differential equations and equations reducible to linear form. Linear Differential equations of second and higher order with constant and variable coefficients. Applications of ordinary differential equations. Series solution of differential equations.

Vector Spaces: Linear dependence of vectors, Basis and Dimensions; Linear Transformations(maps), Range and Kernel of a linear map, Rank and Nullity, Inverse of a linear transformation, Rank-Nullity Theorem, Composition of Linear maps, Matrix associated with a linear map.

Algebraic Equations: Elements of the theory of polynomial equations. Fundamental theorem of Algebra, Relation between the roots and the coefficients of an equation, Solution of cubic & bi-quadratic equations.

Recommended Text/Reference Books:

Text Books:

1. Shanti Narayan, Differential calculus, *S. Chand & Sons*.
2. J. W. Brown, R. V. Churchill, Complex variables and Applications, *McGraw Hill Education India.*
3. Raisinghania M. D., Ordinary and Partial Differential equation, *S. Chand & Sons*.
4. Kreyszig I., Advanced Engineering Mathematics, *John Wiley & Sons.*

Reference Books:

1. James Stewart, Calculus, *Early Transcedentals*.
2. Bali N. P., A text Book on Engineering Mathematics, *Luxmi Publications.*
3. Jain R. K., Iyengar S. R. K., Advanced Engineering Mathematics, *Narosa Publications.*
4. Hoffmann &Kunze, Linear Algebra, *Prentice Hall of India.*
5. Piaggio H. T., Differential equations and its applications, *Prentice Hall of India*.
6. Sastry, Engineering mathematics Vol I-II, *Prentice Hall of India*.

BIO101F Environmental Science L=3, P=0

Introduction to Environmental Science: Scope and importance, Public Environmental awareness and methods of its propagation, Consumerism and Green Consumerism. Environmental issues, Environmental Ethics-Anthropocentricism and Eco-centricism.

I**ntroduction to Ecosystem and Ecology**: Types of Ecosystems, Structure of an Eco system-biotic and abiotic components, Food chain and Food Web, Ecological Pyramids; Ecological Succession, Energy flow in an ecosystem, Major World Ecosystems and their characteristics.

Natural resources: Classification and their conservation; Biodiversity-Definition, values and threatsto biodiversity; Classification of species as per IUCN; Hot Spots of Biodiversity. Conservation approaches – *In-Situ* and *Ex-Situ* conservation; Alternatives to conventional developmental approaches – Sustainable Development.

Introduction to global climate change: Greenhouse effect, global warming, acid rain, ozone layer depletion. Definition, Cause, effects and control measures of Air pollution, water pollution, soil pollution, noise pollution, thermal pollution and Solid waste pollution.

Field work (Field work equal to 5 lecture hours): Visit to a local area to document environmental assets river/forest/grassland/hill/mountain. Visit to a local polluted site-Urban/Rural/Industrial/Agricultural. Study of common plants, insects, birds. Study of simple ecosystems-pond, river, hill slopes, etc.

Recommended Text/Reference Books:

1. Ecology and Environment, P. D. Sharma, *Rastogi Publications*.
2. Environmental Science Towards a Sustainable Future, Nebel and Wright, *Prentice Hall of India.*
3. Environmental Studies, Erach Barucha, *Oxford Publications.*
4. Environmental Studies From Crises to Cure authored, R. Rajagopalan, *Oxford University Press.*
5. Environmental Management by Oberoi, *Excel Books.*
6. Principles of Environmental Science: Inquiry & Applications, William Cunningham & Mary Cunningham, *Tata McGraw Hill.*
7. Perspectives of environmental studies, A. P. Kaushik and C.P. Kaushik, *New Age International Publications.*

MEC101C Engineering Graphics and Design L=1, T=0, P=4

Introduction: Principles of Engineering Graphics; Orthographic Projection; Descriptive Geometry; Drawing Principles; Isometric Projection; Surface Development; Perspective; Reading a Drawing; Sectional Views; Dimensioning & Tolerances; True Length, Angle; intersection, Shortest Distance, Drawing instruments, lettering, Conic sections; Cycloid, Epicycloid, Hypocycloid and Involute; Scales.

Orthographic Projections: Principles of Orthographic Projections, Conventions, Projections of Points and lines inclined to both planes; Projections of planes inclined Planes, Auxiliary Planes;

Projections of Solids: Auxiliary Views; Draw simple annotation, dimensioning and scaling. Floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc.

Sections of Solids: Prism, Cylinder, Pyramid, Cone, Auxiliary Views; Development of surfaces; sectional orthographic views, objects from industry and dwellings.

Isometric Projections: Principles of Isometric projection, Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa.

Overview of Computer Graphics: Computer technologies, 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, Different commands used in CAD, Isometric Views of lines, Planes, Simple and compound Solids.

Customization& CAD Drawing: 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 and tolerancing; Orthographic constraints.

Recommended Text/Reference Books:

Text Books:

1. Gill P. S., Engineering Drawing, *S. K. Kataria and sons.*
2. Bhatt N. D., Engineering Drawing, *Charotar Book Stall.*
3. James D. Bethune, Engineering Graphics with Auto CADD, *Pearson Education.*

Reference Books:

1. Shah M. B., Rana B. C., Engineering Drawing and Computer Graphics, *Pearson Education.*
2. Agrawal B., Agrawal C. M., Engineering Graphics, *TMH Publication.*

ENG101F Communication Skills L=2, T=0, P=2

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

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

Identifying Common Errors in Writing: Subject-verb agreement, Noun-pronoun agreement, Misplaced modifiers, Articles, Prepositions, Redundancies, Clichés.

Nature and Style of sensible Writing: Describing, Defining, Classifying, Providing examples or evidence, writing introduction and conclusion.

Writing Practices: Comprehension, Précis Writing, Essay Writing.

Oral Communication: (This unit involves interactive practice sessions in Language Lab): Listening Comprehension, Pronunciation, Intonation, Stress and Rhythm, Common Everyday Situations: Conversations and Dialogues, Communication at Workplace, Interviews, Formal Presentations.

Recommended Text/Reference Books:

1. Michael Swan, Practical English Usage, *OUP, 1995*.
2. Wood F. T., Remedial English Grammar, *Macmillan, 2007.*
3. William Zinsser, On Writing Well, *Harper Resource Book, 2001.*
4. Liz Hamp-Lyons and Ben Heasly, Study Writing, *Cambridge University Press, 2006*.
5. Sanjay Kumar and Pushp Lata, Communication Skills, *Oxford University Press, 2011*.
6. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad, *Oxford University Press.*

CIV150C Engineering Mechanics L=3, P=0

Force Systems: Basic concepts, equilibrium of rigid bodies, system of forces, coplanar concurrent forces, components in space, resultants, moment of forces and its application, couples and resultant of force system, equilibrium of system of forces, free body diagrams, equations of equilibrium of coplanar systems and spatial systems, static indeterminacy.

Centroid and Second Moment of Area: Centroid of simple figures from first principle, centroid of composite sections; Area moment of Inertia**,** Moment of Inertia of plane sections from first principles, theorems of moment of inertia, moment of inertia of standard sections and composite sections.

Basic Structural Analysis: Equilibrium of deformable bodies, external and internal forces, stresses and strains in bars, basic introduction to beams, shear force and bending moment in simple beams, basic introduction to torsion, and analysis of trusses using method of joints.

Friction: Types of friction, limiting friction, dry friction, laws of friction, static and dynamic friction; motion of bodies, wedge friction, screw jack, friction clutches and brakes.

Centre of Gravity and Moment of Inertia: Centre of gravity and its implications; Mass moment of inertia, Moment of inertia of Cylinder, Cone, Sphere, etc.

Fundamentals of Dynamics: Kinematics and Kinetics of particles in rectilinear and curvilinear motion; Kinematics and Kinetics of Rigid bodies, types of motion, instantaneous centre of rotation in plane motion, D'Alembert's principle and its applications in plane motion and connected bodies, Work Energy principle, Impulse-Momentum principle, Impact.

Recommended Text/Reference Books:

Text Books:

1. Irving H. Shames, Engineering Mechanics, *Prentice Hall India, New Delhi.*
2. R. C. Hibbler, Engineering Mechanics: Principles of Statics and Dynamics, *Pearson Education.*

Reference Books:

1. F. P. Beer, E. R. Johnston, Vector Mechanics for Engineers, Vol I &Vol II, *McGraw Hill Education (India).*
2. Andy Ruina and Rudra Pratap, Introduction to Statics and Dynamics, *Oxford University Press.*
3. Shanes and Rao, Engineering Mechanics, *Pearson Education.*
4. Hibler and Gupta, Engineering Mechanics (Statics, Dynamics), *Pearson Education.*
5. Bansal R. K., A Text Book of Engineering Mechanics, *Laxmi Publications.*

MTH153C Mathematics-II L=4, P=0

Integral Calculus: Definite Integrals and their properties, Differential under the sign of integration. Double and triple integrals, Change of variables, Beta and Gamma functions, Fourier series.

Non-linear differential equation of first order, Simultaneous differential equation, Simultaneous differential equation of the form dx/P = dy/Q = dz/R . Partial differential equations of first order, langrage linear equation, Standard form, Charpit`s Method to solve non- linear partial differential equation, Partial differential equations of second and higher order, Homogeneous Partial Differential equations with constant coefficients, Solutions by the method of separation of variables, heat flow equation, Wave equation.

Matrices: Eigen values and Eigen vectors of a matrix, Cayley-Hamilton Theorem, Symmetric, Skew-symmetric, Hermitian, skew- Hermitian, Orthogonal and unitary matrices and their properties, Diagonalization; Inner product spaces, Gram-Schmidt Orthogonalization.

Complex Variables: Differentiation, Cauchy-Riemann Equations, Analytic functions, Harmonic functions, elementary analytic functions(exponential, logarithmic and trigonometric) and their properties, Taylor's series and Laurent's series.

Recommended Text/Reference Books:

Text Books:

1. Kreyszig I., Advanced Engineering Mathematics, *John Wiley & Sons.*
2. Piaggio H. T., Differential equations and its applications, H *Prentice Hall of India*.
3. Raisinghania M. D., Ordinary and Partial Differential equation, *S. Chand & Sons*.

Reference Books:

1. James Stewart, Calculus, *Early Transcedentals*.
2. Hoffmann & Kunze, Linear Algebra, *Prentice Hall of India.*
3. Shanti Narayan, Integral Calculus by Shanty Narayan, *S. Chand & Sons*.
4. Greenberg, Advanced Engineering Mathematics, *Pearson education.*
5. Sastry, Engineering mathematics Vol I-II, *Prentice Hall of India*.

CSE150F Programming for Problem Solving L=3, P=0

Introduction to Programming: Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc. Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseu-docode with examples. From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code.

Branching, Loops, and Arrays: Arithmetic expressions and precedence, Conditional Branching and Loops, Writing and evaluation of conditionals and consequent branching, Iteration and loops. Arrays, Arrays (1-D, 2-D), Character arrays and Strings.

Algorithms, Order complexity and Functions: Basic Algorithms, Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexity through example programs (no formal definition required), Function, Functions (including using built in libraries), Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference.

Recursion: Recursion as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort, Structure, Structures, Defining structures and Array of Structures.

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

Recommended Text/Reference Books:

Text Books:

1. E. Balaguruswamy, Programming in ANSI C, *McGraw Hill Education India.*
2. Yashavant Kanetkar, Let Us C, *BPB Publications*

Reference Books:

1. Gottfried, Schaum's Outline of Programming with C, *McGraw Hill Education India.*
2. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, *Prentice Hall of India.*

MEC150C Workshop Practice L=1,T=0, P=4

(i) Lectures and Videos

1. Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods.
2. CNC machining, Additive manufacturing.
3. Fitting operations & power tools.
4. Electrical & Electronics.
5. Carpentry.
6. Plastic moulding, glass cutting.
7. Metal casting.
8. Welding (arc welding & gas welding), brazing.

(ii) Workshop Practice

1. Machine shop
2. Fitting shop
3. Carpentry
4. Electrical & Electronics
5. Welding shop (Arc welding, gas welding)
6. Casting
7. Smithy Shop

Recommended Text/Reference Books:

Text Books:

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., Elements of Workshop Technology, Vol. I 2008 and Vol. II 2010, *Media promoters and publishers private limited, Mumbai.*
2. Kalpakjian S. And Steven S. Schmid, Manufacturing Engineering and Technology, 4th edition, *Pearson Education India Edition, 2002.*

Reference Books:

1. Gowri P. Hariharan and A. Suresh Babu, Manufacturing Technology – I, *Pearson Education,2008.*
2. Roy A. Lindberg, Processes and Materials of Manufacture, 4th edition, *Prentice Hall India, 1998.*
3. Rao P.N., Manufacturing Technology, Vol. I and Vol. II, *Tata McGraw Hill House, 2017.*

ELE150C Basic Electrical Engineering L=3, P=0

DC Circuits: Electrical circuit elements (R, L and C), voltage and current sources, Kirchoff's current and voltage laws, analysis of simple circuits with dc excitation. Superposition, Thevenin and Norton Theorems.

AC Circuits: Representation of sinusoidal waveforms, peak and RMS values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits, resonance in series and parallel RLC circuits. Three phase balanced circuits, voltage and current relations in star and delta connections.

Transformers: Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency. Three-phase transformer connections.

Electrical Machines: Generation of rotating magnetic fields. Construction and working of a three-phase induction Motor. Significance of torque-slip characteristic. Starting of induction motor. Construction, working, torque-speed characteristic of separately excited dc motor. Construction and working of synchronous generators.

Electrical Installations: Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB,MCCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries.

Recommended Text/Reference Books:

Text Books:

1. D. P. Kothari and I. J. Nagrath, Basic Electrical Engineering, *Tata McGraw Hill, 2010.*
2. D. C. Kulshreshtha, Basic Electrical Engineering, *McGraw Hill, 2009.*
3. V. D. Toro, Electrical Engineering Fundamentals, *Prentice Hall India, 1989.*

Reference Books:

1. E. Hughes, Electrical and Electronics Technology, *Pearson, 2010.*
2. Charles K. Alexender, Mathew N. O. Sadiku, Fundamentals of Electric circuits, *McGraw Hill,*
3. Jack E. Kemmerly William H. Hayt, Engineering Circuit Analysis,*McGraw Hill, 2012.*
4. L. S. Bobrow, Fundamentals of Electrical Engineering, *Oxford University Press, 2011.*

CSE151F Programming Lab L=0, P=2

List of Experiments:

1. Familiarization with the programming environment.
2. Simple computational problems using arithmetic expressions.
3. Problems involving if-then-else structures.
4. Iterative problems e.g., sum of series.
5. 1D Array manipulation.
6. Matrix problems, String operations.

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7. Simple functions.
8. Programming for solving Numerical methods problems.
9. Recursive functions.
10. Pointers and structures.
11. File operations.

