MOM II MEETING UDAC ONLINE HELD ON 02122020.pdf

SCHEME EE 2019-20.pdf

Syllabus EE 2019-20.pdf

Department of Electrical Engineering

Scheme & Syllabus

of

Bachelor of Technology

Electrical Engineering

From III to VIII Semester

Effective from Academic session 18-19

for B.Tech.- EE (Effective for student admitted in first year in 19-20)

University Teaching Departments

Rajasthan Technical University, Kota

Approved
Dean, FA & UD

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Resolution: The Agenda was approved by the respected members.

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

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

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

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

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Dean, FA & UD

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

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

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

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

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

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

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

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

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

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

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

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Dean, FA & UD

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

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

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

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

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

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

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

Agenda 6: To approve BOS of HEAS department.

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Approved
Dean, FA & UD

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

Resolution: The Agenda was approved by the respected members.

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

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

Members are requested to approve.

Resolution: The Agenda was approved by the respected members.

Reporting Item:

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

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

Resolution: The Agenda was approved by the respected members.

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Dean, FA & UD

The meeting ended with a vote of thanks to The Chair

Dr Vikas Bansal
Member Secretary, UDAC)

Prof Anil Mathur
Chairman, UDAC

Copy to:

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

Dr Vikas Bansal
Member Secretary, UDAC)

Prof Anil Mathur
Chairman, UDAC

Department of Electrical Engineering
Rajasthan Technical University, Kota (Raj) – 324010.

No. RTU/EED/

Date: 20/10/2020

Office Order

Sub: Meeting of BOS(UD) (Electrical Engineering)

Agenda: To discuss and approve the Scheme and syllabus for BTech (Electrical Engineering) (UD) (2018-19 admitted and 2019-20 admitted Batches)

The meeting of BOS(UD) (Electrical Engineering) will be held as per following schedule to discuss the Agenda as mentioned above. All the respected members are requested to kindly make it convenient to attend the meeting and contribute.

Date and Time	20/10/2020, Tuesday 10.30 AM
Venue	HOD (Electrical Engineering) Chamber

20/10/2020

(Dr. S. R. Kapoor)

HOD, EED

Copy to:

1. Prof. D. Birla
2. Prof. A. Bhargava
3. Prof. D. K. Palwalia
4. Dr. D. K. Sambariya

20.7.2020

20/10/2020

20/10/2020

Approved
Dean, FA & UD

Department of Electrical Engineering
Rajasthan Technical University, Kota (Raj) – 324010.

No. RTU/EED/ Date: 20/10/2020

Minutes of Meeting of the Board of Studies (BOS) (UD), Electrical Engineering held on 20/10/2020)

The meeting of the Board of Studies (BOS) (UD), Electrical Engineering held on 25/7/2020 in the chamber of HOD, Electrical Engineering at 10.30 AM to discuss and approve the Scheme and syllabus for BTech (Electrical Engineering) (2018-19 admitted and 2019-20 admitted Batches).

Following were present:

1. Prof. Dinesh Birla
2. Prof. A Bhargava
3. Prof. D. K. Palwalia
4. Dr. D. K. Sambariya
5. Dr. S. R. Kapoor

Following points were resolved:

1. The scheme and syllabus of BTech (Electrical Engineering) (2018-19 admitted and 2019-20 admitted Batches) (UD) was modified and is approved as per the enclosed annexure. Any changes, if any, shall be discussed in the next meeting of BOS (UD).
2. The MOOC courses of credits 4 (12 – 16 weeks) and credit 3 (8 – 10 weeks) are approved to be introduced in 7th Sem and 8th Sem respectively. This decision is approved as follow up of the MOM meeting (Online) of Head of Departments, RTU, Kota on 02/09/2020 and 05/09/2020.
3. Following site/platform are approved ~~to be introduced~~ for MOOC courses in 7th Sem and 8th Sem respectively.

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

Some other platforms for MOOC courses, if deemed necessary, shall be approved by the BOS at a later stage.

This decision is approved as follow up of the MOM meeting (Online) of Head of Departments, RTU, Kota on 02/09/2020 and 05/09/2020.

4. The BOS EED (UD) will finalise the list of approved MOOC courses almost two months from the starting of the respective semester

20/10/2020
(Prof. D. Birla)

20/10/2020
(Prof. A Bhargava)

20/10/2020
(Prof. D. K. Palwalia)

20.X.2020
(Dr. D. K. Sambariya)

20/10/2020
(Dr. S. R. Kapoor)

Approved
Dean, FA & UD

Department of Electrical Engineering
Rajasthan Technical University Kota

Scheme
(session 2019-20 admitted batch)

Semester- III

Course Name	Type of Course	Course Code	Max. Marks			Contact Hours per Week				Credits
			IA	TE	SUM	L	T	P	SUM	
Advanced Engg. Mathematics	DSC	3EEU01	50	100	150	3	1	0	4	4
Electronic Devices & Circuits	DCC	3EEU02	50	100	150	3	0	0	3	3
Transformer and Asynchronous Machines	DCC	3EEU03	50	100	150	3	0	0	3	3
Circuit Analysis	DCC	3EEU04	50	100	150	3	0	0	3	3
Digital Electronics	DCC	3EEU05	50	100	150	3	0	0	3	3
Generation of Electrical Power	DEC	3EEU06	50	100	150	3	0	0	3	3
Electronic Devices Lab	DCC	3EEU11	50	25	75	0	0	2	2	1
Electrical AC Machine Lab	DCC	3EEU12	50	25	75	0	0	2	2	1
Digital Electronics Lab	DCC	3EEU13	35	15	50	0	0	2	2	1
Electrical Circuits &Programming Lab	DCC	3EEU14	35	15	50	0	0	2	2	1
Humanities & Social Sciences	HSMC	3EEU15	35	15	50	0	0	2	2	1
Discipline & Extra Curricular Activity		3EEU20			50	0	0	0	0	1
Sub Total					**1250**	**18**	**1**	**10**	**29**	**25**

IA- Internal Assessment, TE- Term Examination, L- Lecture, T- Tutorial, P- Practical

20/10/2020

20/10/2020

Anil K. Mathur

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Dean, FA & UD

Department of Electrical Engineering
Rajasthan Technical University Kota

Semester- IV

Course Name	Type of Course	Course Code	Max. Marks			Contact Hours per Week				Credits
			IA	TE	SUM	L	T	P	SUM	
Advanced Engineering Mathematics-II	DSC	4EEU01	50	100	150	3	1	0	4	4
Analog Electronics	DCC	4EEU02	50	100	150	3	0	0	3	3
Network Analysis and Synthesis	DCC	4EEU03	50	100	150	3	0	0	3	3
Electrical Measurements	DEC	4EEU04	50	100	150	2	0	0	2	2
Transmission and Distribution of Electrical Power	DCC	4EEU05	50	100	150	3	0	0	3	3
Electrical Machines	DCC	4EEU06	50	100	150	3	1	0	4	4
Analog Electronics Lab	DCC	4EEU07	50	25	75	0	0	2	2	1
Electrical Measurement Lab	DEC	4EEU08	50	25	75	0	0	2	2	1
Power System Design Lab	DCC	4EEU09	50	25	75	0	0	2	2	1
Electrical Machines Lab	DCC	4EEU10	50	25	75	0	0	3	3	2
Discipline & Extra Curricular Activity		4EEU20			50	0	0	0	0	1
Sub Total					**1250**	**17**	**2**	**9**	**28**	**25**

Approved
Dean, FA & UD

Department of Electrical Engineering
Rajasthan Technical University Kota

Semester- V

Course Name	Type of Course	Course Code	Max. Marks			Contact Hours per Week				Credits
			IA	TE	SUM	L	T	P	SUM	
Power Electronics	DCC	5EEU1	50	100	150	3	1	0	4	4
Microprocessors and Microcontrollers	DCC	5EE02	50	100	150	3	0	0	3	3
Control System	DCC	5EEU3	50	100	150	3	0	0	3	3
Utilization of Electric Power	DCC	5EEU4	50	100	150	3	0	0	3	3
Elective –I 1. EMFT 2. Restructured Power Systems	DEC	5EEU5.x	50	100	150	3	0	0	3	3
Elective -II 1. Optimization Techniques 2. High Voltage Engineering	DEC	5EEU6.x	50	100	150	3	1	0	4	2
Power Electronics Lab	DCC	5EEU11	50	25	75	0	0	3	3	2
Micro-processor Lab	DCC	5EEU12	50	25	75	0	0	3	3	2
System Simulation Lab		5EEU13	50	25	75	0	0	2	2	1
Professional Ethics and Disaster management Lab		5EEU14	50	25	75	0	0	2	2	1
Discipline & Extra Curricular Activity		5EEU20			50	0	0	0	0	1
Sub Total					**1250**	**18**	**1**	**10**	**29**	**25**