PHY150C Physics Lab L=0, P=2

List of Experiments:

1. To determine the value of e/m of an Electron by Thompson Method
2. To determine the value of Acceleration due to gravity(g) by using Bar Pendulum
3. To determine the value of Acceleration due to gravity(g) by using Kater's Reversible Pendulum
4. To determine the Young's Modulus of rigidity of rectangular Steel Bar by Bending of Beam Method.
5. To determine the Wavelength of Sodium Light by Newton's Rings.
6. To determine the Wavelength of Laser Source by Fresnel Biprism
7. To determine the frequency of AC by Melde's Method
8. To determine The Resolving Power of Telescope.
9. To study the moment of Inertia of a Fly Wheel
10. To determine the refractive index of Crown Glass Prism.
11. To determine the wavelength of Sodium Light by Plane diffraction Grating.
12. To study the characteristics of Zener Diode.
13. To determine the Wavelength of Prominent lines of Mercury Light by Plane Diffraction Grating.
14. To study the characteristics of PN Junction Diode (Forward Bias)
15. To verify Biot-Savart's Law by showing that magnetic field produced is directly proportional to the current passed in a coil.
16. To study the characteristics of G.M. Tube.
17. To determine Planck's constant by LED Method.
18. To verify Stefan's Law by Electrical method.
19. Determination of Modulus of rigidity by Maxwell's Needle.

20. Determination of velocity of Sound by Standing Wave Method.

21. To study the Hall Effect:

    (i) Determination of Hall Voltage and RH.

    (ii) Determination of mobility of charge carriers and carrier concentration.

CHM150C Chemistry Lab L=0, P=2

List of Experiments:

1. Basic Introduction on Solution Preparation, Concentration terms, Handling of Glass ware, Chemicals, Instruments: Precautions.
2. Determination of strength of NaOH solution by standardization of sodium hydroxide using Oxalic acid
3. To determine the acid value of a given mineral oil or vegetable oil.
4. To determine the moisture content of a given sample of coal.
5. To determine the Degree of dissociation of a weak acid by Conductometry.
6. Determination of the strength and pKa value of the weak acid by titration with an alkali.
7. To determine the Aniline point of the given sample of a Lubricating oil.
8. Synthesis of the phenol formaldehyde resin.
9. To determine the temporary and permanent hardness of a sample of water by complexometric titration.
10. To determine the Alkalinity of the given sample of water.
11. Determination of the ion exchange capacity of cation exchange resin.

Demonstration Experiments:

1. Determination of pH of different concentration of acid and bases by pH meter.
2. Spectrophotometer (concentration determination, wavelength maximum)

Text Books/Reference Books:

1. Laboratory Manual On Engineering Chemistry by S. K. Bhasin, S. Rani, 2009, *D R Publications.*
2. J. B. Yadav, Advanced Practical Physical Chemistry.

ELE201C Electromagnetic Field Theory L=3, P=0

Unit I

Electromagnetic theory (Vector Analysis): Review of Vector-Analysis, Concept of scalar and vector fields, Geometrical and Physical interpretation of Gradient, Divergence and Curl, Continuity Equation. Co-ordinate systems: Cartesian, Polar, Cylindrical and Spherical polar co-ordinate systems, representation of curl gradient and divergence in different co-ordinate systems, Gauss Divergence Theorem, Stokes Theorem, Green's Function and Dirac Delta Function, Tutorial Problems.

Unit II

Electrostatic fields: Introduction, Coulomb's law of force, Electric field intensity—Electric field due to a system of charges, field due to sheet of charge, field due to continuous volume charge, electric flux density: Gauss law and its applications; Electrostatic potential; Poisson's equation and Laplace Equation; capacitors and capacitances; energy associated in electrostatic fields; Dielectrics in static electric field, Boundary conditions for electrostatic fields.

Unit III

Magneto-static fields: Introduction, Biot-Savart's law or (Ampere law for forces); Magnetic flux density, Magnetic field intensity, Ampere Circuital Law, magnetic scalar and vector potential, Inductor, magnetic induction and Faraday's law. Time-varying fields: Review of Maxwell's equations, Boundary conditions, Time varying field equations, Solution of wave equation in free space.

Unit IV

Electromagnetic waves: Introduction, wave equation for conducting media, uniform plane wave propagation, wave propagation in lossless and conducting mediums; wave propagation in good conductors, Skin depth penetration, wave propagation in good dielectrics, wave polarization, reflection and refraction of plane waves at plane Boundary (perfect conductor-normal incidence), Poynting vector and Poynting theorem.

Unit V

Wave Guides: Introduction to Wave Guides, Electromagnetic Waves between Parallel Conducting Planes, the TEM Solution, TE Waves, TM Waves.

Reference/Text Books Recommended:

1. Introduction to Electromagnetics by Griffith.
2. Theoretical Physics Vol-II by Constant .
3. Electromagnetic field and waves by Corson& Lorrain.
4. Electromagnetic Field Theory of Fundamentals by Bhag Guru.
5. Principles of Electromagnetics by Mathew N. O. Sadiku, S.V. Kulkarni.
6. Engineering Electromagnetics by William H.Hayt, John A. Buck.

ELE202C Network Analysis L=3, T=1, P=0

UNIT I

Review of the basic network theorems. First order differential equation: Differential equations as applied in solving networks, Application of initial conditions, Evaluating initial conditions in networks, Laplace Transformation properties, Solution of Network problems with Laplace transformation, Wave form analysis and synthesis: The unit step, ramp and impulse functions and their Laplace transforms, Initial and final value of f (t) from f (S), Convolution integral, convolution as summation.

UNIT II

Network theorems and impedance functions: Complex frequency, transform impedance and transform circuits, series and parallel combinations of elements, Network Functions-poles and zeroes: Network functions for one port and two port networks (ladder and general networks), Poles and zeroes of network functions, Restriction on pole and zero locations for driving point and transfer functions, Time domain behavior from pole zero plot.

UNIT III

Two port parameters: Relationship of two port parameters, Admittance, impedance, transmission and hybrid parameters, Relationship between parameter sets, Parallel connection of two port Networks, Characteristics impedance of two port networks.

UNIT IV

Network synthesis- Synthesis problem formulation, properties of positive real functions, Hurwitz polynomials, properties of RC, LC and RL driving point functions, Foster and Cauer synthesis of LC and RC circuits.

UNIT V

Filter fundamentals – pass and stop band, filter classification, constant K & m derived filters, behavior of characteristic impedance over pass & stop bands, design of filters.

Books Recommended:

1. Network Analysis by Van Valkenberg.
2. Network Analysis & Synthesis by F. Kuo.
3. Ryder JD, Networks, Fields & Lines.
4. Circuit Theory (Analysis & Synthesis) by A. Chakrabarti, Dhanpat Rai & Co.

ECE213C Analog Electronics L=3, P=0

Unit I

P-N junction, Diode characteristics, clipper & clamper circuit, Zener Diode characteristics, Voltage regulator using Zener Diode.

Unit II

Transistor fundamentals, Base width modulation & Early effects, Compensation techniques, UJT – JFET& MOSFET characteristics ,Low& High frequency analysis of BJT & UJT , Miller theorem, Power Amplifier.

Unit III

OPAMP characteristics, CMRR , Inverting & Non Inverting Amplifier, Summing & Subtracting Amplifier, Integrator & Differentiator Amplifier, Instrumentation Amplifier, voltage to current convertor ,current to voltage convertor using OPAMP.

Unit IV

Active filters (Low pass, High pass, Band pass, All Pass) using OPAMP, Butterworth first & Second order filter.

Comparators -Inverting & Non Inverting, Schmitt Trigger, Multivibrator (Astable, Mono-stable & Bi-stable).

Unit V

Oscillator theory, Barkhausen Criteria, RC phase shift Oscillator, LC Oscillator, Wien bridge Oscillator, Hartley Oscillator, Colpitts Oscillator, IC 555 Timer.

Negative feedback Amplifier, Sampling Network –Voltage & Current Sampling

Books Recommended: ·

1. Electronic Circuits by D. Schelling and C. Belove.
2. Integrated Electronics by Millman & Halkias.
3. Electronic circuits by G. Grob.
4. Electronic Devices and Circuit Theory by Boylestead and Nashelsky.
5. Microelectronic Circuits Adel S. Sedra and Kenneth C. Smith.
6. Electronic Circuits: Analysis and Design by Donald A Neamen

ELE205C Signals and Systems L=3, P=0

Unit I

Introduction to signals and Systems Representation: Classification of signals and systems: Introduction to signals and systems, Continuous time and discrete time signals, Classification of CT and DT signals periodic and non-periodic, Even and Odd, Power and Energy, Invertible and Non-invertible, Deterministic and Random. Elementary signals - exponential, sine, step, impulse and its properties, ramp, rectangular, sine, triangular, signum, Operations on signals: Amplitude scaling, addition, multiplication, differentiation, integration(Accumulator for DT), time scaling, time shifting and folding.

Unit II

System: definition, classification – Linear and Non-Linear, Time Variant and Time Invariant, Causal and Non-causal, Stable and Unstable (BIBO stability), Static and Dynamic. Convolution-Circular & Linear, FIR and IIR systems

Unit III

Fourier series Analysis: Analysis of continuous time signals: Definition and necessity of CT and DT Fourier series and Fourier transforms, Fourier series representation of continuous time and discrete time periodic signals properties of continuous time and discrete time Fourier series. Continuous Time Fourier Transform (CTFT), amplitude and phase spectra of CT signals, Harmonics Identification (even, odd and Triplen), Dirchlet Condition, Parseval Power Theorem

Unit IV

Analysis of Continuous time LTI Systems: Fourier Transform: Properties of Fourier Transform, Duality, Time Scaling, shifting, frequency shifting, Differentiation in time and frequency, Gaussian function, Convolution in time, frequency Convolution, Integration in time, ROC and pole zero, Parseval Power Theorem Laplace Transform :Properties of Laplace Transform, ROC of Laplace Transform, Zero state response, Zero input response, Steady state response, Initial & final value theorem, causality & stability.

Unit V

Analysis of Discrete Time Systems: Z-Transform: Introduction to Z transform. ROC, Properties: linearity, time shift, scaling ,time reversal ,differentiation ,convolution, accumulation Unilateral Z transform, Initial & final value theorem, causality & stability. Realization of Digital Filters (FIR & IIR)Sampling of CT signals and aliasing, Distortion less Transmission, Phase Delay.

Text/Reference Books Recommended:

1. AlanV. Oppenheim, Alan S.Willsky with S. Hamid Nawab, Signals & Systems, 2nd editionn., Pearson Education, 1997.
2. Signals and systems by Simon Haykins and Barry Van Veen.

Reference Books:

1. John G. Proakis & Dimitris G. Manolakis, Digital Signal Processing, Principles, Algorithms and Applications, 3rd edn, PHI, 2000.
2. M.J.Roberts, Signals and Systems Analysis using Transform method and MATLAB, TMH 2003.
3. Simon Haykin and Barry Van Veen, Signals and Systems, John Wiley, 1999
4. K. Lindner, "Signals and Systems", McGraw Hill International, 1999.
5. Moman .H. Hays," Digital Signal Processing ", Schaum's outlines, Tata McGraw-Hill Co Ltd., 2004.
6. Ashok Amhardar, "Analog and Digital Signal Processing", 2nd Edition Thomson 2002

MTH203C Applied Mathematics for Engineers L=3, P=0

Laplace transform: shifting theorem, Laplace transforms of derivatives and integrals, Heaviside's unit function. Dirac Delta function and its Laplace transforms. Laplace transforms of periodic functions, Heaviside's expansion theorem.

Inverse Laplace transforms: initial and final value theorems. Convolution theorem and its applications, use of Laplace transforms in the solution of linear differential equations.

Complex analysis: Complex variables, analytic functions, Cauchy Riemann equations. Complex integration, Cauchy's fundamental theorem, Cauchy's integral formula, Cauchy's inequality and Liouville's theorem on integral function.

Expansions and Series in calculus: Taylor's & Laurent's expansions, Zeros & poles of analytic functions, Residues. Fourier series, Harmonic analysis.

Fourier transform: Fourier sine and cosine transform. Fourier integral formula and its applications to solution of boundary value problems.

Text Books/Reference Books:

1. Saff E. B., Snider A. D., Fundamentals of Complex Analysis for Mathematics, Science, and Engineering, *Prentice Hall India, New Delhi*.
2. Spiegel, Laplace Transforms, *Schaum Series.*
3. Churchill R. V., Complex variables and applications, *McGraw Hill Education (India)*.
4. Snedden N., The use of Integral Transforms, *McGraw Hill Education (India)*.

ECE214C Analog Electronics Lab L=0, P=2

List of Experiments:

1. To get familiar with the working knowledge of the following instruments: CRO, Multi-meter, function generator, Regulated power supply, Active and Passive Components, Breadboard.
2. Study of V-I characteristics of diode.
3. To study and draw the characteristics of half wave and full wave rectifiers.
4. To study and draw the characteristics of rectifier filter circuits.
5. To assemble and observe the performance of clipper and clamping circuits.
6. To obtain Zener diode characteristics and use zener diode as voltage regulator.
7. To obtain the characteristic of transistor configurations (CE, CB, CC).
8. To plot the V-I characteristics of BJT and determine hfe, hre, hie, hoe.
9. To plot the drain and transfer characteristics of MOSFET
10. OP-AMP as non-inverting, inverter amplifier, summer, subtractor, integrator differentiator.
11. Design of firing circuit using IC-555 timer

ELE203C Basic Electrical Engineering Lab L=0, P=2

List of Experiments:

1. To study the color coding of resistors. Connection of Ammeters, voltmeters, Wattmeter's and Milli-ammeters in DC and AC circuits and selection of their ranges, Use of LCRQ meter.
2. To study the series and parallel operation of resistors and verifying their effective values by LCRQ meter.

b) Repeat the same for inductors.

c) Repeat the same for capacitors.

Experiments on D.C. Circuits:

3. To verify the KVL and KCL in D.C. circuits.
4. To verify the star delta transformation of networks.
5. To verify the superposition theorem.
6. To verify the maximum power transfer theorem.
7. To verify Norton's Theorem.
8. To verify Superposition Theorem.

Experiments on A.C. Circuits:

9. To measure electric power, voltage and current in a single phase AC circuits with resistive load, RL load and RLC load using CRO.
10. To measure the power and power factor in three phase AC circuits.
11. To study the series resonance.
12. To study the parallel resonance.

ELE204C Introduction to Simulation Softwares L=0, P=2

1. Introduction to MATLAB/SCILAB: – Different layouts, using Command Window as a scratch pad, functions of various windows, docking and undocking of windows, creating m–files, use of help command.
2. Introduction to Matrices and Arrays: – Variable types, initializing variables using *input* command, arrays and matrices, manipulation of arrays and matrices, operations on matrices, transpose and inverse of a matrix, Displaying output data.
3. Two – Dimensional Plotting: – Simple 2D Plots (line color, line style, markers, legend, labeling axes, title, controlling axes), multiple plots on the same figure, multiple figures, subplots, Logarithmic and Polar plots.
4. Control Flow/Branching Statements: – Logical data type, Relational operators, if – else statements, switch – case construct, related examples.
5. Loops: – while and for loop, nested loops, break and continue statements and related examples.
6. User – Defined Functions: – How to define a function, Simple examples to demonstrate use of user-defined functions.
7. Additional Data and Plot Types: – Complex Data, Complex numbers with relational operators, Complex functions, String functions, 3D line plots, 3D surface, mesh and contour plots.

Books Recommended:

1. MATLAB programming for engineers, Stephen J Chapman.
2. SCILAB: Theory to Practice-I-Fundamentals, Philippe Roux and Claude Gomez

ELE251C Electrical Machines-I L=3, T=1, P=0

Unit I

Introduction, classification and construction of transformers, electromotive force (e. m. f.) equation, Equivalent circuit model, Phasor diagrams, Losses and efficiency, Voltage regulation, Transformer tests (polarity test, open circuit test and short circuit test), All day efficiency, Parallel operation, Autotransformers, Distribution transformers and Power transformers.

Unit II

Construction of three phase transformers, Different types of Connections: Star-Star, Star-Delta, Delta-Star, Delta-Delta, Open delta connection, Scott connection, Phase Conversions(3 phase to 2 phase/ 2 phase to 3 phase), Three winding transformer, Constant Current Transformer, Instrument Transformers (Introduction).Vector group of transformers.

Unit III

Principles of electromechanical energy conversion, Energy balance, Coupling field reaction, Energy conversion in singly excited magnetic field systems and electric systems, Field energy, mechanical force, and co-energy.

Unit IV

Introduction & principle of operation of DC Generators, Construction of DC Generators, Types of DC Generators, e.m.f equation, Types of windings, power stages and efficiency, commutation and armature reaction, characteristics of DC Generators, Applications of DC Generators.

Unit V

Principles of operation of DC Motors, construction of DC Motors, Types of DC Motors, Back e.m.f and Torque equation, torque and speed of DC Motors, characteristics of various types of DC motors, speed control of DC motors, starting and electric braking. Performing the different tests to determine the efficiency of DC motors.

Books Recommended:

1. Electric Machinery by Fitzgerald, Kingslay, Umans.
2. Electric Machinery Fundamentals by Chapman.
3. Electric Machines by Nagrath and Kothari.
4. Electric Machinery and Transformer by Guru, Hiziroglu.
5. Electrical Machinery by P. S. Bhimbra.
6. Electrical Machines and Transformers by Irving Kosov.
7. Electrical Machinery by Charles S. Siskins.

STA253C Probability and Statistics L=3, P=0

Statistics: Measures of central tendency and Measures of variations (Dispersions), Moments, Measures of Skewness and Kurtosis. Moment generating functions, problems.

Standard Distributions: Binomial, Poisson and Normal Distributions, Beta and Gamma Distribution, t Distribution, F-Distribution, Chi-square Distribution and their applications.

Method of Least Squares & Correlation: Methods of least squares, fitting of straight line and parabola of degree 'p'. Regression and Correlation. Multiple and Partial Correlation.

Probability: Random experiment, sample space, events, classical, statistical and axiomatic definitions of probability. Statements and proof of theorems on addition and multiplication of probabilities, problems.

Conditional Probability: Bayes theorem on conditional probability. Random variables, Derivation of formulae for mean, variance and moments of random variables for discrete and continuous cases. Laws of expectation problems.

Text Books/Reference Books:

1. Gupta S. C., Kapoor V. K., Fundamentals of Mathematical Statistics, *S. Chand & Sons.*
2. Brownlee, Statistical Theory and Methodology in Science & Engineering, *John Wiley & Sons.*
3. Walpole R. E., Introduction to Mathematical Statistics, *Macmillan publications*.
4. Meyer, Data Analysis for Scientists & Engineers, *John Wiley & Sons.*

ECE263C Digital Electronics L=3, P=0

Unit I

Number Systems and Codes: Binary, octal, and hexa- decimal number systems, binary arithmetic, binary code, excess-3 code, gray code, error detection and correction codes. Boolean algebra: Postulates and theorems, logic functions, minimization of Boolean functions using algebraic, Karnaugh map and Quine – McClausky methods, realization using logic gates.

Unit II

Combinational Circuits: Introduction to combinational circuits, realization of basic combinational functions like Adder, Subtractor, Encoder/Decoder, Multiplexer, Comparators, delays and hazards in combinational circuits, Code converters – Implementation using MUX and ROM

Unit III

Sequential Circuits: Flip-Flops: SR, JK, T, D, Master/Slave FF, triggering of FF, Analysis of clocked sequential circuits-their design, state minimization, state assignment, circuit implementation, Registers: shift registers, inter-conversion of shift registers, Counters.

Unit IV

Programmable Logic Devices (PLD's):Programmable Array Logic, Programmable Logic Array – GAL, CPLD – basic concepts.

Unit V

Logic Families: RTL, DCTL, I^2L, DTL, HTL, TTL, ECL, NMOS and CMOS logic gates, circuit diagram and analysis, characteristics and specifications, tri-state gates, totem-pole configuration.

Text /Reference Books recommended:

Text Books:

1. Morris Mano, "Digital logic and Computer Design ", Prentice-Hall of India.

Reference Books:

1. Floyd T.L., "Digital Fundamentals ", Charles E. Merrill Publishing Company.
2. Jain R.P., "Modern Digital Electronics ", Tata McGraw Hill.
3. Ronald J. Tocci, "Digital Systems, Principles and Applications", Prentice-Hall of India.

ELE252C Control Systems L=3, T=1, P=0

Unit I

Control Systems- examples and classification; Open Loop and closed loop control systems and their differences; Transfer functions; Block diagram representation of systems; Signal flow graphs - Reduction using Mason's gain formula; Models of some Industrial Control Devices and Systems. Introduction to the State variable representation.

Unit II

Standard test signals; Time domain performance of first and second order control systems-time domain specifications of these systems-steady state and transient response, steady state errors and error constants. Proportional, Integral, Derivative (P, I, D) Control with characteristics.

Unit III

The concept of stability, BIBO stability, Relation between characteristic equation roots and BIBO stability, Routh-Hurwitz stability criterion, Relative stability analysis.

Unit IV

Root Locus and Frequency Response Analysis: The Root locus technique and its Construction Principles; Frequency response and Frequency domain specifications; Bode diagrams - Determination of Stability, Phase Margin and Gain Margin from the Bode Diagrams, Nyquist Methods - Determination of Stability, Phase Margin and Gain Margin from the Nyquist Diagrams.

Unit V

Control System Design using Root Locus methods - Relationship between Root Locus and Time Domain – Cascade (Lag, Lead, Lag-Lead, PI, PID) and Feedback (PD) compensation using Root Locus plots; Compensator design using Bode plots - Cascade (Lead, Lag, Lag-Lead, PI, PID) and Feedback (PD) compensation.

Text /Reference Books recommended:

1. Control Systems Engineering by Norman S. Nise, John Wiley and Sons.
2. Control Systems–Principles and Design by M. Gopal, Tata McGraw-Hill Ltd.
3. Design of Feedback Control Systems by R. Stefani, C. Savant B. Shahian & G. Hostetter, Saunders College Publishing, 3rd edition.
4. Modern Control Engineering by Katsuhiko Ogata, Prentice Hall of India Pvt. Ltd.

ELE253C Electrical Engineering Materials L=3, P=0

Unit I

Crystal structure: crystalline state, Bravais lattices, Miller indices, Reciprocal lattice, Common Crystal structures, Crystalline Interference, Bragg Diffraction, crystal imperfections.

Unit II

Free electron theory, conduction in metals and alloys, conductors and resistors, Materials for resistors, colour coding of resistors, some important resistor alloys, capacitors and inductors.

Unit III

Magnetism, magnetic properties of materials, B-H curve, diamagnetic, paramagnetic and ferromagnetic materials, soft and hard magnetic materials, CRGO and HRGO steel. Magnetic dipole moment. Ferromagnetism and anti-ferromagnetism, ferrites and other magnetic materials.

Unit IV

Mechanism of Conduction in semiconductor materials: Types of semiconductors, current carriers in semiconductors, Half effect, Drift and Diffusion currents, continuity equation, mobility, Fermi Direct Distribution Function, Fermi Level, properties of semiconducting materials.

Unit V

Dielectric materials and their properties, types of insulating materials, parallel plate capacitor, dielectric constant, properties of optical materials, piezoelectricity, superconducting materials.

Text /Reference Books recommended:

1. Introduction to solid-state physics by Kittle.
2. Solid state physics by Dekker.
3. Material science & Engineering by Raghavan.
4. Electronics & materials by Streetman.
5. Dielectric Materials and Application by A.R. Van Hippel

ELE254C Electrical Machines-I Lab L=0, P=2

List of Experiments:

Experiments on Transformers:

1. To perform open circuit and short circuit tests on a single-phase transformer.
2. To perform polarity test on a single phase transformer.
3. To determine the efficiency and voltage regulation of a single phase transformer.
4. To perform Sumpner's test on two identical transformers.
5. To study three phase connections on a bank of three single phase transformers

Experiments on Direct Current Machines:

1. To study various parts of a dc machine and draw sketches of the same.
2. To plot the saturation curve of a dc machine.
3. To plot the external characteristics of a separately excited dc generator.
4. To study the voltage build-up of a dc shunt generator.
5. To plot the external characteristic of a dc shunt generator and compare the characteristics with that of a separately excited generator.
6. To plot the external characteristics of a dc series generator.
7. To plot the external characteristic of a dc compound generator and compare the characteristics when run as a shunt generator, an over compound generator, a flat compound generator, an under compound generator and differentially compounded generator.
8. Starting of DC motor by using a starter.
9. To plot the torque- speed characteristics of DC shunt and series motor.
10. Speed control of DC series and shunt motor by armature voltage control.
11. Speed control of DC shunt motor by flux or field control.

Simulation Based Experiments:

1. Evaluation of the efficiency and voltage regulation of a transformer.
2. Determination of circuit parameters of a transformer equivalent circuit.
3. Determination of external characteristics of DC machine.
4. Determination of torque-speed characteristics of a DC machine.

ECE264C Digital Electronics Lab L=0, P=2

List of Experiments:

1. To verify the truth table of the following logic gates:
   a) AND, OR, NOT
   b) NAND, NOR, XOR, XNOR

Realization of :

   a) Half Adder and verify its truth table.
   b) Full Adder and verify its truth table.
   c) Half subtractor and verify its truth table.
   d) Full subtractor and verify its truth table.
2. To design multiplexer and demultiplexer using 2-input NAND gates.
3. Realization of : • Flip-Flops • Ripple Counters, Universal Shift Register.

ELE260C **Control Systems Lab** **L=0, P=2**

List of Experiments:

1. To study D.C. motor angular position control system, step response studies for various values of forward gain.
2. To study the torque-speed characteristics of an AC servomotor, determine its parameters and evaluate its transfer function.
3. To study the characteristics of AC servo angular position control system.
4. To study the characteristics of 2^{nd} order RLC circuit, trace the transient response and evaluate transient response specifications.
5. To study the effect of velocity feedback on the transient and steady state performance of DC motor speed control system.
6. To design, implement and study the effects of different cascade compensation networks for a given system.
7. Study of Light Intensity Control System.
8. Study of Magnetic levitation system.

ELE302C Electrical Machines-II L=3, T=1, P=0

Unit I

The rotating magnetic field, Magneto-motive force and flux distribution, Induced voltage, Production of torque, Leakage fluxes.

Unit II

Three Phase Induction Motors Principle of operation of an induction motor, Construction, Types, slip, Equivalent circuit, Torque/speed characteristics, losses and efficiency, crawling and cogging, Induction motor tests, Starting, Speed control.

Unit III

Double field revolving theory, Types of 1-phase induction motors, Equivalent circuit of 1-phase induction motors, Shaded-pole Motor, Stepper Motor, Universal Motor, Reluctance motor.

Unit IV

Constructional features, Types and working principle of alternators, EMF equation, windings, pitch factor and distribution factor, leakage reactance, armature reaction, Equivalent circuit, phasor diagram, short circuit ratio (SCR), voltage regulation and its determination, Two- axis theory for salient type machines.

Unit V

Construction, principle of operation, starting, Effect of load on synchronous motor, Effect of varying excitation, Equivalent circuit, Phasor diagram, different torques, V and inverted V curves, hunting, damper windings , Synchronous condenser/ synchronous phase Modifier.

Books Recommended:

1. Electric Machinery by Fitzgerald Kingslay, Umans Tata Mcgraw Hill
2. Electric Machines Nagrath and Kothari Tata Mcgraw Hill
3. Electric Machines Guru Oxford university press
4. Electrical Machines and Transformers Geroge McPherson John Wiley.
5. Electric Machinery Fundamentals Chapman Tata Mcgraw Hill
6. Electric machinery by P.S. Bimbhra, Khanna Publishers
7. Electrical Machines by Charles Siskin.
8. Electrical Machines and transformers by Irving Kosov.

ELE303C Power Systems-I L=3, T=1, P=0

Unit I

Introduction to Power System, Single line diagram, Single Phase and Three Phase transmission, Overhead and Underground transmission System, Elements of AC distribution. Singly fed, Doubly fed and Ring main distributor. Introduction to micro-grid.

Unit II

Transmission line parameters, Types of overhead conductors, calculations of inductance and capacitance of single and double circuit line, Transposition of transmission conductors, Effect of earth on capacitance of a transmission line, Bundled conductors, Skin and Proximity effect.

Unit III

Modelling and performance analysis of short, Medium and Long transmission lines, ABCD parameters, Surge Impedance Loading (SIL), Ferranti effect. Power flow through a transmission line. Methods of Voltage control.

Unit IV

Mechanical design of overhead transmission line, Types of insulators and their applications, Voltage distribution over a string of insulators, String Efficiency & methods of its improvement. Corona, Interference of power lines with communication lines.

Unit V

Classification of cables, Cable conductors, Insulating materials, Insulation Resistance, Electrostatic stress, Grading of cables, Capacitance calculation, Losses and current carrying capacity. Neutral grounding: Different types of grounding. Equipment Earthing.

List of recommended books:

1. Power System Analysis, J.J. Grainger and W.D Stevenson McGraw-Hill.
2. Electric Power Systems, C.L. Wadhwa, New Age International.
3. Power System Engineering, Nagrath and Kothari, Tata McGraw-Hill.
4. Transmission and Distribution of Electrical Energy, H. Cotton.
5. Modern Power System Analysis by Turan Gonan.
6. Electrical Power Transmission System Engineering: Analysis and Design by Turan Gonan.

MTH308C Numerical Methods in Engineering L=3, P=0

Finite Differences and Interpolation: Difference Table and its usage. The difference operators Δ and the operator E. Interpolation with equal intervals, Newton's advancing difference formula. Newton's backward difference formula. Interpolation with unequal intervals. Newton's divided difference formula. Lagrange's interpolation formula.

Central Differences and Inverse interpolation: The central difference operator δ and theover-raging operator μ. Relations between the operators. Gauss forward and backward interpolation formula, Sterlings, Bessel's, Laplace and Everetts formulae. Inverse interpolation by (i) Langrange's (ii) Methods of successive e approximation & (iii) Methods of elimination of third differences.

Numerical solution of algebraic and Transcendental Equations and Numerical differentiation & Numerical Integration: Graphic Method, Regula-Fast method, Balzano's Processof bisection of intervals, Newton-Raphson Method and its geometrical significance. Numerical differentiation of a function. Differential coefficient of a function in terms of its differences. Numerical Integration, General Quadrature Formula, Trapezoidal rule, Simpson's one-third and three-eight rules, Weddles' rule, Euler- Maclaurin expansion formula.

Difference Equations and Numerical Solution of ordinary differential equations: Linear homogeneous and non-homogeneous difference equations of order n with constant coefficient, and their solution, methods of undetermined coefficient. Numerical solution of ordinary differential equations, Picard's method. Taylors series method, Euler's method, Runge-Kutta Method.

Numerical solution of simultaneous equations and Eigen value problem: Gauss elimination method, Gauss Jordon method, Gauss- Jacobi and Gauss- Seidel iteration methods, power methods for solving Eigen value problems.