IA- Internal Assessment, TE- Term Examination, L- Lecture, T- Tutorial, P- Practical

20/10/2020

20/10/2020

20/10/2020

Approved
Dean, FA & UD

Department of Electrical Engineering
Rajasthan Technical University Kota

Semester- VI

Course Name	Type of Course	Course Code	Max. Marks			Contact Hours per Week				Credits
			IA	TE	SUM	L	T	P	SUM	
Modern Control theory	DCC	6EEU1	50	100	150	3	1	0	4	4
Computer Aided Design of Electrical Machines	DCC	6EEU2	50	100	150	3	1	0	3	4
Switchgear & Protection	DCC	6EEU3	50	100	150	3	0	0	3	3
Advanced Power Electronics	DCC	6EEU4	50	100	150	3	0	0	3	3
1. Smart Grid Technology 2. Power Quality	DEC	6EEU5.x	50	100	150	3	0	0	3	3
1. Power System Planning 2. Power System instrumentation	DEC	6EEU6.x	50	100	150	2	0	0	2	2
Advance Power Electronics Lab	DCC	6EEU11	50	25	75	0	0	3	3	2
Control Systems Lab	DCC	6EEU12	50	25	75	0	0	3	3	2
Power System Protection Lab	DCC	6EEU13	50	25	75	0	0	2	2	1
Entrepreneurship Development	DCC	6EEU14	50	25	75	0	0	2	2	1
Discipline &Extra Curricular Activity		6EEU20			50	0	0	0	0	1
Sub Total					**1250**	**17**	**2**	**10**	**29**	**26**

IA- Internal Assessment, TE- Term Examination, L- Lecture, T- Tutorial, P- Practical

Anil K. Mathur

Approved
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Department of Electrical Engineering
Rajasthan Technical University Kota

Semester- VII

Course Name	Type of Course	Course Code	Max. Marks			Contact Hours per Week				Credits
			IA	TE	SUM	L	T	P	SUM	
Power System Analysis	DCC	7EEU1	50	100	150	3	1	0	4	4
Economic Operation of Power System	DCC	7EEU2	50	100	150	3	1	0	4	4
Power System Engineering	DCC	7EEU3	50	100	150	3	0	0	3	3
Electric Drives and Control	DCC	7EEU4	50	100	150	3	0	0	3	3
1. HVdc Transmission Systems 2. Line Commutated and Active Rectifiers 3. Digital Control Systems	DEC	7EEU5.X	50	100	150	3	0	0	3	3
MOOC COURSE	IEC	7EEU6.X								4
Power System Modelling and Simulation Lab	DCC	7EEU11	50	25	75	0	0	3	3	2
Electric Drives and Control Lab	DCC	7EEU12	50	25	75	0	0	2	2	1
Industrial Economics and Management	DCC	7EEU13	50	25	75	0	0	2	2	1
Practical Training and Industrial Visit	DCC	7EEU14	150	75	225	0	0	4	4	4
Discipline & Extra Curricular Activity		7EEU20	50		50	0	0	0	0	1
Sub Total					**1250**	**15**	**2**	**11**	**28**	**30**

IA- Internal Assessment, TE- Term Examination, L- Lecture, T- Tutorial, P- Practical.

20/10/2020

20/10/2020

Approved
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Department of Electrical Engineering
Rajasthan Technical University Kota

Semester- VIII

Course Name	Type of Course	Course Code	Max. Marks			Contact Hours per Week				Credits
			IA	TE	SUM	L	T	P	SUM	
1. Artificial Intelligence 2. Machine Learning 3. Soft Computing Techniques	DEC	8EEU1.X	50	100	150	3	0	0	3	3
1. FACTS Devices and their Applications 2. Wind and Solar Energy Systems 3. Electrical Energy Conservation and Auditing	DEC	8EEU2.X	50	100	150	3	0	0	3	3
1. Industrial Electrical System 2. Electrical and Hybrid Vehicles 3. Power System Dynamics and Control	DEC	8EEU3.X	50	100	150	3	0	0	3	3
MOOC CORSE	IEC	8EEU4.X								3
SEMINAR	DCC	8EEU9	150	75	225	0	0	4	4	4
PROJECT	DCC	8EEU10	350	175	525	0	0	18	18	12
Discipline &Extra-Curricular Activity		8EEU12	50		50					1
Sub Total					1250	9	0	22	31	29

IA- Internal Assessment, TE- Term Examination, L- Lecture, T- Tutorial, P- Practical

Approved
Dean, FA & UD

3EEU01	Advance Engineering Mathematics- I	3L:1T:0P	4 credits

S.No.	CONTENTS	CONTACT HOURS
1.	**Laplace Transform** Definition and existence of Laplace transform, properties and formulae, unit step function, Dirac Delta function, Heaviside function, inverse Laplace transform, Convolution theorem, application of Laplace transform to ordinary differential equation, solution of integral equations.	10
2.	**Fourier Transform** Fourier Complex, Sine and Cosine transform, properties and formulae, inverse Fourier transforms, Convolution theorem, application of Fourier transforms to partial ordinary differential equation (One dimensional heat and wave equations).	10
3.	**Z-Transform:** Definition, properties and formulae, Convolution theorem, inverse Z-transform, application of Z-transform to difference equation .	5
4.	**Numerical Analysis:** Interpolation, difference operators- forward, backward, central, shift and average operators, Newton's forward and backward interpolation formulae, Gauss's forward and backward interpolation formulae, Stirling's formula, Lagrange interpolation formula for unequal intervals. Inverse interpolation. Numerical differentiation by Newton's, Gauss's and Stirling's formula. Numerical integration: Trapezoidal Rule, Simpson's 1/3 and 3/8 Rule. Numerical solution of ODE of first order: Picard's method, Euler's method, Modified Euler's method, Runge-Kutta forth order method, Milne's Method	15

TEXT BOOKS:

1. *Advanced Engineering Mathematics*, Jain and Iyengar, Narosa Publications.
2. *Engineering Mathematics for semesters III and IV*, C.B. Gupta, Mc Graw Hill Education, India.
3. *Advanced Engineering Mathematics*, Denis Zill and Warren Wright, Jones & Bartlett India Private Limited.
4. *Advanced Engineering Mathematics,* O'neil, Cengage Learning, India.

REFERENCE:

1. *Advanced Engineering Mathematics*, Irvin Kreyszig, Wiley, India.
2. *Advanced Engineering Mathematics*, M. Greenberg, Pearson Education, India.
3. *Advance Engineering Mathematics*, Potter, Oxford, India.
4. *Engineering Mathematics*, Pal and Bhunia, Oxford, India.
5. *Higher Engineering Mathematics*, B. V. Ramana, Mc Graw Hill Education, India.
6. *Numerical Methods for Scientific & Engineering Computation*, Jain and Iyengar, Jain, New Age International Publication, India.
7. *A First Course in Numerical Methods*, Uri M Asher and Chen Greif, SIAM Publication, India.
8. *Introductory Methods of Numerical Analysis*, S. S. Sastry, PHI Lerning, India.
9. *Numerical Methods for Engineers*, Chapra, Mc Graw Hill Education, India.
10. *Engineering Mathematics*, Paras Ram, CBS Publisher, India.