List of recommended Text /Reference books:

1. Jain M. K., Iyengar S. R., Jain R. K., Numerical Methods for Scientists and Engineering, *Wiley Eastern Ltd.*
2. Scarborough S. C., Mathematical Numerical Analysis, *Oxford and IBH publishing Company*.
3. Sastry S. S., Introductory methods in Numerical Analysis, *Prentice Hall of India.*
4. Jain M. K., Numerical Solution of Differential equations, *New Age International Publishers.*
5. Stanton R. G., Numerical Methods for Science & Engineering, *Prentice Hall of India.*

ECE313C Microprocessors and Microcontrollers L=3, P=0

Unit I

Microprocessors: Evolution of microprocessors and microcontrollers, Internal architecture of 8085/8086(ALU, Register Array, Timing and Control Unit), flags, different addressing modes, instruction set, arithmetic and logic operations, 8085 assembly language programming.

Unit II

Microcontrollers: Overview of 8051 Microcontroller family, Architecture, Basic assembly language programming concepts, The program Counter and ROM Spaces in the 8051, Data types, 8051 Flag Bits ad PSW Register, 8051 Register Banks and Stack.

Unit III

Microcontroller/Microprocessor Programming: Assembly language programming and Embedded C. Timer programming, Time delay generations and calculations, I/O port programming, Counter Programming, Interrupt Programming, Serial communication programming.

Unit IV

Microcontroller/Microprocessor Interfacing: Interfacing of I/O Devices like, LEDs, LCD, Keyboard, Motors, ADCs, Sensors, and External Memory with microprocessors microcontrollers.

Unit V

Arduino and Raspberry Pi Board: Introduction to ATMega microcontrollers and Arduino Boards. Interfacing of various I/O devices with Arduino boards. Introduction to Raspberry Pi Board.

List of recommended Text /Reference books:

1. Goankar R. S., Microprocessor architecture, programming and Applications with 8085, Penram International Publishing.
2. Mazidi M.A. and Mazidi J. G., The 8051 Microcontroller and Embedded Systems: Using Assembly and C, Pearson Publications.
3. Mazidi M.A. and Naimi S., AVR Microcontroller and Embedded Systems: Using Assembly and C, Pearson Publications.
4. Microprocessors by K. L. Short
5. Microcontrollers by J. Ayalla

ELE304C Electrical Measurements &Instrumentation L=3, T=1, P=0

Unit I

Units, dimensions, classification of errors, accuracy and precision, statistical analysis of errors, standards for measurement, temperature, emf, resistance, current, inductance, capacitance methods of measurements, Classification of instruments- absolute, secondary, indicating, recording, integrating.

Unit II

Instruments for voltage and current measurement, control, balancing and damping forces of instruments, Galvanometer- PMMC (Permanent magnet moving coil), moving iron, dynamometer type instruments, Electrostatic and induction type instruments, Use of rectifier for measuring instruments. Extension of range of voltmeter and ammeter, Current transformer (CT) and Potential transformer (PT) - theory, ratio and phase angle error, characteristics, effect of power factor, secondary burden.

Unit III

Power in ac circuits, construction and operation of dynamometer and induction type wattmeter, Measurement of power using wattmeter for single phase circuits and three phase circuits, Measurement of reactive power.

Unit IV

Measurement of energy- single phase induction type watt-hour meter, Poly-phase watt-hour meters, Meters for special purposes- prepayment meters, flux meter, power factor meter, and synchroscope , clamp on meters .

Unit V

CRO: construction and working. Phase, time, frequency and amplitude of a signal using CRO. Working of probe of CRO. Digital Voltmeter (DVM), Electronic Voltmeter (EVM), DAC and ADC.

List of recommended Text /Reference books:

1. Electronic Instruments and Measurements by W. D. Cooper & A. D. Helfric, Prentice Hall of India, New Delhi.
2. Electrical Measurements and Measuring Instruments by E. W. Golding and F. C. Widdis, JOBS Publications.
3. A Course in Electrical and Electronic Instruments and Measurements by A.K. Sawhney, Dhanpat Rai and Sons, Delhi.

ELE305C Electrical Machines-II Lab L=0, P=2

List of Experiments:

1. To study the different parts of an Induction motor.
2. To determine the equivalent–circuit parameters of a 3-phaseInduction motor by: (i) No load test (ii) Blocked rotor test.
3. To determine the Torque / speed characteristics of a 3-phase Induction motor.
4. To determine the equivalent circuit parameters of a 1-phase Induction motor by: (i) No load test (ii) Blocked rotor test.
5. To Study of the construction of a synchronous machine.
6. To obtain the OCC and SCC of a synchronous machine by Synchronous impedance method.
7. To find voltage regulation of an alternator by actual loading.
8. To obtain the V-curves and inverted V-curves of a synchronous motor.

Simulation Based Experiments:

1. Production of RMF for the balanced two phase and three phase system.
2. To determine the torque-speed characteristics of an Induction machine.
3. To determine the equivalent circuit parameters of an Induction machine.
4. To determine the voltage regulation and V-curves of a Synchronous machine.

ELE306C Power Systems-I Lab L=0, P=2

List of Experiments:

1. To study different types of insulators.
2. To study potential distribution across different units of a string of insulators with and without guard ring.
3. To study different parts of a HT and LT cable.
4. To measure the insulation resistance of a cable.
5. To determine the charging current of a cable.
6. To study different types of overhead conductors.
7. To determine ABCD parameters of a transmission line.
8. To determine voltage regulation and efficiency of a transmission line.
9. Study of Ferranti effect.
10. To study the AC distribution system

Simulation based experiments:

1. To determine the transmission line parameters.
2. To determine the voltage regulation and efficiency of a transmission line.

ELE-307C Electrical measurements and Instrumentation Lab L=0, P=2

List of Experiments:

1. Calibration of ac voltmeter and ac ammeter.
2. Measurement of form factor of a rectified sine wave and determine source of error if r.m.s. value is measured by a multi-meter.
3. Measurement of power and power factor of a single phase inductive load and to study effect of capacitance connected across the load on the power factor.
4. Measurement of low resistance by Kelvin's double bridge.
5. Measurement of voltage, current and resistance using dc potentiometer.
6. Measurement of inductance by Maxwell's bridge.
7. Measurement of inductance by Hay's bridge.
8. Measurement of inductance by Anderson's bridge.
9. Measurement of capacitance by Owen's bridge.
10. Measurement of capacitance by De Sauty bridge.
11. Measurement of capacitance by Schering bridge.
12. Measurement of transformer insulation resistance by using Megger
13. Measurement of phase difference, frequency of a sinusoidal ac voltage using lissajous pattern in C.R.O. and D.S.O.
14. To study the transient analysis of a system using D.S.O.

ECE314C Microprocessors and Microcontrollers Lab L=0, P=2

List of Experiments:

1. Familiarity with 8085 microprocessor kits and writing simple arithmetic programs.
2. Introduction to Keil simulator/Atmel Studio.
3. ALP/C Program to read/send data from/to ports.
4. To simulate timer and counter programs.
5. Interfacing of LEDs and 7 segment display with microcontrollers.
6. Interfacing of LCD with microcontrollers.
7. Interfacing of keyboard with microcontrollers.
8. Interfacing of motors.
9. Familiarity with Arduino boards and Arduino shields.
10. Interfacing of sensors and actuators with Arduino.
11. Familiarity with Raspberry Pi board.

ELE351C Power Systems-II L=3, T=1, P=0

Unit I

Transients in simple circuits, Three-phase short circuit on an alternator, Re-striking Voltage after removal of short circuit. Single line diagram, per unit system and reactance diagram.

Faults, Types of faults: Symmetrical & Unsymmetrical, Analysis of Symmetrical faults.

Unit II

Symmetrical components of a three phase system, Evaluation of components, Three-phase power in terms of symmetrical components, Sequence impedances. Sequence network. Calculation of fault currents for unsymmetrical faults: Single Line to Ground, Line-to-Line, Double Line to Ground faults and for symmetrical 3-phase balanced faults, current limiting reactors.

Unit III

Load flow analysis: Introduction, Bus classifications, Nodal admittance matrix (Y_{BUS}), Development of load flow equations. Load flow solution using Gauss-Seidel and Newton-Raphson method, Approximation to N-R method. Calculation of line flows and line losses.

Unit IV

Power System Stability, Transient and Steady State stability, Power Angle Equation, Swing Equation, Equal Area Criterion of Stability, Critical clearing angle, Factors affecting transient stability. Active and Reactive power control.

Unit V

Travelling waves on transmission lines: Reflection and refraction coefficient, open-end line, Short-circuited line, Line terminated through impedance. Line terminated through cable, Surge Impedance loading, Bewley Lattice Diagrams.

List of recommended books:

1. Power System Analysis, J.J. Grainger and W.D Stevenson McGraw-Hill.
2. Electric Power Systems, C.L. Wadhwa, New Age International.
3. Power System Engineering, Nagrath and Kothari, Tata McGraw-Hill.
4. Transmission and Distribution of Electrical Energy, H.Cotton.
5. Modern Power System Analysis by Turan Gonan.
6. Electrical Power Transmission System Engineering: Analysis and Design by Turan Gonan.

ELE352C Power Electronics L=3, T=1, P=0

Unit I

Goals and objectives of power electronics, Characteristics and specifications of semiconductor power devices: Diode, Thyristors, Diac, Triac, GTO, MOSFET, IGBT, Thyristor firing circuits, SIC based switches and their drivers. Methods of triggering and commutation of a thyristor, di/dt& dv/dt protection of switches, Snubber circuits.

Unit II

Single-phase half-wave and full-wave rectifiers, Single-phase full-bridge thyristor rectifier with R-load and highly inductive load, RLE load. Three-phase full-bridge thyristor rectifier with R-load and highly inductive load, RLE load. Concept of freewheeling, Controlled rectifier performance calculations.

Unit III

DC-DC converters: Introduction, Buck, Boost and Buck-Boost chopper configurations, Continuous and Discontinuous conduction mode of operations, Waveforms analysis at steady state, duty ratio control of output voltage, Soft-Switched Converters.

Unit IV

Inverters: Introduction, Principle of operation of voltage source inverters, Single phase inverters, Square wave operation of the inverter, concept of average voltage over a switching cycle, bipolar sinusoidal modulation and unipolar sinusoidal modulation, modulation index and output voltage, Total Harmonics distortion and Power factor analysis and computations.

Unit V

Power circuit of a three-phase voltage source inverter (VSI), switch states, instantaneous output voltages, Sinusoidal pulse width modulation in three phase VSI, AC Voltage controllers introduction-principle of AC voltage control (On-Off control, Phase control) single-phase ac controllers (Analysis for different types of load).

Books Recommended:

1. M. H. Rashid, “Power electronics: circuits, devices, and applications”, Pearson Education India, 2009.
2. N. Mohan and T. M. Undeland, “Power Electronics: Converters, Applications and Design”, John Wiley & Sons, 2007.
3. L. Umanand, “Power Electronics: Essentials and Applications”, Wiley India, 2009.
4. P.S. Bimbhra , “Power Electronics”, 4th edition, Khanna Publisher, India, 2018.
5. M.S.J. Asghar, “Power Electronics”, Prentice-Hall of India, 2004.
6. V. Ram Narayan, “Power Electronics”

ELE353C Electrical Machine Design L=3, P=0

Unit I

Principles of electrical machine design: Considerations in design, design factors, limitations in design, modern trends in design. Magnetization curves, Magnetic leakage, calculation of MMF for air gap and teeth, effect of saliency.

Unit II

Armature winding design: Integrated approach for windings, A.C armature windings, production of EMF in windings, MMF distribution of armature windings, eddy current losses in conductors.

Unit III

Design of transformers: Output equation, core design, winding design, yoke design, Design of transformer tank with tubes, design of insulation.

Unit IV

Design of DC machines: Output equation, Main dimensions, Armature design, Armature windings, Design of commutator and brushes, Design of Field systems, Design of inter-poles.

Unit V

Design of Induction Motors: Output equation, main dimensions, Stator winding, stator conductors, shape of stator slots, number of stator slots, stator core, rotor design (squirrel cage and wound rotor).

Books Recommended:

1. Electric Machine Design by A.K. Sawhney.
2. Design of Electrical Machines by Mittle and Mittla.
3. Electrical machine Design by R.K. Agarwal.
4. Electrical Machine Design by M. G. Sen.
5. Electrical Machine Design by Rajiv Nagaranjan.

ECE364C Communication Systems L=3, P=0

Unit I

Amplitude modulation (AM): definition, AM modulation index, Spectrum of AM signal, Power analysis of AM signal, Standard AM generation and detection, Introduction to DSB/SC, SSB/SC and VSB AM signals, Frequency division multiplexing.

Unit II

Angle modulation: Basic definition, Generation and detection of FM waves, Bandwidth of FM signal, Narrow band and broad band FM signal.

Unit III

Elements of digital communication systems, advantages of digital communication systems, Elements of PCM: Sampling, Quantization and Coding, Differential PCM systems (DPCM), Delta modulation, adaptive delta modulation.

Unit IV

Pulse modulation Techniques-Pulse Amplitude modulation (PAM), Pulse Position Modulation(PPM) Pulse Width Modulation (PWM), definition of noise, Types and Sources of noise, signal to noise ratio, Noise comparison of AM, FM and digital communication systems.

Unit V

Introduction to basic digital modulation techniques (ASK, FSK, PSK, QAM), Introduction to Optical Fiber Communication: Block diagram of optical fiber communication system, Advantages of optical fiber communication, Principal components of an optical fiber communication system.

Books Recommended:

1.Modern Analog and Digital Communication system by B. P.Lathi

2. Communication System by Simon Hykin

3. Principles of communication system, Taub and Schilling, Mcgraw Hill, 3rd Ed.

4. Communication system; Analog and Digital, Sanjay Sharma.

5. Data Communication by Stalling.

ELE354C Power Systems-II Lab L=0, P=2

List of Experiments:

1. To measure positive, negative and zero sequence reactance of synchronous machine.
2. Measurement of positive, negative and zero sequence impedance and currents of the transmission line.
3. Measurement of earth resistance.
4. To Study The Single Line To Ground Fault.
5. To Study Line To Line Fault.
6. Use of MATLAB/SCILAB SIMULINK/XCOS for Power System Analysis.
7. Series parallel connections of a Solar Photovoltaic Panels.

Simulation based experiments:

1. To obtain the sub-transient, transient and steady state short circuit current of an alternator.
2. To obtain the Y_{BUS} and perform the load flow analysis.
3. To perform symmetrical fault analysis in a power system.
4. To perform un-symmetrical fault analysis in a power system.

ELE355C Power Electronics Lab L=0, P=2

List of Experiments:

1. V-I static Characteristics of Power Diodes and Thyristors.
2. V-I static Characteristics of TRIAC and GTO.
3. Switching characteristics of MOSFET and IGBT.
4. Various triggering Methods and Protection Circuits of SCR.
5. Realization and analysis of single phase uncontrolled and controlled rectifier with R, RL Load & with and without freewheeling diodes.
6. Realization and analysis of three phase full controlled converter with R, RL & RLE Load
7. DC chopper circuits and waveforms analysis at steady state.
8. Operation of single phase full bridge inverter in Unipolar PWM and Bipolar PWM modes.
9. To operate a 3-Phase Inverter with SPWM technique.
10. Single phase AC voltage controllers (Analysis for different types of loads).

ELE356C Modeling and Simulation of Electrical Systems L=0, P=2

1. Review of the Simulation Software. Introduction to MATLAB/SCILAB. Introduction to different SIMULINK/XCOS blocks useful for Electrical Engineering.
2. Use of Simulation Software for analysis of DC circuits, ac circuits, resonance, DC and AC transient analysis.
3. Use of Simulation Software to analyze the power electronic converters: Choppers and inverters.
4. Use of Simulation Software for performance analysis of second order system in control system using P, PI, PID, Lead, Lag and Lead-Lag compensators.
5. To plot the V-I characteristics of a PV cell.
6. Simulation of a Wind Turbine.
7. To perform the Load Flow Analysis

ELE401C Electrical Drives L=3, T=1, P=0

Unit I

Definition of Electric Drive, Structure and Elements of an Electric Drive, classification of Electric Drives Advantages of Electrical Drives, Types of Loads, Quadrant Diagrams, Four quadrant operation, Power requirement of different loads, Drive specifications.

Unit II

Review of dc chopper and duty ratio control, chopper fed dc motor for speed control, steady state operation of a chopper fed drive, Motoring and regeneration operation of chopper-fed separately-excited DC Motor Drive, Chopper-fed series motor drive, dynamic braking, Composite braking, two quadrants and four quadrant operation of chopper-fed DC Motor Drives.

Unit III

Control structure of DC drive, inner current loop and outer speed loop, dynamic model of dc motor – dynamic equations and transfer functions, modeling of chopper as gain with switching delay, plant transfer function, for controller design, current controller specification design, speed controller specification and design.

Unit IV

Review of induction motor equivalent circuit and torque-speed characteristic, variation of torque-speed curve with (i) applied voltage, (ii) applied frequency and (iii) applied voltage and frequency, typical torque-speed curves of fan and pump loads, operating point, constant flux operation, flux weakening operation, static rotor resistance control of 3-phase slip ring Induction Motor, V/f control of induction motor, steady-state performance analysis based on equivalent circuit, speed drop with loading, slip regulation.

Unit V

Impact of rotor resistance of the induction motor torque-speed curve, operation of slip-ring induction motor with external rotor resistance, starting torque, power electronic based rotor side control of slip ring motor, slip power recovery. Control of synchronous Motor: Self-controlled synchronous motor, vector controlled synchronous motor, Drive for brushless DC motor & application in solar powered pump.

Books Recommended:

1. An Introduction to Electrical Drives by G.K. Dubey.
2. Power Semi-conductor controlled Drives by G.K. Dubey
3. Power Electronic Control of A.C Motors by Murphy & Turnbull
4. Power Electronics and A.C Drives by B.K. Bose
5. R. Krishnan, “Electric Motor Drives: Modeling, Analysis and Control”, Prentice Hall, 2001.
6. W. Leonhard, “Control of Electric Drives”, Springer Science & Business Media, 2001.

ELE402C Switchgear and Protection L=3, T=1, P=0

Unit I

Introduction to Protection System: Introduction to protection system and its elements, functions of protective relaying, protective zones, primary and backup protection, desirable qualities of protective relaying, basic terminology.

Electromagnetic Relays: Electromagnetic attracted and induction type relays, thermal relay, gas actuated relay, design considerations of electromagnetic relay.

Unit II

Relay Application and Characteristics of Different Electromagnetic relays: over current relays, directional relays, distance relays, differential relay

Static and Numerical Relays: Introduction to static relays, Amplitude and phase comparators, Duality between Amplitude and Phase Comparator, classification and their description, over current static relays, Comparison with electromagnetic relay, Basics of Numerical Relays. Hardware Block diagram, Advantages of Numerical Relays.

Unit III

Protection of Transmission Line and Feeders: Over current protection of radial feeders, Protection of Parallel and ring mains feeders, distance protection, pilot wire protection, carrier current protection, differential protection of bus-bar, High Impedance bus-bar protection, auto re-closing.

Unit IV

Transformer Protection: over current Protection, Percentage differential protection, inrush phenomenon, inter-turn faults, incipient faults, Phenomenon of over fluxing. REF protection, Buchholz Relay.

Generator Protection and motor: Failure of prime mover, Failure of field, over current, over speed, over voltage, Negative Phase Sequence Protection, stator winding faults (phase to ground, phase to phase, inter-turn fault between same phases). Motor abnormal operating condition due to failure of electrical supply and mechanical parts.

Unit V

Fuse: Fusing elements, classification of fuses, current carrying capacity of fuses, high rupturing capacity (HRC) cartridge fuses, characteristics of HRC fuses.

Circuit Breaker: Circuit Breaking: Properties of arc, arc extinction theories, re-striking voltage transient, current chopping, resistance switching, capacitive current interruption, short line

interruption, circuit breaker ratings, constructional features and operation of Bulk Oil, Minimum Oil, Air Blast, SF6, Vacuum and d. c. circuit breakers.

Books Recommended:

1. Art and Science of Protective Relaying by Mason.

2. Protective relaying, Principles and Applications by J. L Black Burn

3. Computer Relaying for Power Systems, by A.G. Phadke and J.S Thorp.

4. Power System Protection and Switchgear by B. Ravindra nath and M. Chander.

5. Power System Protection by Bhidhe and paithankar.

ELE403C Switchgear and Protection Lab L=0, P=2

List of Experiments:

1. To study inverse over current relay (electro mechanical type).
2. To study Percentage Differential Relay using Numerical Relay.
3. To study the instantaneous over and under voltage relay.
4. Operating quantity versus polarizing quantity characteristic of a directional attracted armature relay.
5. To study the earth fault relay and determine the characteristics.
6. Characteristics of inverse time over current relays.
7. Time graded protection using inverse time O/C relays.
8. Characteristics of fuses of different relays.
9. Study of circuit breakers.
10. Study of differential protection scheme of three phase transformer.
11. Study of an oil circuit breaker.
12. Study of gas actuated Buchholz relay for the protection of the transformer.
13. Current graded protection of feeders using static over current relay.

ECE462C Digital Signal Processing L=3, P=0

Signals and Systems: Basic elements of digital signal processing, concept of frequency in continuous time and discrete time, sampling theorem, discrete time signals, discrete time systems, analysis of LTI systems, convolution.

Z Transform: Z Transform, ROC of Z transform, properties of Z transform, inverse Z transform, convolution in Z domain, system function.

Structures for discrete time systems: Representation of DSP algorithms, block diagram representation, signal flow graph, data flow graph. FIR filter structures: direct form, transposed form, cascaded form, frequency sampling structures, transposition theorem. IIR filter structures: direct form, Direct Form I, Direct Form II, cascaded form, parallel form, lattice structures.

Filter Design Techniques: Design of discrete time IIR filters from continuous time filters, impulse variance, bilinear transformation. Design of FIR filters: windowing method, Kaiser window filter design method.

Fast Fourier Transform: Introduction to DFT, efficient computation of DFT, properties of DFT, FFT algorithms, radix 2, decimation in time, decimation in frequency algorithms, use of FFT algorithms in linear filtering and correlation.

List of recommended Text/Reference Books:

1. Mitra S. K., Digital Signal Processing: A Computer Based Approach, Tata McGraw Hill.
2. Proakis J. G. and Manolakis D. G., Digital Signal Processing: Principles, Algorithms and Applications, Prentice Hall.
3. Oppenheim A. V., Schafer R. W. and Buck J. R., Discrete Time Signal Processing, Pearson Education

DMS-CC-IM-01 Industrial Management and Economics of Marketing L=3, P=0

Unit I

Industry, concept and meaning of Industrialization, , Evolution of modern Industry, Industrial policy and progress after independence, application and scope of industrial management, productivity, definition meaning and measurement, recent trends in industrial engineering.

Unit II

Management Functions:
Principles of management, functions of management, Taylor's scientific management theory, Fayol's principles of management, production planning specification of production requirements,

Unit III

Introduction to economics, theory of demand and supply Theory of wealth maximization, inventory cost models, introduction to supply chain management, quality control, process control and control charts introduction to TQM.

Unit IV

Marketing environment, Strategic marketing planning, MIS, Decision making, new product development, environmental issues, environmental pollution (water, Air, solid waste), introduction to sustainable development.

Books Recommended:

1. WilIiam H. Shaw*, Business Ethics.*
2. MarlUelG. Valesquez, (1998). *Business Ethics,* Pearson Education.
3. Drucker P Panbooks (2000). *Managing in Turbulent times* London.
4. Boatright J. R, (1999) *Ethics and Conduct of Business* Pearson Education.
5. Enis,B.M. Marketing Classics: (1991). *A Selection of Influential Articles,* New York, McGraw Hill.
6. Kotler, Phillip and Armstrong, (1997). *G. Principles of Marketing,* New Delhi, Prentice Hall of India.
7. Ramaswamy,V.S and Namakumari,(2000). *S. Marketing Management Planning,* Control. New Delhi,

ECE-463C **Digital Signal Processing Lab** **L=0 P=2**

List of Experiments:

1. Realization of sampling theorem for a given CTS.
2. To find DFT/IDFT of given DT signal
3. Implementation of FFT of given sequence (Radix 2 and Radix 4)
4. Implementation of LP FIR filter for a given sequence
5. Implementation of HP FIR filter for a given sequence
6. Implementation of LP IIR filter for a given sequence
7. Implementation of HP IIR filter for a given sequence
8. Implementation of windowing techniques (Rectangular and Kaiser)

Discipline Centric Electives

ELE 350E Utilization of Electrical Energy L=3, P=0

Unit I

Electric Heating: Advantages and methods of electric heating, Resistance heating, Electric arc heating, Induction heating, Dielectric heating.

Unit II

Electric Welding: Electric Arc Welding Electric Resistance welding Electronic welding control Electrolyte Process: Principles of electro deposition, Laws of electrolysis, applications of electrolysis.

Unit III

Illumination: Various definitions, Laws of illumination, requirements of good lighting Design of indoor lighting and outdoor lighting systems Refrigeration and Air Conditioning: Refrigeration systems, domestic refrigerator, water cooler Types of air conditioning, Window air-conditioner.

Unit IV

Electric Traction – I Types of electric traction, systems of track electrification Traction mechanics- types of services, speed time curve and its simplification, average and schedule speeds Tractive effort, specific energy consumption, mechanics of train movement, coefficient of adhesion and its influence.

Unit V

Electric Traction – II Salient features of traction drives Series – parallel control of dc traction drives (bridge transition)and energy saving Power Electronic control of dc and ac traction drives Diesel electric traction

Book s Recommended:

1. Utilization Of Electric Energy, E Openshaw Taylor 12th Impression, 2009, Universities Press.
2. Modern Electric, Hybrid Electric and Fuel Cell Vehicles, E. Gay, Mehrdad, Ehsani, YiminGao, Sabastien. Ali Emadi, CRC Press.
3. Art & utilization of Electric Energy, H. Partab.
4. Utilization of Electric Power & Electric Traction J.B Gupta]
5. H. Partab, "Art and Science of Electrical Energy" DhanpatRai& Sons.

Reference Books:

1. H. Partab, " Modern Electric Traction" DhanpatRai& Sons.
2. C.L. Wadhwa, " Generation, Distribution and Utilization of Electrical Energy" New Age International Publications.

ELE351E Special Electrical Machines L=3, P=0

Unit I

Synchronous Reluctance Motors: Constructional features, Types, Axial and radial air gap motors – Operating principle, Reluctance, Phasor diagram, Characteristics, Vernier motor.

Unit II

Stepping Motors: Constructional features, Principle of operation, Variable reluctance motor, Hybrid motor, Single and multi stack configurations, Theory of torque predictions, Linear and nonlinear analysis, Characteristics, Drive circuits.

Unit III

Switched Reluctance Motors: 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: Principle of operation, Types, Magnetic circuit analysis, EMF and torque equations, Power controllers, Motor characteristics and control

Unit V

Permanent Magnet Synchronous Motors: Principle of operation, EMF and torque equations, Reactance, Phasor diagram, Power controllers, Converter, Volt-ampere requirements, Torque speed characteristics, Microprocessor based control.

Books Recommended:

1. T. Kenjo, Stepping Motors and Their Microprocessor Controls", Clarendon Press London, 1984.
2. T. Kenjo and S. Nagamori, Permanent Magnet and Brushless DC Motors", Clarendon Press, London, 1988.
3. T.J.E. Miller, Brushless Permanent Magnet and Reluctance Motor Drives", Clarendon Press, Oxford, 1989.
4. P.P. Aearnley, Stepping Motors – A Guide to Motor Theory and Practice", Peter Perengrinus, London, 1982.

ELE352E Computational Electromagnetics L=3, P=0

Fundamental Concepts: Review of Electromagnetic Theory, electrostatic fields, Magnetostatic fields, Time-varying fields, Boundary conditions, Wave equations, Time-Varying Potentials, Time harmonic Fields. Classification of Electromagnetic problems, classification of Solution regions, Differential Equations and Boundary Conditions.

Finite Difference (FD) Method: FD schemes for different PDE's, Accuracy and stability of FD solutions - FDTD (Finite-Difference Time-Domain) method, Practical Applications.

Finite Element Method (FEM): FEM in one and two dimensions, Nodal and edge elements, Galerkin's method and variational formulations, Application to microwave cavities, magnetostatics and eddy current problems.

Method of Moments (MoM): Integral formulation of electrostatics and Maxwell's equations, Green's functions and numerical integration, Application to capacitance calculation and electromagnetic scattering from a thin wire.

Books Recommended:

1. Computational Electromagnetics, Anders Bondeson, Thomas Rylander, Par Ingelstrom.
2. M. N. O. Sadiku, “Numerical Techniques in Electromagnetics”, CRC press, 2001.

ELE353E Sensors and Transducers L=3, P=0

Unit-I

Transducer – I: Definition, advantages of electrical transducers, classification, characteristics, factors affecting the choice of transducers, Potentiometers, Strain gauges, Resistance thermometer, Thermistors, Thermocouples, LVDT,RVDT

Unit-II

Transducer–II: Capacitive, Piezoelectric and Hall effect and opto-electronic transducers. Measurement of Motion, Force pressure, temperature, flow and liquid level.

Unit-III

Telemetry: General telemetry system, land line & radio frequency telemetering system, transmission channels and media, receiver & transmitter. Data Acquisition System: Analog data acquisition system, Digital data acquisition system, Modern digital data acquisition system.

Unit-IV

Display Devices and Recorders: Display devices, storage oscilloscope, spectrum analyzer, strip chart & x-y recorders, flux meters, magnetic tape & digital tape recorders.

Unit V

Recent Developments: Computer aided measurements, fiber-optic transducers, micro sensors, smart sensors, smart transmitters.

Books Recommended:

1. A. K. Sawhney, "Advanced Measurements & Instrumentation", Dhanpat Rai & Sons.
2. B.C. Nakra & K. Chaudhary, "Instrumentation, Measurement and Analysis", Tata McGraw Hill 2nd Edition.
3. Curtis Johns, "Process Control Instrumentation Technology", Prentice Hall.
4. E.O. Decblin, "Measurement System – Application & design", McGraw Hill.
5. W.D. Cooper and A.P. Beltried, "Electronics Instrumentation and Measurement Techniques" Prentice Hall International .
6. Rajendra Prasad,"Electronic Measurement and Instrumentation Khanna Publisher.
7. M.M.S. Anand, "Electronic Instruments and Instrumentation Technology" PHI International.