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3EEU02	Electronic Devices and Circuits	3L:0T:0P	3 credits

S.No.	CONTENTS	CONTACT HOURS
1	**Semiconductor Physics** Mobility and conductivity, Fermi levels in semiconductor. Generation and recombination of charges, diffusion and continuity equation, transport equations, Mass action Law, Hall Effect	8
2	**Junction Diodes** Energy band diagrams, calculation of contact potential and depletion width, V- I characteristics, diode parameters and load line concept, V-I characteristics and doping profile. .	4
	Applications of diodes in rectifier, clipping, clamping circuits and voltage multipliers. Transient behaviour of PN diode. Breakdown diodes, Schottky diodes, and Zener diode as voltage regulator	4
3	**Transistors** CE, CB and CC configuration & characteristics hybrid model, DC model of transistor, h-parameter equivalent circuits	4
	DC and AC analysis of single stage CE, CC (Emitter follower) and CB amplifiers, Biasing & stabilization techniques.	4
4	**JFET & MOSFET** Construction and operation of JFET & MOSFET, noise performances of FET, parasitic of MOSFET, small signal models of JFET & MOSFET Biasing of JFET's & MOSFET's.	4
	Low frequency single stage CS and CD (source follower) JFET amplifiers, FET as voltage variable resistor and active load	4
5	**Small Signal Amplifiers at Low Frequency** Analysis of BJT and FET multistage amplifier, DC and RC coupled amplifiers. Frequency response of single and multistage amplifier, mid-band gain, gains at low and high frequency	4
	Analysis of DC and differential amplifiers, Miller's Theorem, use of Miller and bootstrap configuration .Cascade and cascade configuration of multistage amplifiers (CE-CE, CE-CB, CS-CS and CS-CD), Darlington pair	4

Text Books/ Reference Books

- Millman Halkias, Integrated Electronics, TMH
- R. L. Boylestad, Louis Nashelsky, Electronic devices & circuits theory, Pearson Education
- Millman, Electronics Devices and Circuits, ed. 3, TMH

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3EEU03	Transformer and Asynchronous Machines	3L:0T:0P	3 credits

S.No.	CONTENTS	CONTACT HOURS
1	**Magnetic circuits** Electromechanical energy conversion: Basic principles, conservation of energy, physical phenomenon involved in conversion, energy balance, energy stored in magnetic field.	6
2	**AC Machines Fundamentals** Introduction, emf equation, mmf of three phase AC winding, production of rotating magnetic field, types of AC windings Concentric, distributed and chorded windings, pitch factor, distribution factor, effect of these factors on induced emf, effect of harmonics.	6
3	**Poly-phase Induction Motor** Construction, principle, starting and running torque, condition for maximum torque, equivalent circuits, no load and block rotor test.	4
	Torque-slip characteristics, losses and efficiency, circle diagram, starting of induction motor, speed control, cogging and crawling, double cage rotor, induction generator, application .	4
4	**Single Phase Induction Motor** Introduction, construction, principle, double revolving field theory, equivalent circuit, performance calculations, starting methods, and their types, torque slip characteristics of various types	6
5	**Transformer** Construction, Principle, emf equation, no load and short circuit test, equivalent circuits, back-to-back (Sumpner's test), phasor diagram, Voltage regulation, Efficiency, Condition for maximum efficiency, all day efficiency, parallel operation , auto-transformer.	6
6	**Poly-phase Transformer** Construction and connections , open delta connection, Scott connection, three phase to two phase conversion and vice-versa, Applications, Parallel operation and its conditions	4
	Three to six phase conversion. Switching currents in transformers, inrush of magnetizing current. Three winding transformer	4

Text Books/ Reference Books

- P.S Bhimbra, Electrical machines Khanna publisher.
- Kothari & Nagrath, Electric Machines, 3/e, TM

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3EEU04	Circuit Analysis	3L:0T:0P	3 credits

S.No.	CONTENTS	CONTACT HOURS
1	**Basic Elements of Circuit and Resonance** Introduction to circuit elements and their characteristics, current and voltage reference. Response of single element, double element and triple element circuits. Resonance, selectivity & Q-factor in ac circuits	4
2	**Network Analysis** Network voltages. Mesh & node systems of network equations and their comparison. Graph of network, tree, incidence matrix, fundamental circuit functions, cut sets, f-circuits analysis and f-cut set analysis, node and node pair analysis. Duality and Method of obtaining dual network	4
3	**Network Theorems** Thevenin's, Norton's, Superposition, Reciprocity, Compensation, Millman's theorem Tellegen's, Maximum power transfer and Miller`s theorems in DC & AC Circuits.	4
4	**Poly-phase Circuits** General Circuit Relations: Three Phase Star, Three Phase Delta, Star and Delta Combination, Four Wire Star Connection. Balanced and unbalanced Three Phase Voltages, currents and Impedances. Power and Reactive Volt-Amperes in a 3-Phase System.	4
5	**Power Relations in AC Circuits** Instantaneous Power in AC Circuits, Power Factor, Apparent Power, Reactive Power, Power Triangle, Complex Power	4
6	**Non-Sinusoidal Waves** Complex Periodic Waves and Their Analysis by Fourier series. Different Kinds of Symmetry, Determination of Co-Efficient. Average and Effective values of non-sinusoidal wave	4
	Power in A circuit of non-sinusoidal waves of current and voltage, Form Factor, Equivalent Sinusoidal Wave and Equivalent Power Factor. Response of Linear Network to Non-Sinusoidal Periodic Waves.	4
7	**Time Domain and Frequency Domain Analysis** Response of networks to step ramp, impulse, pulse and sinusoidal inputs	4
	Shifting Theorem Initial and final value theorems, Special signal waveform with Laplace transform and application to circuits operation	4

Text Books/ Reference Books

- Van Volkenburg , Network Analysis , PHI .
- D. Roy choudhury Networks and Systems, New Age internationa

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3EEU05	Digital Electronics	3L:0T:0P	3 credits

S.No.	CONTENTS	CONTACT HOURS
1	**Data Representation** Number Systems, Boolean algebra and Logic Gates; Simplification of Boolean Functions	4
	Karnaugh -Map Quine -Macluskey Minimisation Technique, Determination and Selection of Prime- Implicants; Conversion of truth tables in POS and SOP form. Incomplete specified functions. Variable mapping. Quinn- Macluskey minimization techniques	
2	**Digital Logic Gate Characteristics** TTL logic gate characteristics: Theory & operation of TTL NAND gate circuitry. Open collector TTL. Three state output logic	4
3	**Combinational Logic** Design Procedure, Adders and Subtractors, Code Conversion, Multilevel NAND and NOR Circuits, Binary Parallel Adder & Subtractor, BCD Adder & Subtractor, Magnitude Comparator, Encoder, Decoder, Multiplexer, Demultiplexer.	8
4	**Sequential Systems** Latches, flip-flops, R-S, D, J-K, and Master Slave flip flops.Conversions of flip-flops.	3
5	**Registers, Counters** Registers -Buffer Register, Shift Registers, Serial and Parallel Loading of Data. Counters - Ripple Counters, Modulus Counter, Ring Counter, Synchronous Counter, UP and DOWN Counters	5

Text Books/ Reference Books

- M. Morris Mano, Digital Logic and Computer Design, Pearson Edu. 2014
- Millman Taub, Pulse Switching and Network, TMH 2009
- A. Anandkumar, Fundamentals of Digital circuits, PHI 2009
- Floyd, Digital Funadamentals, Pearson 2008
- S. Salivahanan, Sarivazhagan, Digital circuit design, Vikas publications 2009
- Leach, Digital Principles and Applications, ed. 7, TMH 2008

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3EEU06	Generation of Electrical Power	3L:0T:0P	3 credits

S.No.	CONTENTS	CONTACT HOURS
1	**Conventional Energy Generation Methods** Thermal Power plants: Basic schemes and working principle. (ii) Gas Power Plants: open cycle and closed cycle gas turbine plants, combined gas & steam plants-basic schemes	5
	Hydro Power Plants: Classification of hydroelectric plants. Basic schemes of hydroelectric and pumped storage plants. (iv) Nuclear Power Plants: Nuclear fission and nuclear fusion. Fissile and fertile materials. Basic plant schemes with boiling water reactor, heavy water reactor and fast breeder reactor. Efficiencies of various power plants	3
2	**New Energy Sources** Impact of thermal, gas, hydro and nuclear power stations on environment. Green House Effect (Global Warming).Renewable and nonrenewable energy sources	5
	Conservation of natural resources and sustainable energy systems. Indian energy scene. Introduction to electric energy generation by wind, solar and tidal	3
3	**Loads and Load Curves** Types of load, chronological load curve, load duration curve, energy load curve and mass curve. Maximum demand, demand factor, load factor, diversity factor, capacity factor and utilization.	4
	Power Factor Improvement Causes and effects of low power factor and advantages of power factor improvement. Power factor improvement using shunt capacitors and synchronous condensers	4
4	**Power Plant Economics** Capital cost of plants, annual fixed and operating costs of plants, generation cost and depreciation. Effect of load factor on unit energy cost. Role of load diversity in power system economics	5
	Calculation of most economic power factor when (a) kW demand is constant and (b) kVA demand is constant. (iii) Energy cost reduction: off peak energy utilization, co-generation, and energy conservation	3
5	**Tariffs** Objectives of tariffs. General tariff form. Flat demand rate, straight meter rate, block meter rate. Two part tariff, power factor dependent tariffs, three part tariff. Spot (time differentiated) pricing	4
6	**Selection of Power Plants** Comparative study of thermal, hydro, nuclear and gas power plants. Base load and peak load plants. Size and types of generating units, types of reserve and size of plant. Selection and location of power plants	4