ELE401E Advanced Control Systems L=3, P=0

Unit I

Important concepts of Linear Algebra: Fields and Vector spaces, Linear independence and dependence, Basis and Dimension, Subspace, Orthonormalization, Linear Algebraic Equations, Similarity Transformation, Eigen values and Eigen vectors, Functions of a square matrix and Cayley-Hamilton theorem, lyapunov equation, Quadratic form and positive definiteness.

Unit-II

Mathematical description of systems: Casuality and Lumpedness, Linear Systems, Linear Time Invariant (LTI) systems, Input-output Description, Transfer function Matrix, State space equations, writing state space equations for circuits and mechanical systems; Controllable, Observable and Diagonal Canonical forms, Diagonalization, Realization: Conversion from transfer function to State variable model and vice-versa.

Unit III

Solution of state equations, Properties of state transition matrix, Computation of state transition matrix, Input-Output stability and Internal Stability of LTI systems, Lyapunov Stability, Concepts of Controllability, Observability, Stabilizability and Reachability.

Unit IV

Control System design using State variable methods, State variable feedback structure, Pole placement design using state feedback, Necessary and Sufficient conditions for arbitary pole placement, State Regulator design, Servo Design, Limitations of State Feedback, State feedback with Integral control,

Unit-V

Observers, Open loop observer and the Luenberger observer, Full order and reduced order observers, Compensator design using the Separation Principle, Observer-based state feedback control.

Books Recommended:

1. C.T. Chen, Linear System: Theory and Design
2. M.Gopal, Digital Control and State Variable Methods.
3. Stefani R., Savant C., Shahian B., Hostetter G., Design of Feedback Control Systems.

ELE402E Power Station Practice L=3, P=0

Unit I

Overview of different types of power stations and their auxiliaries: Thermal power plants, hydroelectric stations, nuclear power stations, diesel power stations, gas turbine plants. Power generation terms: Connected load, Maximum Demand, Demand Factor, Load factor, capacity factor, Diversity factor, Load duration curve, mass curve , base load and peak load plants, operating and spinning reserves, effect of voltage and frequency on loads, load forecasting.

Unit II

Economics of generation, effect of load factors and diversity factor on the generation cost, reduction of costs by interconnection of stations, choice in size of plant and size of units, load curve and selection of generating units, important points in the selection of units. Power factor, disadvantages of low power factor, methods of improving power factor, location of power factor improvement apparatus

Unit III

Tariffs in Electrical energy, factors influencing the rate of tariff, designing tariff, different types of tariff, flat rate tariff, block rate tariff, two part tariff, maximum demand tariff, power factor tariff.

Unit IV

Energy Problems: Energy use and development, Environmental problems, greenhouse problem, threat to international relations, energy use trends in developing countries as well as for India, future prospects of energy use, prospects of changes of energy supply, agenda for sustainable development.

Unit V

Introduction, classification of substations, equipment for substations, selection and location of site for substation, Comparison between Outdoor and Indoor Sub-stations Key diagram of typical substations, substation auxiliary supply, substation earthing.

Books Recommended:

1. Electric power stations by Car.

2. Electric power system control by H.P. Young.

3. Elements of Power Station design by M.V. Deshpande

4. Generation of Electrical Energy by B. R. Gupta.

ELE403E Power System Operation and Control L=3, P=0

Unit I:

Introduction: Basic Review of Physical Structure of power system, Operation and Control Functions and Hierarchies Design and Operating Criteria.

Unit II:

Optimal system operation: Optimal System Operation and Unit Commitment. Economic load dispatch studies, Development of loss formula for optimum load dispatch, Optimum power dispatches in hydrothermal power systems: short and long range scheduling.

Unit III:

Control of voltage and reactive power: Mechanism of real and reactive power control, AVR control, Governor Control, supplementary control, Single area and two area power system, tie-line power flows, Q-V and P-f control loops, Net interchange tie-line bias control.

Unit IV:

Power system security: Introduction, factors affecting power system security, Security analysis, Contingency Selection, Techniques for contingency evaluation-D.C. load flow and fast decoupled load flow.

Unit V:

Energy control centers and load dispatch centre: Energy Control Centers, load dispatch centers. Online computer control, SCADA, Data acquisition systems, Emergency control, Preventive control and Restorative Control.

Books Recommended:

1. R.N. Dhar: Computer Aided P.S Operation and Analysis.
2. D. P. Kothari, I. J. Nagrath: Modern Power System Analysis, TMH
3. Haadi Sadat: Power system Analysis, TMH, India.
4. K. R. Padiyar: HVDC Power Transmission System Technology and System Interaction; Wiley Eastern.
5. K. R. Padiyar: FACTS Controllers in Power Transmission and Distribution. New Age International, 2009.

ELE404E High Voltage Engineering L=3, P=0

Unit I

Causes of over voltages and their effects on power system – Lightning, switching and temporary over voltages – protection against over voltages – Insulation coordination.

Unit II

Gaseous breakdown in uniform and non-uniform fields – corona discharges –Vacuum breakdown – conduction and breakdown in pure and commercial liquids– breakdown mechanisms in solid and composite dielectrics.

Unit III

Generation of high DC voltages - multiplier circuits –Van de Graff generator – high alternating voltage generation using cascade transformers-production of high frequency AC high voltages-standard impulse wave shapes-Marx circuit generation of switching surges - impulse current generation-tripping and control of impulse generators.

Unit IV

HVDC measurement techniques – measurement of power frequency A.C voltages sphere gap measurement technique-potential divider for impulse voltage measurements – measurement of high D.C, A.C and impulse currents.

Unit V

Tests on insulators-testing of bushings-testing of isolators and circuit breakers cable testing-testing of transformers-surge diverter testing -radio interference measurement-use of I.S for testing.

Books Recommended

1 .High Voltage Engineering by M.S. Naidu and Kamaraju, Tata McGraw Hill.
2. High Voltage Engineering by C.L. Wadhwa, Wiley Eastern Limited.
3. High Voltage Engineering by E. Kuffel and M. Abdullah, Pergamon Press.
4. An Introduction to High Voltage Experimental Technique by Dieter Kind, Wiley Eastern Limited.

ELE450E Advanced Power Electronics L=3, P=0

Unit I

Switched -Mode Power Supplies (SMPS), Advantages of Switching Power Supplies over Linear Power Supplies, Non-Isolated DC-DC Converters: Buck, Boost, Buck boost, Cuk, SEPIC, Zeta, Power factor correction.

Unit II

Isolated DC-DC Converters; fly-back, forward, half bridge, push-pull and full bridge in CCM and DCM, Power factor correction at ac mains in these converters, their application in SMPS, UPS. Design aspects of Magnetics for DC-DC Converters,

Unit III

PWM Techniques for DC-DC Converter, Modeling and control of switched mode power converters, generalized state-space averaging, and feedback linearization techniques. Practical design procedures for type II and type III compensators with voltage-mode error-amplifier for DC/DC converters

Unit IV

DC-AC converters: Voltage Source Inverter: PWM techniques of voltage fed converters: Selective Harmonic Elimination (SHE), sine PWM, Third harmonic injection, Hysteresis Current Control, Space Vector Pulse Width Modulation: under modulation and over modulation and their implementation.

Unit V

Multi-level converters, Concept of multi-level, Topologies for multi-level: Diode Clamped, Flying capacitor and Cascaded H-bridge multilevel Converters configurations; Features and relative comparison of these configurations and applications, Pulse width modulation control in multi level converters.

Books Recommended:

1. Mohan, Undeland, Robbins, “Power Electronics Converters, Applications, and Design” Wiley, Indian Edition.
2. Bin Wu, “High Power Electronics Converters and ac drives” Wiley-IEEE Press, 2002
3. DG Holmes and T Lipo, “Pulse width modulation for power converters” Wiley-IEEE Press, 2002
4. Bimal K. Bose, “Power Electronics and Motor Drives: Advances and Trends”, Academic Press
5. IEEE Transactions on Power Electronics & Industrial Electronics.

ELE451E Digital Control Systems L=3, P=0

Unit-I

Basics of Digital Control Systems. Discrete representation of continuous systems. Digitization, Effect of Sampling. Sample and hold circuit. Mathematical Modeling of sample and hold circuit. Choice of sampling frequency.

Unit-II

Linear Difference Equations. z-Transform and Inverse z-Transform for analyzing discrete time systems. Pulse Transfer function. Pulse transfer function of closed loop systems.

Unit-III

Solution of Discrete time systems. Time response of discrete time systems. Stability analysis by Jury's test.

Unit-IV

State space models of discrete systems, Controllability and Observability analysis of discrete systems, Design of Discrete PID Controller, Design of Discrete time state feedback controllers.

Books Recommended

1. Franklin, Gene F., J. David Powell, and Michael L. Workman, ***Digital Control of Dynamic Systems***.
2. M Gopal, *Digital Control and State Variable Methods.*
3. K. Ogata, *Discrete Time Systems*

ELE452E Flexible AC Transmission Systems L=3, P=0

Unit I

Electrical transmission network – Need of transmission interconnections – power flow in AC systems – power flow and dynamic stability considerations – Relative importance of controllable parameters – Basic types of FACTS controllers Brief description & definitions – Benefits from FACTS technology.

Unit II

Introduction to shunt compensation – Objectives of Shunt compensation –Voltage control by SVC – VI characteristics – advantages of slope in dynamic characteristics – Influence of SVC on system voltage, SVC applications: Steady-state power transfer capacity – enhancement of transient stability – Prevention of voltage instability.

Unit III

Introduction to series compensation – Objectives of series compensation –Operation of TCSC: Different modes of operation – Modeling of TCSC: variable reactance model, Transient stability model – TCSC applications: Improvement of system stability limit –voltage collapse prevention. Basic concept of voltage source converters and current source converter. SSSC – principle of operation – Applications, advantage of SSSC over TCSC.

Unit IV

STATCOM – principle of operation –VI characteristics – Applications – UPFC: - Modes of operation – Applications — Comparison and advantages of SVC over STATCOM. Introduction to IPFC.

Unit V

Objectives of voltage and phase angle regulators — Approaches to thyristor controlled voltage and phase angle regulators – Industrial applications of FACTS devices- Case studies.

Books Recommended

1. Understanding FACTS–Concept &technology of flexible AC transmission systems byNarain G. Hingorani and Laszl Gyugyi Standard publishers distributors, IEEE press.

2. FACTS Controllers in Power Transmission and Distribution by K.R.Padiyar, New Age International (P) Limited New Delhi.

ELE453E EHV AC & DC Transmission L=3, P=0

Unit I

Introduction-Necessity for EHV Transmission, Problems and disadvantages involved in EHV Transmission, Operational aspects of EHV power transmission, Compensation in EHV transmission system- series, shunt and mixed compensation, Gas insulated EHV lines, Environmental and biological effects.

Unit II

Standard voltage levels for transmission lines, Selection of suitable voltage levels for transmission lines, Hierarchical levels of Transmission network, Average values of line parameters, Power handling capacity and line losses in EHV Transmission line, Number of circuits needed for an EHV Transmission line, Cost of transmission line and equipment, Mechanical consideration in line performance, Comparison of over head and underground lines.

Unit III

Transient stability of AC line- First swing stability, Coherency, power angle equation and multi machine stability, Power flow through an EHV line and transmission efficiency, Corona - factors effecting corona, Audible noise, Measurement formula for audible noise, Towers, Insulation coordination and Surge arrestor protection, Clearance and Creepage distances.

Unit IV

Comparison of AC and DC Transmission, Economics of DC power Transmission, Technical performance and reliability, Choice of HVDC Transmission system, Description of HVDC converter station, Types of HVDC links, Merits and limitations of HVDC system, Modern trends in HVDC Transmission.

Unit V

Pulse number, Choice of converter configuration, Simplified analysis of Graetz circuit, Principle of HVDC link control, DC breaker, Harmonic elimination, AC and DC filter design, over current and over voltage protection scheme in HVDC substation.

Books Recommended:

1. Begamudre. R.D,"Extra voltage AC Transmission Engineering", Third Edition, New Age International (P) Limited, Publisher, 2009.
2. Padiyar. K. R," HVDC Power Transmission System", New Age International (P) Limited, Publisher, 2009.
3. Chakrabarti.AM. L.Soni, P. V. Gupta, U. S. Bhatnagar," Power System Engineering", DhanpatRai and Co., 2010.
4. Sunil S. Rao," Switchgear Protection and Power Systems", Khanna Publishers, 2004.

ELE454E Electrical Energy Conservation and Auditing L=3, P=0

Unit- I

Introduction to Energy Conservation, Need for Energy Conservation, Energy Sources, Supply & Demand Overview of Electrical and Thermal Energy, difference between energy conservation and efficiency.

Unit-II

Policy & Regulations for Energy Conservation: Institutional Structure, Energy Conservation Policies & Legislations, National and International Programmes.

Green Buildings: Net Zero Carbon Buildings A Framework Definition, World Green Building Trends 2018 Smart Market Report, How can we make our buildings green?

Unit-III

Energy Conservation Opportunities: Electrical, Buildings & Lighting Systems, Motors Pumps, Transformers, Power Transmission & Distribution System.

Energy Conservation Opportunities – Thermal, Boilers Furnaces & Waste Heat Recovery Systems, Cogeneration Systems, HVAC.

Unit-IV

Energy Audit Basics: Definition and Objectives, Energy or process Flow diagram, Types of Energy Audit, major energy consuming equipment and systems, Duties of Energy Auditor & Manager, relevance of energy costs.

Unit-V

Energy Audit Procedure: Energy Audit Procedure, Energy Audit instruments, Energy Audit reporting formats, Energy audits for buildings, Energy audits for commercial buildings, Economic analysis.

Recommended Text/Reference Books:

1. B. R. Gupta,"Generation of Electrical Energy",S. Chand.
2. Dr. Sanjeev S.,UmeshR.,"Energy Management", Katson.
3. LC Witte, PS Schmidt and DR Brown: Industrial Energy Management and Utilization (Hemisphere Publishing Corporation, Washington, 1998).

Reference Books:

1. JL Threlkeld: Thermal Environmental Engineering, Second Edition (Prentice Hall,1970)
2. YP Abbi and Shashank Jain: Handbook on Energy Audit and Environment Management, (TERI Press, 2006)
3. WC Turner: Energy Management Handbook, Seventh Edition, (Fairmont Press Inc., 2007)
4. George Polimeros: Energy Cogeneration Handbook, (Industrial Press, Inc., New York, 1981)

Generic Electives

ELE 350G Renewable Energy Systems L=3, P=0

UNIT I

Historical development of energy demand and supply systems. Impact of fossil fuel based systems. Energy scenario – global and national; Renewable energy potential – global and national. Renewable energy.

Small Hydro Power - Resource assessment, Environmental restrictions, SHP schemes.

UNIT II

Solar Energy: Solar cell, principle and operation. Solar module & array, solar radiation, solar collectors – flat plate & concentrating collectors, solar water heaters & solar thermal power plants. Miscellaneous Applications.

UNIT III

Wind Energy: Wind electric generation systems – grid-connected systems. Comparison of performance. Economic performance. Development of wind farms, site selection, wake effect, performance indices.

Small WEGs – stand-alone and hybrid systems.

UNIT IV

Ocean-thermal energy conversion; Tidal energy conversion; Wave energy conversion; Geothermal energy conversion; MHD; Hydrogen and fuel cells.

UNIT V

Energy from Biomass – Biomass Resources, Biomass conversion Techniques – direct combustion pyrolysis, gasification, anaerobic digestion, bioethanol and biodiesel production.

Recommended Text / References:

1. T. Ackermann, “Wind Power in Power Systems”, John Wiley and Sons Ltd., 2005.
2. G. M. Masters, “Renewable and Efficient Electric Power Systems”, John Wiley and Sons, 2004.
3. S. P. Sukhatme, “Solar Energy: Principles of Thermal Collection and Storage”, McGraw Hill, 1984.
4. H. Siegfried and R. Waddington, “Grid integration of wind energy conversion systems” John Wiley and Sons Ltd., 2006.
5. G. N. Tiwari and M. K. Ghosal, “Renewable Energy Applications”, Narosa Publications, 2004.

6. J. A. Duffie and W. A. Beckman, “Solar Engineering of Thermal Processes”, John Wiley & Sons, 1991.
7. B. H. Khan, “Non Conventional Energy Sources” Tata McGraw-Hill Education Private Limited.

ELE 351G Fuzzy Logic and Artificial Neural Networks L=3, P=0

Unit I

Introduction to Fuzzy Logic Principles. Basic concepts of fuzzy set theory ,operations of fuzzy sets, properties of fuzzy sets, Crisp relations , Fuzzy relational equations ,operations on fuzzy relations, fuzzy systems, propositional logic , Inference , Predicate Logic , Inference in predicate logic , fuzzy logic principles , fuzzy quantifiers , fuzzy inference , fuzzy rule based systems .

Unit II

Advanced Fuzzy Logic Applications: Fuzzy logic controllers , principles , review of control systems theory ,various industrial applications of FLC adaptive fuzzy systems , fuzzy decision making ,Multi-objective decision making, fuzzy classification.

Unit III

Introduction to Artificial Neural Networks: Fundamentals of neural networks, model of an artificial neuron , neural network architectures Learning methods , Taxonomy of Neural network architectures , Standard back propagation algorithms, selection of various parameters, variations Applications of back propagation algorithms.

Unit IV

Other Ann Architectures: Associative memory , exponential BAM ,Associative memory for real coded pattern pairs, Applications of adaptive resonance theory, introduction, ART 1, ART2, applications. Neural networks based on competition, kohenen self organizing maps, learning vector quantization , counter propagation networks , industrial applications.

Unit V

Recent Advances**:** Fundamentals of genetic algorithms, genetic modeling, hybrid systems, integration of fuzzy logic, neural networks and genetic algorithms.

Recommended Books:

1. Neural Networks – James A Freeman and Davis Skapura, Pearson Education, 2002.
2. Neural Networks – Simon Hakins , Pearson Education
3. Neural Engineering by C. Eliasmith and CH. Anderson, PHI
4.Neural Networks and Fuzzy Logic System by Bart Kosko, PHI Publications.

ELE 352G Biomedical Engineering L=3, P=0

Unit I

Introduction to electrophysiology, action potential, transducers for biomedical.

Unit II

Heart and cardiovascular system ,blood pressure measurement, plethysmography ,heart lung machine ECG – Eindhoven 's law - 12 lead system ,cardiac pace maker ,defibrillator.

Unit III

EMG – introduction to nervous system and brain -EEG – Introduction to intensive care monitoring –patient monitoring instruments –organization of hospital for patient care monitoring.

Unit IV

Ultrasonic Lasers in medicine - X ray and radio isotopes – radio therapy equipment -safety and dosage, Renal physiology.

Unit V

Respiratory physiology, measurements in respiratory system , respiratory therapy equipments, instrumentation for sensory measurement and behavioural studies.

Books Recommended:

1. Hand book of Biomedical instrumentation By RS Khandpur, Tata McGrawHill , 2007.
2. Biomedical instrumentation and measurements By Leslie Cromwell, Fred J Weibell Erich A Pfeiffer , Pearson 2008.
3. Principles of Applied biomedical instrumentation , Geddes & Baker , 3rd edition John Wiley & Sons

ELE 353G Applied Linear Algebra L=3, P=0

Unit I

Fields, Vector spaces, Subspaces, Linear combinations and subspaces, Linear dependence and independence, Spanning Set and Basis, Finite dimensional spaces, Dimension.

Unit II

Gaussian elimination, Solving Ax = b for square systems by elimination, pivots, multipliers, back substitution, invertibility of A, Elementary and Permutation matrices, Row Reduced Form, LU and LDU Factorization, Gauss-Jordan method to find inverse of A, The Four Fundamental Subspaces associated with a matrix, Linear Transformations.

Unit III

Inner product, Euclidean Norm, Orthogonal Vectors, Orthogonal Subspaces, Projections, Projection onto a line, Projection onto a subspace, Projection Matrix, Orthogonal Bases and Orthonormalization by Gram-Schmidt, QR factorization. Properties of determinants, cofactor formula, applications to finding inv (A).

Unit IV

Eigen values and Eignevectors, Diagonalization of a Matrix, Characteristic equation, Cayley-Hamilton theorem, computing powers A^k and matrix exponentials to solve difference and differential equations.

Unit V

Symmetric matrices, positive definite matrices, tests for positive definiteness, real Eigen values and orthogonal eigenvectors, Linear transformations and change of basis, Singular Value Decomposition, orthonormal bases for Diagonalization.

Books Recommended:

1. Introduction to Linear Algebra by Gilbert Strang.
2. Linear Algebra: Step by Step: Kuldeep Singh.
3. Linear Algebra, Schaum's Outline Series..

ELE401G Optimization for Engineering Design L=3, P=0

Unit I

Introduction, Historical development, Engineering applications of optimization, Optimization problem formulation, Classification of Optimization Problems.

Unit II

Single Variable unconstrained optimization - Optimization criteria, bracketing methods – Exhaustive search method, Bounding phase method; Region Elimination methods – Fibonacci search method, Golden section search method; Gradient based methods – Newton Raphson method, Bisection method; Root finding using optimization technique.

Unit III

Multi variable unconstrained optimization- Optimality criteria; Unidirectional search, Direct search methods, Box's evolutionary optimization method, Coordinate Descent method, Powell's conjugate direction method; Gradient based methods, Cauchy's steepest descent method, Newton's method, Conjugate gradient method.

Unit IV

Constrained optimization, problem formulation, local and global mininma in constrained problems, Kuhn tucker Conditions; Transformation to unconstarined problems using Penalty functions, Linearised Search Techniques, Frank-Wolfe Method; Specialized Methods- Integer programming, Solving integer programming problems using Penalty function method and Branch and Bound method; Introduction to Geometric programming.

Unit V

Introduction to Genetic algorithms, Differences and similarities between Genetic algorithms and Traditional methods, GAs for Constrained Optimization; Introduction to Simulated Annealing.

Books Recommended:

1. Kalyanmoy Deb, “Optimization for Engineering design”, Prentice Hall, India.
2. Kalyanmoy Deb, “Multi objective optimization using Evolutionary algorithms”, John Wiley.
3. S. Rao , Optimization Techniques

ELE 402G Electric Hybrid Vehicles L=3, P=0

Unit I

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

Unit II

Hybrid and Electric Drive-trains: Basic concept of traction, introduction to various drive-train topologies, power flow control in drive-train topologies, fuel efficiency analysis. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles.

Unit III

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 IV

Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Analysis of various energy storage devices – Battery, Fuel Cell, Super, Flywheel - Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor and power electronics, selecting the energy storage technology, Communications, supporting subsystems.

Unit V

Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification, comparison and implementation issues of energy management strategies. Case Studies: Design of a Hybrid Electric Vehicle (HEV) and Battery Electric Vehicle (BEV).

Books Recommended:

1. M. Ehsani, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2005.
2. A. E. Fuhs, Hybrid Vehicles and the Future of Personal Transportation, CRC Press, 2009.
3. C. C. Chan and K. T. Chau, Modern Electric Vehicle Technology, Oxford Science Publication, 2001.
4. I. Husain, Electric and Hybrid Electric Vehicles, CRC Press, 2003

5. G. Lechner and H. Naunheimer, Automotive Transmissions: Fundamentals, Selection, Design and Application, Springer, 1999.
6. Gianfranco, Electric and Hybrid Vehicles: Power Sources, Models, Sustainability, Infrastructure And The Market, Pistoia Consultant, Rome, Italy, 2010.
7. M. H. Rashid, Power Electronics: Circuits, Devices and Applications, 3rd ed., Pearson, 2000.
8. V. R. Moorthi, Power Electronics: Devices, Circuits and Industrial Applications, Oxford University Press, 2007.
9. R. Krishnan, Electric motor drives: modeling, analysis, and control, Prentice Hall, 2001
10. P. C. Krause, O. Wasynczuk, S. D. Sudhoff, Analysis of electric machinery, IEEE Press, 1995.
11. L. Guzella, A. Sciarretta, Vehicle Propulsion Systems, Springer, 2007.

ELE 403G Virtual Instrumentation Lab L=0, P=2

Topics:

1. Introduction to Lab View , advantages , control panels and block diagram
2. Repetition and loops
3. Arrays ,function and indexing
4. Clusters
5. Plotting data
6. Structures
7. Strings and files I/O

List of experiments:

1. Add and multiply more than two numeric inputs.
2. Convert Celsius to Fahrenheit using VI lab .
3. Convert radians to degrees and degrees to radians using VI lab .
4. Perform various Boolean operations (AND, OR , NAND,NOR, XOR) using VI lab .
5. Split and input strings into two outputs with reference to a separating character. Find the length of the input string and reverse the strings?
6. Create a VI to compute full adder logic using half adder logic as sub VI.
7. Create a VI to find the roots of a quadratic equation using sub VI. Find both the values of the roots and the nature of the roots?
8. Create a VI to find the factorial of the given number using For loop and shift registers .
9. Create a VI to find the sum of first n natural numbers using a WHILE Loop with a feedback node.
10. Create a VI to find " ${}^{n}c_{r}$ and ${}^{n}p_{r}$ " of a given number using a For Loop.
11. Create a one dimensional (1D) numeric array using the Build Array functions which gets array elements from numeric controls.
12. Create a 1D numeric array from loops (For and While) using random numbers and obtain the reverse of the array.
13. Create a 2D numeric array (5*5) containing random numbers and find its transpose.
14. Build a VI to find the sum and product of array elements.
15. Build a VI to find the products of two matrix using matrix function.
16. Build a VI to find the rank of a matrix using matrix functions .
17. Create a VI to compare clusters and switch ON an LED in the output clusters , if the nth element of cluster 1 is greater than the nth element of the clusters 2.
18. Build an array of clusters controls in which each clusters consists of a numeric control and 1D numeric array (with 5 elements). This forms a database of marks of student. The numeric control indicates the roll number and the array indicates the test marks of five subjects . Build logic to modify the mark in a particular subject of a particular student. Input the roll number, subject in which mark is to be changed and the new marks. Display the change database on a separate array indicate.

19. Build a VI that generate 50 random numbers and plot it on a waveform chart using for and while loop. Accumulate the random numbers into an array and display it on waveform graph.
20. Build a VI to plot a circle in the XY graph using a For loop.
21. Create a VI to add or subtract two numbers . Use Case structures to switch between addition and subtraction.
22. Build a VI to create a seven segment LED display.
23. Build a VI to find the roots of a quadratic equation. Input the coefficient of x^2 ,x and constant as a, b and c respectively .Display the roots and the message if the roots are real or imaginary.
24. Build a VI to execute the following expression using stacked sequence structure: [(A+b)/[(A+b)*2]].
25. Build a VI to execute the expression shown in the above problem using the flat sequence structure .
26. Create a VI which consist of two string inputs .Find the length of each string input. Join the string concatenate string function . Find the length of the concatenate string.
27. Build a VI which gets a string input . Replace a particular word in the input string by a new word . Use the Replace substring function for this.
28. Use the Format into String function to combine a text with a number .
29. Build a VI to split numbers and words available in a string . Display the splitted numbers and words in separate arrays.
30. Build a VI which finds the numbers of occurrence of a particular string in an array of strings.

Books Recommended:

1. Virtual instrumentation using *LabView* by Jovitha Jerome

Annexure V

List and Syllabus of Open elective courses floated by the Department of Electrical Engineering.

List of Open Elective Courses

S. No.	Course Code	Course Title	Hours Per Week			Credits
			L	T	P	
1.	ELE001	Technology: What, Why and why not?	2	0	0	2
2.	ELE002	Introduction to Electrical Technology	2	0	0	2
3.	ELE003	Electricity in daily life	2	0	0	2

Note:

1. *Open electives are offered to the students of all Departments of the university other than the Department of Electrical Engineering.*
2. *The students of the Department of Electrical Engineering have to choose Open Electives offered by the departments other than the Department of Electrical Engineering.*

ELE001 Technology: What, why and why not? L=2, P=0

Brief history of technology; Introduction to Philosophy of technology and philosophy of science, the relationship between technology and science; Technological artifacts; Technological knowledge; Technological processes; Technology and the nature of humans; Ethics and aesthetics of technology; Design and technology; Ethical and Social Aspects of Technology.

Books Recommended:

1. Teaching about Technology, Marc J. De Vries.
2. Philosophy of Technology, Val Dusek.
3. A Companion to the Philosophy of Technology Edited by Jan Kyrre Berg Olsen, StigAndur Pedersen and Vincent F. Hendricks.

ELE002 Introduction to Electrical Technology L=2, P=0

Unit I

Introduction to DC circuits, Active and passive two terminal elements, Ohms law, Voltage-Currentrelations for resistor, inductor & capacitor, Kirchhoff's laws, Power, Energy.

Unit II

Sinusoids, Generation of AC, Average and RMS values, Introduction to three phase systems types of connections, Relationship between line and phase values, Generation, Transmission and Distribution of Electrical Energy.

Unit III

Working principle, construction and applications of DC machines and AC machines (1-phase transformers, single phase induction motors)

Unit IV

Symbols and sign conventions as mentioned in electricity rules, Safety measures in electrical system, Types of wiring: wiring accessories, staircase, fluorescent lamps & corridor wiring, Basic principles of earthing, Casing and capping. Wiring: Wiring of main distribution boards.

Unit V

Concept of measurement and measuring instruments, Types of electrical measuring instruments: Ammeters, Voltmeters, Wattmeters, Energy Meters, Recent trends: Electric vehicles, renewable power generation.

Books Recommended:

1. Electrical Engineering fundamentals by Deltoro, Prentice Hall India (PHI).
2. Basic Electrical Engineering by D.P. Kothari. and I. J. Nagrath Tata McGraw – Hill.
3. Basic Electrical and Electronics Engineering by S.K. Bhattacharya Pearson Education.

ELE003 Electricity in Daily Use L=2, P=0

Fundamental concepts: What is electricity, how is electricity produced, how is current produced, how is current and voltage measured, concept of resistance, basic DC circuits, Power in DC circuits, Series and Parallel connections, What is Alternating current, Alternating current circuits, Power in AC circuits.

Safety, Wiring and Earthing: Features of power supplied to domestic consumers, Symbols and sign conventions as in Electricity rules, safety measures in electrical circuits, Earthing and its utility, Typical wiring layout in a home, specifications of wires, plugs and sockets of different current ratings.

Features of various electrical equipment used by domestic consumers: Power rating and other features of Incandescent and CFL lamps, Domestic water pumps, Single phase transformers and Automatic voltage stabilizers, Inverters, Refrigerators, Televisions, Water heaters, Induction heaters, Rice cookers, Micro-wave ovens, Mixers and Grinders.

Electricity Tariff: Various Electrical Utility companies supplying power to consumers in the state, Measurement of power consumption by the consumer by the Utility, Significance of power usage agreement signed with the Utility, Tariff calculation and understanding the electricity bill.