Text Books/ Reference Books

- V. K. Mehta, Principles of Power system (3/e), S. Chand Publication
- Soni, Gupta and Bhatnagar, Generation of Electrical Power, Dhanpat Rai & Sons
- L. Elgerd Olle, Electric Energy Systems Theory
- C. A. Gross, Power System Analysis, TMH

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[3EEU07] Electronic Devices Lab (Common to EE, EX, EC and EI)

1. Study the following devices: (a) Analog & digital multimeters (b) Function/ Signal generators (c) Regulated d. c. power supplies (constant voltage and constant current operations) (d) Study of analog CRO, Measurement of time period, amplitude, frequency & phase angle using Lissajous figures.

2. Plot V-I characteristic of P-N junction diode & calculate cut-in voltage, reverse saturation current and static & dynamic resistances.

3. Plot V-I characteristic of zener diode and study of zener diode as voltage regulator. Observe the effect of load changes and determine load limits of the voltage regulator.

4. Plot frequency response curve for single stage amplifier and to determine gain bandwidth product.

5. Plot drain current - drain voltage and drain current – gate bias characteristics of field effect transistor and Measure of Idss &Vp.

6. Application of Diode as clipper & clamper.

7. Plot gain- frequency characteristic of two stages RC coupled amplifier & calculate its bandwidth and Compare it with theoretical value.

8. Plot gain- frequency characteristic of emitter follower & find out its input and output resistances.

9. Plot input and output characteristics of BJT in CB, CC and CE configurations. Find their h-parameters.

10. Study half wave rectifier and effect of filters on wave. Also calculate theoretical & practical ripple factor.

11. Study bridge rectifier and measure the effect of filter network on DC voltage output and ripple factor.

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[3EEU08] Electrical AC Machine Lab

1. To perform O.C. and S.C. test on a 1-phase transformer and to determine the parameters of its equivalent circuit its voltage regulation and efficiency.

2. To perform back-to-back test on two identical 1-phase transformers and find their efficiency & parameters of the equivalent circuit

3. To determine the efficiency and voltage regulation of a single-phase transformer by direct loading.

4. To perform the heat run test on a delta/delta connected 3-phase transformer and determine the parameters for its equivalent circuit.

5. To perform the parallel operation of the transformer.

6. Separation of no load losses in single phase transformer.

7. To make a Scott connection of transformer.

8. To perform no load and blocked rotor test on a 3 phase induction motor and to determine the parameters of its equivalent circuits.

9. Draw the circle diagram and compute the following (i) Max. Torque (ii) Current (iii) slips (iv) p. f. (v) Efficiency.

10. Speed control of 3- Φ Induction Motor.

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[3EEU09] Digital Electronics Lab

1. To verify the truth tables of basic logic gates: AND, OR, NOR, NAND, NOR. Also to verify the truth table of Ex-OR, Ex-NOR (For 2, 3, & 4 inputs using gates with 2, 3, & 4 inputs).

2. To verify the truth table of OR, AND, NOR, Ex-OR, Ex-NOR realized using NAND & NOR gates.

3. To realize an SOP and POS expression

4. To realize Half adder/ Subtractor & Full Adder/ Subtractor using NAND & NOR gates and to verify their truth tables.

5. To realize a 4-bit ripple adder/ Subtractor using basic half adder/ Subtractor & basic Full Adder/ Subtractor.

6. To verify the truth table of 4-to-1 multiplexer and 1-to-4 demultiplexer. Realize the multiplexer using basic gates only. Also to construct and 8-to-1 multiplexer and 1-to-8 demultiplexer using blocks of 4-to-1 multiplexer and 1-to-4 demultiplexer.

7. Design & Realize a combinational circuit that will accept a 2421 BCD code and drive a TIL -312 seven segment display.

8. Using basic logic gates, realize the R-S, J-K and D-flip flops with and without clock signal and verify their truth table

9. Construct a divide by 2,4& 8 asynchronous counter. Construct a 4-bit binary counter and ring counter for a particular output pattern using D flip flop.

10. Perform input/output operations on parallel in/Parallel out and Serial in/Serial out registers using clock. Also exercise loading only one of multiple values into the register using multiplexer

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[3EEU10] Electrical Circuit and Programing Lab

1. Draw the circuit symbols.
2. Verify theorems for A. C. & D. C. circuits.
3. Programs for Circuit Analysis using C / C + +:

   a. Calculate the resistance of a conductor, given its dimensions & resistivity or determine the change in conductor resistance when the temp changes.

   b. D.C.: Analysis of resistor networks to determine all junction voltages, component voltages, and component currents.

   c. Transient: Analysis RC & RL circuits to produce tables of component voltage & current levels for a given set of time instants.

   d. Convert Y-connected resistor networks to delta-connected circuits.

4. Simulation using Simulation Tools for Circuit Analysis:

   a. DC: Analysis resistor networks to determine node voltages, components voltages, and component currents.

   b. DC: Analysis of resistor networks that have several voltage and current sources and variable load resistors.

   c. Transient: Analysis of RC & RL circuits to produce tables of component voltage & current levels for a given set of time instants & to produce graphs of voltages & currents versus time.

   d. AC: Analysis of impedance networks to determine the magnitude & phase of node voltages, components voltages and component currents.

Determine the magnitude & phase and component voltages and currents in resonant circuits & produce voltage and current verses frequency grap

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[3EEU11] Humanities & Social Science

India

Brief history of Indian Constitution, farming features, fundamental rights, duties, directive principles of state. History of Indian National Movement, socio economic growth after independence.

(8 hours)

Society

Social groups- concept and types, socialization- concept and theory, social control: concept, social problem in contemporary India, status and role.

(6 hours)

The Fundamentals of Economics

Meaning, definition and importance of economics, Logic of choice, central economic problems, positive and normative approaches, economic systems-socialism and capitalism.

(4 hours)

Microeconomics

Law of demand supply, utility approach, indifference curves, elasticity of demand and supply and applications, consumer surplus, Law of returns to factors and returns to scale market structure. **(8 hours)**

Macroeconomics

Concepts relating to National product–National income and its measurement, Simple Keynesian theory, simple multiplier, money and banking. Meaning, concept of international trade, determination of exchange rate, Balance of payments. Monetary and fiscal policies, inflation. **(8 hours)**

Indian Economy

Characteristics, structure. **(6 hours)**

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4EEU01	Advanced Mathematical Techniques	3L:1T:0P	4 credits

S.No.	CONTENTS	CONTACT HOURS
1	**Complex Analysis** Differentiability and Analytic functions, Cauchy-Riemann equations (Cartesian and Polar forms), Harmonic functions. Conformal mapping. Complex Line integral, M-L inequality, Cauchy theorem, Morera's theorem, Cauchy integral formulae, Taylor series and Laurent series. Singularities and Zeros, residues at poles and infinity, residues at isolated essential singular point, Cauchy residue theorem, evaluation of real definite integrals and improper integrals.	18
2	**Special Functions:** Legendre's function, Rodrigues formula, generating function, Simple recurrence relations, orthogonal property. Bessel's functions of first and second kind, generating function, simple recurrence relations, orthogonal property	12
3	**Statistics & Probability:** Basic concepts of probability, conditional probability, Baye's theorem. Random variable and distributions: Discrete and continuous random variables, Moments, Expectation, Moment generating function, Binomial, Poisson and Normal distribution	10

TEXT BOOKS:

5. *Advanced Engineering Mathematics*, Jain and Iyengar, Narosa Publications.
6. *Advanced Engineering Mathematics*, Denis Zill and Warren Wright, Jones & Bartlett India Private Limited.
7. *Introduction to Probability and Statistics,* Seymour Lipschutz and John J. Schiller, Mc Graw Hill Education, India.
8. *Advanced Engineering Mathematics,* O'neil, Cengage Learning, India.

REFERENCE:

11. *Advanced Engineering Mathematics*, Irvin Kreyszig, Wiley, India.
12. *Advanced Engineering Mathematics*, M. Greenberg, Pearson Education, India.
13. *Advance Engineering Mathematics*, Potter, Oxford, India.
14. *Engineering Mathematics*, Pal and Bhunia, Oxford, India.
15. *Higher Engineering Mathematics*, B.V. Ramana, Mc Graw Hill Education, India.
16. *Complex Variables and Applications*, J.W. Brown & R.V. Churchill, Mc Graw Hill Education, India.
17. *Probability and Statistics*, Murray Spiegel, John Schiller, R. Alu Srinivasan, McGraw Hill Education, India.
18. *Engineering Mathematics*, Paras Ram, CBS Publisher, India

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4EEU02	ANALOG ELECTRONICS	3L:0T:0P	3 credits

SNo	CONTENT	HOURS
1	**Feedback Amplifiers**	5
	Classification, Feedback concept, Feedback Topologies, Transfer gain with feedback, General characteristics of negative feedback amplifiers.	
	Analysis of voltage-series, voltage-shunt, current-series and current-shunt feedback amplifier.	4
2	**Oscillators & Multivibrators**	4
	Classification. Criterion for oscillation. Tuned collector, Hartley, Colpitts, RC Phase shift, Wien Bridge and crystal oscillators.	
	Astable, monostable and bistable multivibrators; Schmitt trigger.	3
3	**High Frequency Amplifiers**	
	Hybrid Pi model, conductance and capacitances of hybrid Pi model; high frequency analysisof CE amplifier.	4
	Gain bandwidth product, unity gain frequency fT, Emitter follower at high frequencies.	4
4	**Tuned Amplifier**	7
	Analysis of Single Tuned Amplifier, Primary & Secondary Tuned Amplifier with BJT; Double Tuned	
	Transformer Coupled Amplifier. Stagger Tuned Amplifier.	
5	**Power Amplifiers**	9
	Classification, Power transistors; Output power, power dissipation and efficiency analysis of Class A,	
	class B, class AB, class C; Pushpull amplifiers with and without transformers. Complementary	
	symmetry & quasi complimentary symmetry amplifiers.	

TEXT/REFERENCE BOOKS	Year
Millman, Integrated Electronics, ed. 2, TMH.	2010
A. S. Sedra, Kenneth C. Smith, Microelectronic Circuits, Oxford university press.	2009
M. H. Rashid, Microelectronic Circuits Analysis and design, Cengage Learning.	2009
David A. BELL, Electronic Devices and Circuits, Oxford university press.	2009

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4EEU03	Network Analysis and Synthesis	3L:0T:0P	3 credits

S.No.	CONTENTS	CONTACT HOURS
1	**Impedance and Admittance Functions** The concept of complex frequency, transform impedance and admittance, series and parallel combinations..	8
2	**Network Functions** Terminals and terminal pairs, driving point impedance transfer functions, poles and zeros. Restrictions on pole and zero location in splane Time domain behavior from pole and zero plot. Procedure for finding network functions for general two terminal pair networks.	5 3
3	**Network Synthesis** Hurwitz polynomial, positive real functions, reactive networks. Separation property for reactive networks. The four-reactance function forms, specification for reactance function Foster form of reactance networks. Cauer form of reactance networks. Synthesis of R-L and R-C networks in Foster and Cauer forms	3 5
4	**Two Port General Networks** Two port parameters (impedance, admittance, hybrid, ABCD parameters) and their inter relations Equivalence of two ports. Transformer equivalent, inter connection of two port networks. The ladder network, image impedance image transfer function, application to L-C network, attenuation and phase shift in symmetrical T and pi networks.	2 6
5	**Two Port Reactive Network (Filters)** Constant K filters. The m-derived filter. Image impedance of m-derived half (or L) sections, composite filters. Bands pass and band elimination filters. The problem of termination, lattice filters, Barlett's bisection theorem. Introduction to active filters	5 3

Text Books/ Reference Books

Desoer C. A. and Kuh E. S., "Basic Circuit Theory", McGraw Hill International Book Company

DeCarlo R. A. and Lin Pen-Min, "Linear Circuit Analysis", 2nd Ed., Oxford University Press

Hayt W. H., Kemmerly J. E. and Durbin S. M., "Engineering Circuit Analysis", 6th Ed., Tata McGraw Hill Publishing Company Ltd

Director S. W., "Circuit Theory: A Computational Approach", 2nd Ed., John Wiley and Sons Inc.

Valkenberg V., "Network Analysis", 3rd Ed., Prentice Hall International Edition

M.L. Soni , J.C. Gupta, "A Course in Electrical Circuit Analysis", Danpat Rai & Sons

Anil K. Mathur
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4EEU05	TRANSMISSION & DISTRIBUTION OF ELECTRICAL POWER	3L:0T:0P	3 credits

SNo	CONTENT	HOURS
1	**Supply systems** Basic network of power system. Transmission and distribution voltage, effect of system voltage on size of conductor and losses. Comparison of DC 2- wire, DC 3-wire, 1-phase AC and 3-phase AC (3-wire and 4-wire) systems.	5
2	**Distribution Systems** Primary and secondary distribution systems, feeder, distributor and service mains. Radial and ring- main distribution systems. Kelvin's law for conductor size.	3
3	**Mechanical Features of Overhead Lines** Conductor material and types of conductor. Conductor arrangements and spacing. Calculation of sag and tension, supports at different levels, effect of wind and ice loading, stringing chart and sag template. Conductor vibrations and vibration dampers.	4 4
4	**Parameters of Transmission Lines** Resistance inductance and capacitance of overheadlines, effect of earth, line transposition. Geometric mean radius and distance. Inductance and capacitance of line with symmetrical and unsymmetrical spacing Inductance and capacitance of double circuit lines. Skin and proximity effects; Equivalent circuits and performance of short and medium transmission lines.	4 4
5	**Generalized ABCD Line Constants** Equivalent circuit and performance of long transmission line. Ferranti effect. Interference with communication circuits. Power flow through a transmission line.	6
6	**Corona** Electric stress between parallel conductors. Disruptive critical voltage and visual critical voltage, Factors affecting corona. Corona power loss. Effects of corona	2
7	**Insulators** Pin, shackle, suspension, post and strain insulators. Voltage distribution across an insulator string, grading and methods of improving string efficiency.	4
8	**Underground Cables** Conductor, insulator, sheathing and armoring materials. Types of cables. Insulator resistance and capacitance calculation. Electrostatic stresses and reduction of maximum stresses. Causes of breakdown. Thermal rating of cable. Introduction to oil filled and gas filled cables.	4

TEXT/REFERENCE BOOKS

	Year
Weedy B.M. and Cory B.J., "Electric Power Systems", 4th Ed., Wiley India.	2008
Grainger J. J. and Stevenson W.D., "Elements of Power System Analysis", Tata McGraw-Hill Publishing Company Limited.	2008
Nagrath I. J. and Kothari D. P., "Modern Power System Analysis", 3 rd Ed., Tata McGraw-Hill Publishing Company Limited.	2008

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4EEU04	ELECTRICAL MEASUREMENTS	2L:0T:0P	2 credits