Electrical energy conservation at home: Steps that can be taken to minimize electrical energy consumption in homes e.g., for lighting, cooking, heating and cooling etc. Choosing appliances which are energy efficient, star rating of appliances.

Text /Reference Books recommended:

1. Basic Electricity by Van Valkenburg
2. Basic Electricity – A self teaching guide by Charles W Ryan

Annexure VI

Syllabus for PhD/PG Courses Electrical Engineering, Batch 2018 Onwards

ELE 501E Linear Systems Theory L=4, P=0

Review of matrix algebra, state variable modeling of continuous and discrete time systems, linearization of state equations, solution of state equations of linear time-invariant and time-varying systems, Controllability and Observability of dynamical systems, Minimal realization of linear systems and canonical forms, Lyapunov's stability theory for linear dynamical systems, State Feedback controllers, Observer and Controller design.

Books Recommended:

1. Chi-Tsong Chen: Linear System Theory and Design, Oxford.
2. Thomas Kailath : Linear Systems, Prentice-Hall.

ELE502E Mathematical Methods in Control L=4, P=0

Linear Spaces – Vectors and Matrices, Transformations, Norms - Vector and Matrix norms, Matrix factorization, Eigen values and Eigenvectors and Applications, Singular Value Decomposition and its Applications, Projections, Least Square Solutions. Probability, Random Variables, Probability distribution and density functions, Joint density and Conditional distribution, Functions of random variables, Moments, characteristic functions, sequence of random variables, Correlation matrices and their properties, Random processes and their properties, Response of Linear systems to stochastic inputs, PSD theorem

Books Recommended:

1. G. Strang, "Introduction to Linear Algebra", 4 th Edition, Wellesley Cambridge Press, 2009.
2. Papoulis and Pillai, Probability, random variable and stochastic processes, Mcgraw Hill, 2002.
3. H. Stark and J.W. Woods, Probability and random processes with application to signal processing, Pearson Education Asia, 2002.
4. J A Gubner: Probability and Random processes.

ELE503E Model order Reduction L=4, P=0

Unit-I

Introduction to Model Order Reduction (MOR): Examples and sources of Large Systems - Circuits, Models obtained by discretization of Partial Differential Equations; The problem of MOR and its requirement; Mathematical formulation of MOR for LTI systems.

Unit-II

Classical Model Reduction Methods – Modal Approximation, Pade Approximation, Routh Approximants, Explicit Moment matching.

Unit-III

Modern Methods – Balancing based methods, methods based on implicit moment matching like Krylov based methods, Arnoldi and Lanczos Algorithms.

Unit-IV

Model order reduction for Nonlinear Systems – Mathematical formulation of MOR for nonlinear systems, Proper Orthogonal Decomposition, Discrete Emprical Interpolation Method, Trajectory Piece-wise Linear approximation.

Books Recommended

5. A. C. Antoulas, "Approximation of Large Scale Dynamical Systems", SIAM, 2005.
6. Related research papers.

ELE504E Optimal Control Theory L=4, P=0

Maximization of functionals of a single and several functions using calculus of variations, Constrained extremals, Euler-Lagrange Equation, Necessary conditions for optimal control, Pontryagin's minimum principle and state inequality constraints, Minimum time problems, Minimum control effort problems, Linear quadratic regulator problems, Riccati Equation, Singular intervals in optimal control problems, The principle of optimality, Application of the principle of optimality to decision making, Dynamic programming applied to routing problems, Solving optimal control problems using dynamic programming, Discrete linear regulator problem, Hamilton -Jacobi -Bellman Equation, Numerical Techniques to determine optimal trajectories.

Books Recommended:

1. M. Athans and P. L. Falb, Optimal Control: An Introduction to the Theory and Its Applications, Dover Books on Engineering, 2006.
2. D. S. Naidu, "Optimal Control Systems", CRC Press, 2002.
3. D. Liberzon, "Calculus Of Variations and Optimal Control Theory: A Concise Introduction", Princeton University Press, Dec 2011.
4. Frank L. Lewis, DragunaVrabie, Vassilis L. Syrmos, Optimal Control, 3rd Edition, Wiley, 2012.

ELE505E Pulse Width Modulation For Voltage Source Converter L=4, P=0

Unit I

Electronic switches, single phase and three phase 2-level VSI, H-bridge, multilevel converters – diode clamp, flying capacitor and cascaded- H-bridge converters; voltage source and current source converters, overview of applications of voltage source converters.

Unit II

Purpose of pulse width modulation (PWM);Review of Fourier series, fundamental and harmonic voltages; machine model for harmonic voltages; undesirable effects of harmonic voltages – line current distortion, increased losses, pulsating torque in motor drives; control of fundamental voltage; mitigation of harmonics and their adverse effects. Square wave operation of voltage source inverter, PWM with a few switching angles per quarter cycle, equal voltage contours, Symmetries in waveforms.

Unit III

PWM for 2-level VSI, Triangle-comparison based PWM, Sine-triangle modulation, Third harmonic injection PWM (THIPWM), Bus-clamping PWM, Pulse width modulation (PWM) at low switching frequency, THD optimized PWM, Selective harmonic elimination and Selective harmonic mitigation, Requirement of dead-time, effect of dead-time on line voltages.

Unit IV

Space vector based PWM: Space vector concept and transformation, per-phase methods from a space vector perspective, space vector based modulation, conventional space vector PWM, bus-clamping PWM, advanced PWM, triangle comparison approach versus space vector approach to PWM, influence of PWM techniques on switching loss.

Unit V

PWM for multilevel inverter: Extensions of sine-triangle PWM to multilevel inverters, voltage space vectors, space vector based PWM, analysis of line current ripple and torque ripple, Selective harmonic elimination and Selective harmonic mitigation.

Books Recommended:

1. D. Grahame Holmes, Thomas A. Lipo, “Pulse Width Modulation for Power Converters: Principles and Practice”, Wiley-IEEE Press, 2003.
2. Haitham Abu-Rub, AtifIqbal, J. Guzinski, “High Performance Control of AC Drives with Matlab/Simulink”, Wiley, 2nd Edition.
3. M.H Rashid, “Power Electronics Handbook”, Elsevier, 4th Edition, 2018.
4. Power Electronics related Journals

ELE506E Renewable Energy and Smart Grid L=3, P=0

Renewable Energy and Energy Storage Systems

Solar Energy: solar photovoltaic and thermal systems, Wind: current status, types, measuring instruments, potential assessment, Biomass: gasification, anaerobic and aerobic decomposition, fermentation and incineration and Energy from waste, Different modes of energy storage, Technology Types– Mechanical energy storage: flywheels, compressed air, and pumped hydro; Electrical and Magnetic Energy storage: Batteries, Capacitors, electromagnets, Chemical energy storage,

Smart Grid:

Introduction Indian smart grid policy. Basic concept and definition of smart grid. Smart grid architecture. Smart grid technologies. Properties of smart grid: flexibility, reliability, demand response and other performance parameters. Application of smart grid Challenges being faced during implementation of smart grid. virtual power plants, Smart Utilities (case studies), Smart Grid Maturity Model (SGMM). DC smart micro grids.

Smart meters and IoT:

Introduction, technology, data management, energy monitoring, smart energy meter, Phasor Measurement Unit (PMU), smart metering infrastructure, data acquisition, IoT for power systems Internet of things for electricity infrastructure and energy management. SCADA, Demand response, AMI, IoT aided smart grid, Big data for power system and introduction to data analytics.

Books Recommended:

1. James Momoh, “Smart Grid: Fundamentals of design and analysis”, John Wiley & sons Inc, IEEE press 2012.
2. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, “Smart Grid: Technology and Applications”, John Wiley & sons inc, 2015.
3. Fereidoon P. Sioshansi, “Smart Grid: Integrating Renewable, Distributed & Efficient Energy”, Academic Press, 2012. Clark W.Gellings, “The smart grid: Enabling energy efficiency and demand response”, Fairmont Press Inc, 2009. Suggested reading
4. Renewable Energy Engineering and Technology – A Knowledge Compendium, ed. VVN Kishore (TERI Press, 2008).

ELE507E Nonlinear Control Systems L=4, P=0

Unit-I

Introduction to nonlinear systems: Types of non-linearities, peculiar properties of nonlinear systems, motivations for studying nonlinear control systems.

Unit-II

Phase plane analysis, Concept and construction of phase portraits, Phase plane analysis of linear and nonlinear systems, Existence of limit cycles.

Unit-III

Describing function method and applications, Describing functions of common nonlinearities, describing function analysis of nonlinear systems.

Unit-IV

Stability of nonlinear systems: Equilibrium points, Concept of stability of nonlinear systems, Linearization and Local stability, Lyapunov's direct method, Lyapunov's analysis of LTI systems

Unit-V

Nonlinear Control System design, Control design based on Lyapunov's direct method, Feedback Linearization, Basic concepts of sliding mode control.

Books Recommended:

a) J. J. E. Slotine and W. Li, Applied nonlinear systems, Prentice Hall, 1991.
b) H. K. Khalil, Nonlinear systems, 3rd edition, Prentice Hall, 2001.
c) M. Vidyasagar, Nonlinear Systems Analysis, Society for Industrial and Applied Mathematics, 2002.

ELE508E Power System Dynamics and Control L=4, P=0

Unit I

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 II

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. Analysis using Numerical Integration Techniques. Issues in Modeling: Slow and Fast Transients, Stiff System.

Unit III

Modeling of Synchronous Machines and Associated Controllers (12 hours) 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 IV

Modeling of other Power System Components (10 hours) 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 V

Stability Analysis (11 hours) Angular stability analysis in Single Machine Infinite Bus System. Angular Stability in multi-machine systems – Intra-plant, Local and Inter-area modes. Frequency Stability: Centre of Inertia Motion. Load Sharing: Governor droop. 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.

Books Recommended:

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.

ELE509E Advanced Electrical Drives L=4, P=0

Unit I

Review of Conventional Drives: speed –torque relation, Steady state stability, methods of speed control, braking for DC motor – Multi quadrant operation, Speed torque relation of AC motors, Methods of speed control and braking for Induction motor, Synchronous motor. Criteria for selection of motor for drives.

Unit II

Converter Control of DC Drives: Analysis of series and separately excited DC motor with single phase and three phase converters operating in different modes and configurations. Chopper Control of DC Drives: Analysis of series and separately excited DC motors fed from different choppers for both time ratio control and current limit control, four quadrant control.

Unit III

Design of DC Drives: Single quadrant variable speed chopper fed DC drives, Four quadrant variable speed chopper fed DC Drives, Single phase/ three phase converter, Dual converter fed DC Drive, current loop control, Armature current reversal, Field current control, Different controllers and firing circuits, simulation.

Unit IV

Inverter fed AC Drives: Analysis of different AC motor with single phase and three phase inverters Operations in different modes and configurations, Problems and strategies. Cyclo-converter fed AC Drives: Analysis of different AC motor with single phase and three phase cyclo-converters Operations in different modes and configurations, Problems and strategies, Vector Control and Rotor side Control.

Unit V

AC Voltage controller fed AC Drives: Speed Control and braking, Operations in different modes and configurations, Control and estimation o AC drives: Induction motor: scalar control, FOC control, DTC, adaptive control, Problems and strategies.

Books Recommended:

1. Bimal.K. Bose, “Power Electronics and Variable frequency drives”, Standard Publishers Distributors, New Delhi, 2000
2. R. Krishnan, “Electric motor drives: modeling, analysis and control, Pearson.
3. Murphy J.M.D, Turnbull, F.G, “Thyristor control of AC motor, Pergamon press, Oxford, 1988.
4. M. H. Rashid, "Power Electronics - Circuits, Devices and Applications", P.H.I Private Ltd. New Delhi, Second Edition, 1994
5. N. Mohan et.al. "Power Electronics- Converters, Applications and Design", John Wiley & Sons (Asia) Private Ltd., Singapore, 1996Bimal K Bose, “ Modern Power Electronics and AC Drives” PHI.

ELE510E Electrical Energy Conservation L=3, P=0

Energy Conservation

Energy conservation Act; Energy Conservation: Basic concept, energy conservation in Household, Transportation, Agricultural, service and Industrial sectors, Lighting, Heating Ventilation & Air Conditioning. Tariffs and Power factor improvement in power system, Demand Side management concept, Energy Efficient Practices and Technologies.

Building and Energy

Role of building design and building services to evaluate the energy performance in buildings.Study of Climate and its influence in building design for energy requirement, Principles of energy conscious design of buildings, Building Envelope, Orientation, Building Configuration, Passive Cooling, Basic Principles of Daylighting.

Green Buildings: Net Zero Carbon Buildings A Framework Definition, World Green Building Trends, SmartMarket Report, How can we make our buildings green?

Energy Policy and Regulation

Assessment of International Energy Policy & Regulatory Aspects; Indian Power Sector – Generation, Transmission and Distribution, Energy Markets & Power Exchange; Indian Electricity Regulations and Acts, Electricity Act 2003, Rural Electrification Policies; CERC – Regulations, Orders, Tariff Guidelines.

Books Recommended:

1. Fereidoon P. Sioshansi, "Smart Grid: Integrating Renewable, Distributed & Efficient Energy", Academic Press, 2012. Clark W.Gellings, "The smart grid: Enabling energy efficiency and demand response", Fairmont Press Inc, 2009. Suggested reading.
2. Renewable Energy Engineering and Technology – A Knowledge Compendium, ed. VVN Kishore (TERI Press, 2008).
3. Sumper Andreas and Baggini Angelo: Electrical Energy Efficiency: Technologies and Applications (John Wiley 2012).
4. Frank Kreith: Handbook on Energy Efficiency and Renewable Energy (CRC Press, 2007).
5. Krishnan, A., Baker, N., Yannas, S., Szokolay, S., (Eds) 2001. Climate Responsive Architecture- A Design Handbook for Energy Efficient Buildings, Tata McGraw-Hill, New Delhi

Annexure VI

Evaluation Mechanism for Practical Courses, Projects (Minor and Major) and Industrial Training

a) Practical Courses

a.i. Attendance - 10 marks
a.ii. Continuous assessment throughout the semester consisting preferrrably of a viva and report evaluation after each experiment is performed – 40 marks
a.iii. Major Exam – 50 marks, consisting of:
    a.i. Viva-voce - 20 marks
    a.ii. Performing a particular practical/simulation during the exam alongwith report writing for the same – 30 marks

b) Projects (Minor)

1. Marks to be given by concerned Project supervisor(s) - 20
2. The following would be evaluated by a duly constituted departmental committee
    7. Preliminary presentation (held at the beginning of the semester) – 20 marks
    8. Final Presentation which would include demonstration of model/simulation (if any) – 30 marks
    9. Final Viva-voce – 20 marks
    10. Report – 10 marks

c) Projects (Major)

1. Marks to be given by concerned Project supervisor(s) – 20
2. Preliminary presentation to be evaluated by a duly constituted departmental committee and held at the beginning of the semester – 20 marks
3. The following would be evaluated by the External examiner
    - Final Presentation which would include demonstration of model/simulation (if any) – 30 marks
    - Final Viva-voce – 20 marks
    - Report – 10 marks

d) Industrial training

The evaluation would be done by a duly constituted departmental committee and would preferably be spaced throughout the semester. The division of marks would be as follows:

1. Presentation – 50 marks
2. Report – 20 marks
3. Viva-voce – 30 marks.