S.No.	CONTENTS	CONTACT HOURS
1	**Measuring Instruments** Moving coil, moving iron, electrodynamic and induction instruments-construction, operation, torque equation and errors. Applications of instruments for measurement of current, voltage, single-phase power and single-phase energy. Errors in wattmeter and energy meter and their compensation and adjustment	6
	Testing and calibration of single-phase energy meter by phantom loading	2
2	**Polyphase Metering** Blondel's Theorem for n-phase, p-wire system. Measurement of power and reactive kVA in phase balanced and unbalanced systems: One-wattmeter, two- wattmeter and three-wattmeter methods. 3-phase induction type energy meter. Instrument Transformers: Construction and operation of current and potential transformers	5
	Ratio and phase angle errors and their minimization. Effect of variation of power factor, secondary burden and frequency on errors. Testing of CTs and PTs. Applications of CTs and PTs for the measurement of current, voltage, power and energy	3
3	**Potentiometers** Construction, operation and standardization of DC potentiometers– slide wire and Crompton potentiometers. Use of potentiometer for measurement of resistance and voltmeter and ammeter calibrations	4
	Volt ratio boxes. Construction, operation and standardization of AC potentiometer in-phase and quadrature potentiometers. Applications of AC potentiometers.	4
4	**Measurement of Resistances** Classification of resistance. Measurement of medium resistances – ammeter and voltmeter method, substitution method, Wheatstone bridge method. Measurement of low resistances – Potentiometer method and Kelvin's double bridge method. Measurement of high resistance: Price's Guard-wire method. Measurement of earth resistance	4 4
5	**AC Bridges** Generalized treatment of four-arm AC bridges. Sources and detectors. Maxwell's bridge, Hay's bridge and Anderson bridge for self-inductance measurement. Heaviside's bridge for mutual inductance measurement. De Sauty Bridge for capacitance measurement. Wien's bridge for capacitance and frequency measurements. Sources of error in bridge measurements and precautions. Screening of bridge components.Wagner earth device	4 4

Text Books/ Reference Books

- **Golding E. W. and Widdis F. C., "Electrical Measurements and Measuring Instruments", 5th Ed., A.H. Wheeler and Compant**
- **Stout M. B., "Basic Electrical Measurements", Prentice Hall of India Private Limited.**
- **W. D. Cooper, Electronic Inst. & Measurement Techniques, Prentice Hall, India**

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4EEU05	ELECTRICAL MACHINES	3L:1T:0P	4 credits

S.No.	CONTENTS	CONTACT HOURS
1	**Synchronous Machine** Introduction, Construction, advantages of rotating field, types of rotors, emf equation, excitation systems, equivalent circuit and their phasor diagrams, voltage regulation, synchronous impedance method, mmf method	5
	Zero power factor method, two reaction theory of salient pole rotor, phasor diagram, power developed and power angle characteristics of salient pole machine, determination of Xd and Xq	5
	Synchronization, synchronizing power and torque, parallel operation application, power and torque, speed torque characteristics, power factor control-effect of change of excitation.	5
	V curve and inverted V curve, synchronous condenser and reactors, synchronous phase modifiers, hunting-causes and remedies, applications, synchronous induction motor application	5
2	**DC Machine** Introduction, construction, types, emf equation, armature reaction, commutation, methods of improving commutation, various characteristics of shunt, series and compound DC machine, losses and efficiency, speed control (field and armature control methods), testing (Brake test and Swinburne test), Application	8
3	**Special Machines** **Hysteresis Motors**: Construction, principle of operation and performance of synchronous reluctance motors. **Stepper Motor**: Construction, principle of operation, control and performance of stepping motors	6
	Switched Reluctance Motor: Construction, principle of operation, control and performance of switched reluctance motors. **Universal Motor**: Construction, principle of operation, control and performance of universal motor. **Servo Motors:** Construction, principle of operation, control and performance of servomotors; Techogenerator.	6

Text Books/ Reference Books

Fitzgeraid A. E., Kingsley C. and Kusko A., "Electric Machinery", 6 th Ed., McGraw-Hill International Book Company. 2008
Say M. G., "The Performance and Design of Alternating Current Machines", CBS Publishers and Distributors. 2005
Say M. G. and Taylor E. O., "Direct Current Machines", 3rd Ed., ELBS and Pitman. 1986
Nagrath I. J. and Kothari D. P., "Electrical Machines", 3rd Ed., Tata McGraw-Hill Publishing Company Limited. 2008
Clayton A. E. and Hancock N., "The Performance and Design of DC Machines", CBS Publishers and Distributors. 2003
Langsdorf A. S., "Theory of AC Machines", 2nd Ed., Tata McGrawHill Publishing Company Limited. 2008

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[4EEU07] ANALOG ELECTRONICS LAB

1) Plot gain-frequency characteristics of BJT amplifier with and without negative feedback in the emitter circuit and determine bandwidths, gain bandwidth products and gains at 1 kHz with and without negative feedback.

2) Study of series and shunt voltage regulators and measurement of line and load regulation and ripple factor.

3) Plot and study the characteristics of small signal amplifier using FET.

4) Study of push pull amplifier. Measure variation of output power & distortion with load.

5) Study Wein bridge oscillator and observe the effect of variation in R & C on oscillator frequency.

6) Study transistor phase shift oscillator and observe the effect of variation in R & C on oscillator frequency and compare with theoretical value.

7) Study the following oscillators and observe the effect of variation of C on oscillator frequency: (a) Hartley (b) Colpitts.

8) To plot the characteristics of UJT and UJT as relaxation.

[4EEU08] ELECTRICAL MEASUREMENT LAB

1) Study working and applications of (i) C.R.O. (ii) Digital Storage C.R.O. & (ii) C.R.O. Probes.
2) Study working and applications of Meggar, Tong-tester, P.F. Meter and Phase Shifter.
3) Measure power and power factor in 3-phase load by (i) Two-wattmeter method and (ii) One-wattmeter method.
4) Calibrate an ammeter using DC slide wire potentiometer.
5) Calibrate a voltmeter using Crompton potentiometer.
6) Measure low resistance by Crompton potentiometer.
7) Measure Low resistance by Kelvin's double bridge.
8) Measure earth resistance using fall of potential method.
9) Calibrate a single-phase energy meter by phantom loading at different power factors.
10) Measure self-inductance using Anderson's bridge.

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[4EEU09] POWER SYSTEM DESIGN LAB

1) Generating station design: Design considerations, basic schemes and single line diagram of hydro, thermal, nuclear and gas power plants. Electrical equipment for power stations.
2) Auxiliary power supply scheme for thermal power plant.
3) Distribution system Design: Design of feeders & distributors. Calculation of voltage drops in distributors. Calculation of conductor size using Kelvin's law.
4) Study of short term, medium term and long term load forecasting.
5) Sending end and receiving end power circle diagrams.
6) Instrument Transformers: Design considerations of CTs & PTs for measurement and protection.
7) Substations: Types of substations, various bus–bar arrangements. Electrical equipment for substations.

NOTE: Problems should preferably be solved through Programming using any Generalised Mathematical Tool.

[4EEU10] ELECTRICAL MACHINES LAB

1) Speed control of D.C. shunt motor by field current control method & plot the curve for speed verses field current.
2) Speed control of D.C. shunt motor by armature voltage control method & plot the curve for speed verses armature voltage.
3) To pre-determine the efficiency of a D.C shunt machine considering it as a motor by performing Swinburne's test on it.
4) To perform Hopkinson's test on two similar DC shunt machines and hence obtain their efficiencies at various loads.
5) To plot the O.C.C. & S.C.C. of an alternator.
6) To determine Zs , X_d and regulation of synchronous motor by synchronous impedance method.
7) To Plot V-Curve and inverted V-Curve of synchronous motor for different values of loads.
8) To synchronize an alternator across the infinite bus (RSEB) and control load sharing.

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5EEU01: POWER ELECTRONICS

UNIT I **HOURS**

Power Semiconductor Devices: Construction, Principle of operation, Characteristics and applications of Power Transistor& Thyristor. 3

Characteristics of GTO, DIAC, MCT, TRIAC, Power MOSFET and IGBT; Two Transistor Model of Thyristor, Thyristor Commutation methods. 5

UNIT II

SCR: Construction and characteristics, specification and ratings, pulse transformer, optical isolators, methods of turn on, triggering circuits for SCR: R, RC, UJT relaxation oscillator. 4

Rating extension by series and parallel connections, string efficiency. Protection of SCR-Protection against over voltage, over current, dv/dt, di/dt, Gate protection. 4

UNIT III

Converters-I: Single Phase half & full wave converters with RL & RLE load, Single phase dual converters, Three phase half wave converters. 5

Three phase full converters with RL load, Three phase dual converters. 3

UNIT IV

Converters-II: Single and three-phase semi converters with RL & RLE load. Power factor improvement Extinction angle control, symmetrical angle control, pulse width modulation control and sinusoidal pulse width modulation control. 6

Inversion operation. Effect of load and source impedances. 2

UNIT V

DC-DC Converters: Step Up/Down Copper, Control strategies, Chopper Configurations, Analysis of type A Chopper. 4

Voltage, current and load commutated chopper. Multiphase Chopper. 4

Text Books

1. M. D. Singh and K. B. Khanchandani: Power Electronics 2/e, MGH,2008
2. M. H. Rashid: Power Electronics, Circuits Devices and Applications, Pearson,2011
3. P. S. Bimbhra: Power Electronics, Khanna Publishers,2012

Reference Books

1. V. R. Moorthi: Power Electronics-Devices, Circuits and Industrial Applications, Oxford, 2005.
2. Theodore Wildi: Electrical Machines, Drives and Power Systems, Pearson,2007.
3. Ned Mohan: Power Electronics, John Wiley,2013
4. Krein P. T.: Elements of Power Electronics, Oxford,1999

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5EEU02: MICROPROCESSORS AND MICROCONTROLLERS

UNIT I	**CONTACT HOURS**
Introduction to 8085 Microprocessor Architecture: CPU, address bus, data bus and control bus. Input/Output devices, buffers, encoders, latches and memories.	4
Internal Data Operations and Registers, Pins and Signals, Peripheral Devices and Memory Organization, Interrupts.	4
UNIT I I	
8085 Microprocessor Instructions: Classification, Format and Timing.	4
Instruction Set: 8 Bit and 16 Bit Instructions, Programming and Debugging, Subroutines.	4
UNIT III	
8085 Microprocessor Interfacing: 8259, 8257, 8255, 8253, 8155 chips and their applications.	5
A/D conversion, memory, keyboard and display interface (8279).	3
UNIT IV	
8086 Microprocessor: Architecture: Architecture of INTEL 8086 (Bus Interface Unit, Execution unit), register organization, memory addressing, memory segmentation, Operating Modes	6
Instruction Set of 8086: Addressing Modes: Instruction format: Discussion on instruction Set:Groups: data transfer, arithmetic, logic string, branch control transfer, processor control. Interrupts: Hardware and software interrupts, responses and types.	2
UNIT V	
Basic Computer Architecture: Central Processing Unit, memory and input/output interfacing. Memory Classification Volatile and non-volatile memory, Primary and secondary memory, Static and Dynamic memory, Logical, Virtual and Physical memory.	4
Types Of Memory: Magnetic core memory, binary cell, Rom architecture and different types of ROM, RAM architecture, PROM, PAL, PLA, Flash and Cache memory, SDRAM, RDRAM and DDRAM. Memory latency, memory bandwidth, memory seek time.	4

Text Books

1. Gaonkar, Ramesh S.: Microprocessor Architecture, programming and Applications with the 8085, Pen Ram International Publishing 5th Ed,2002.
2. K. Udaykumar and B. S. Umashankar: The 8085 Microprocessor: Architecture, Programming and Interfacing, Pearson Publisher,2008

Reference Books

1. Douglas V. Hall: Microprocessors and Interfacing, Revised Second Edition (SIE), MGH,2007
2. Ray. A. K. & Burchandi, K. M.: Advanced Microprocessors and Peripherals, Architecture, Programming and Interfacing, MGH,2006
3. Lyla B. Das: The X 86 Microprocessors: Architecture, Programming and Interfacing (8086 to Pentium), Pearson Publisher,2010
4. Krishna Kant: Microprocessors and Microcontrollers, PHI Learning,2007
5. M. Rafiquzzaman: Microprocessors-Theory and applications, PHI,1993
6. B. Ram: Advanced Microprocessor & Interfacing. MGH,2000

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5EEU03: CONTROLSYSTEMS

UNIT I **HOURS**

Introduction: Elements of control systems, concept of open loop and closed loop systems, Examples and application of open loop and closed loop systems, brief idea of multivariable control systems. 5

Mathematical Modeling of Physical Systems: Representation of physical system (Electro Mechanical) by differential equations, Determination of transfer function by block diagram reduction techniques and signal flow method, Laplace transformation function, inverse Laplace transformation. 3

UNIT II

Time Response Analysis of First Order and Second Order System:
Characteristic equations, response to step, ramp and parabolic inputs. 4
Transient response analysis, steady state errors and error constants,
Transient & steady state analysis of LTI systems. 4

UNIT III

Control System Components: Constructional and working concept of ac servomotor, synchronous and stepper motor. 5

Stability and Algebraic Criteria: concept of stability and necessary conditions, Routh-Hurwitz criteria and limitations. Root Locus Technique: The root locus concepts, construction of root loci. 3

UNIT IV

Frequency Response Analysis: Frequency response, correlation between time and frequency responses, polar and inverse polar plots, Bode plots. 5

Stability in Frequency Domain: Nyquist stability criterion, assessment of relative stability: gain margin and phase margin, M and N Loci, Nichols chart. 3

UNIT V

The design problem and preliminary considerations lead, lag and lead-lag networks,
design of closed loop systems using compensation techniques in time domain and frequency domain. 4
Brief idea of proportional, derivative and integral controllers. 4

Text Books

1. Smarjit Ghosh, Control Systems: Theory and Applications, 2/e, Pearson Publisher,2004.
2. Dhannesh N. Manik: Control System, Cengage Learning,2012.
3. **B s manke linear control with matlab khanna publisher**

Reference Books

1. I. J. Nagrath and M. Gopal: Control Systems Engineering, 3rd Ed, New Age Publication,2008.
2. K. R. Varmah: Control Systems, MGH,2010.
3. Anandnatrajan et. al.: Control Systems Engineering, 4th ed., Scitech Pub,2013.
4. K. Ogata: Modern Control Engineering, Prentice Hall of India,2010.
5. Norman S. Nise: Control System Engineering, John Wiley & Sons,2011.
6. Richard C. Dorf, Robert H. Bishop: Modern Control Systems, Prentice-Hall,2000.
7. Robert H. Bishop: Modern Control Systems, Boyd and Fraser pub,2000.

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5EEU04: UTILIZATION OF ELECTRICAL POWER

UNIT I **CONTACT HOURS**

Electric Heating: Different methods of electric heating. Principle of high frequency induction and dielectric heating. Construction, operation, performance and applications of arc furnace and induction furnace. 4

Electric Welding: Welding process, welding transformer, Classification of Electric Welding: arc welding, resistance welding, welding of various metals. 4

UNIT II

Illuminations: Definitions, laws of illuminations, polar curves, luminous efficiency, photometer, incandescent lamps, filament materials. 4

Halogen lamp, electric discharge lamps, sodium vapour lamp, mercury vapour lamp and fluorescent lamp. Light Calculations: commercial, industrial, street and flood lighting. 4

UNIT III

Electrolytic Process: Principles and applications of electrolysis, electro-deposition, Manufactures of chemicals, anodizing, electro-polishing ,electro-cleaning, electroextraction, electro-refining, electro-stripping (parting) power supplies for electrolytic process. 4

UNIT IV

Electric Traction & Means of Supplying Power: Systems of Electric Traction: DC & AC Systems, Power Supply for Electric Traction System: Comparison and application of different systems. Sub-station equipment and layout, conductor rail & pantograph. 4

UNIT V

Traction Methods: Types of services, speed time and speed distance curves, estimation of power and energy requirements, Mechanics of train movement. 4

Co-efficient of adhesion, Adhesive weight, effective weight. Traction Motor Controls: DC and AC traction motors, Series parallel starting.
Methods of electric braking of traction motors. 4

Text Books

1. C. L. Wadhwa: Utilization of Electric Traction Electric Power,1989.
2. H. Partab: Art and Science of Electrical Energy, Dhanpat Rai & Sons,1975.

Reference Books

1. H. Partab:Modern Electric Traction, Dhanpat Rai & Sons,1973.

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5EEU05.1: ELECTROMAGNETIC FIELD THEORY

UNIT I **CONTACT HOURS**

Introduction: Vector Relation in rectangular, cylindrical, spherical and general curvilinear coordinate system. 4

Concept and physical interpretation of gradient, Divergence and curl, Green's Stoke's and Helmholz theorems. 4

UNIT II

Electrostatics: Electric field vectors-electric field intensity, flux density & polarization. Electric field due to various charge configurations. The potential functions and displacement vector. 4

Gauss's law, Poisson's and Laplace's equation and their solution. Uniqueness theorem. Continuity equation. Capacitance and electrostatics energy. Field determination by method of images. Boundary conditions. Field mappings and concept of field cells. 4

UNIT III

Magnetostatics: Magnetic field vector: Magnetic field intensity, flux density & magnetization , Bio-Savart's law, Ampere's law, Magnetic scalar and vector potential, self & mutual inductance. 4

Energy stored in magnetic field, Boundary conditions, Analogy between electric and magnetic field, Field mapping and concept of field cells. 4

UNIT IV

Time Varying Fields: Faraday's law, Displacement currents and equation of continuity. 4

Maxwell's equations, Uniform plane wave in free space, dielectrics and conductors, skin effect sinusoidal time variations, reflections, refraction & polarization of UPW, standing wave ratio. Pointing vector and power considerations. 4

UNIT V

Transmission Lines: The high-frequency circuit. LCR ladder model. The transmission Line equation. Solution for loss-less lines. 4

Wave velocity and wave impedance. Reflection and Transmission coefficients at junctions. VSWR. 4

Text Books

1. Hayt: Engineering Electromagnetics, 7/e, (With CD), MGH,2012.
2. Matthew N. O. Sadiku: Principles of Electromagnetics, 4th ed., Oxford,2009.

Reference Books

1. G. S. N. Raju: Electromagnetic Field Theory and Transmission Lines, Pearson,2006.
2. J. D. Kraus: Electromagnetic. 5th edition, MGH,1999.
3. S. Baskaran and K. Malathi: Electromagnetic Field and Waves, Scitech Pub,2013.
4. R. S. Kshetrimayum, Electromagnetic Field Theory, Cengage Learning,2012.
5. V.V. Sarwate: Electromagnetic Field and Waves, Willey Eastern Ltd,1993.
6. Bhag Guru: Electromagnetic Field Theory Fundamentals, Cambridge Uni. Press,2004.

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5EEU05.2: Restructured Power Systems

S. No.	Topics	Total Hours
1.	**Introduction to restructuring of power industry** Reasons for restructuring of power industry; Understanding the restructuring process, Entities involved, The levels of competition, The market place mechanisms, Sector-wise major changes required; Reasons and objectives of deregulation of various power systems across the world	4
2.	**Fundamentals of Economics** Consumer and suppliers behavior, Total utility and marginal utility, Law of diminishing marginal utility, Elasticity of demand and supply curve, Market equilibrium, Consumer and supplier surplus, Global welfare, Deadweight loss	7
3.	**The Philosophy of Market Models** Monopoly model, Single buyer model, Wholesale competition model, Retail competition model, distinguishing features of electricity as a commodity, Four pillars of market design, Cournot, Bertrand and Stackelberg competition model	7
4	**Transmission Congestion Management** Transfer capability, Importance of congestion management, Effects of congestion, Classification of congestion management methods, ATC, TTC, TRM, CBM, ATC calculation using DC and AC model, Nodal pricing, Locational Marginal Prices (LMPs), Implications of nodal pricing, Price area congestion management Capacity alleviation methods, Re-dispatching, Counter-trade, Curtailment	10
5	**Ancillary Service Management** Type and start capability service, Provisions of ancillary services, Markets for ancillary services, Co-optimization of energy and reserve services, Loss of opportunity cost, International practices of ancillary services.	5
6.	**Pricing of transmission network usage and Market power** Introduction to transmission pricing, Principles of transmission pricing, Classification of transmission pricing, Rolled-in transmission pricing paradigm. Attributes of a perfectly competitive market, The firm's supply decision under perfect competition, Imperfect competition, Monopoly, Oligopoly. Effect of market power, Identifying market power, HHI Index, Entropy coefficient, Lerner index.	10

Text/Reference Books

1. S R Paranjothi, "Modern Power systems" New Age International Publishers-2017
2. Loi Lei Lai,"Power System Restructuring and Deregulation", John Wiley & Sons Ltd.
3. K. Bhattacharya, MHT Bollen and J.C Doolder, Operation of Restructured Power Systems, Kluwer Academic Publishers, USA, 2001.
4. Lorrin Philipson and H. Lee Willis,"Understanding Electric Utilities and Deregulation", Marcel Dekker Inc, New York.
5. Yong-Hua Song, Xi-Fan Wang, Operation of market-oriented power systems, Springer, Germany

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5EEU06.1: OPTIMIZATION TECHNIQUES

UNIT I **CONTACT HOURS**

Introduction: Engineering application of Optimization, Formulation of design problems as mathematical programming problems, classification of optimization problems. 8

UNIT II

Optimization Techniques: Classical optimization, multivariable with no constraints, unconstrained minimization techniques. 4

Penalty function techniques, Lagrange multipliers and feasibility techniques. 4

UNIT III

Linear Programming: Graphical method, Simplex method, Duality in linear programming (LP), Sensitivity analysis Applications in civil engineering. 5

UNIT IV

Non Linear Programming Techniques/Method: Unconstrained optimization, one dimensional minimization, golden section, elimination, quadratic and cubic, Fibonacci, interpolation. 6

Direct search, Descent, Constrained optimization, Direct and indirect, Optimization with calculus, Khun−Tucker conditions. 2

UNIT V

Constrained Optimization Techniques: Direct, complex, cutting plane, exterior penalty function methods for structural engineering problems. 8

Text Books

1. Rao S. S.: Engineering Optimization- Theory and Practice, New Age International,2009.
2. Hadley. G.: Linear programming, Narosa Publishing House, New Delhi,2003.

Reference Books

1. Deb. K.: Optimization for Engineering Design− Algorithms and Examples, PHI,2012.
2. Bhavikatti S. S.: Structural Optimization Using Sequential Linear Programming, Vikas Publishing House, New Delhi,2003.
3. Spunt: Optimum Structural Design, Prentice Hall,1971.
4. Uri Krisch: Optimum Structural Design, MGH,1981.

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5EEU06.2: HIGH VOLTAGE ENGINEERING

UNIT I **HOURS**

(i) Breakdown in Gases: Introduction to mechanism of breakdown in gases, Townsend's breakdown mechanism. Breakdown in electromagnetic gases,Application of gases in power system

(ii)Breakdown in Liquids: Introduction to mechanism of breakdown in liquids, suspended solid particle mechanism and cavity breakdown. Application of oil in power apparatus. 4

(iii) Breakdown in solids: Introduction to mechanism of breakdown in solids, electromechanical breakdown, treeing & tracking breakdown and thermal breakdown. 4

UNIT II

(i) High DC Voltage Generation: Generation of high dc voltage, basic voltage multiplier circuit.

(ii) **High AC Voltage Generation**: Cascaded Transformers. 5

(iii)**Impulse Voltage generation**: Impulse voltage, basic impulse circuit, Mark's multistage impulse generator.

(iv) **Measurement of High Voltage**: Potential dividers - resistive, capacitive and mixed potential dividers. Sphere gap- Construction and operation. Klydonorgraph. 3

UNIT III

Nondestructive Insulation Tests: **(i)** Measurement of resistively, dielectric constant and loss factor. High Voltage Schering Bridge- measurement of capacitance and dielectric loss. 3

(ii) Partial Discharges: Introduction to partial discharge, partial discharge equivalent circuit. Basic wide-band and narrow band PD detection circuits. 5

UNIT IV

(i) Over voltages: Causes of over voltages, introduction to lightning phenomena, over Voltages due to lighting 2

(ii) Travelling Waves: Travelling waves on transmission lines-open end line, short circuited line, line terminated through a resistance, line connected to a cable, reflection and refraction at a T-junction and line terminated through a capacitance. Attenuation of traveling waves. 6

UNIT V

(i) **Over Voltage Protection**: Basic construction and operation of ground wires protection angle and protective zone, ground rods, counterpoise, surge absorber, rod gap and arcing horn, lighting arresters - expulsion type, non -linear gap type and metal oxide gapless type. 5

(ii)**Insulation Coordination**: Volt-time curves, basic impulse insulation levels, coordination of insulation levels. 3

Text Books

1. Naidu: High Voltage Engineering 4/e, MGH,2013.
2. John Kuffel, E. Kuffel and W. S. Zaengl: High Voltage engineering, Elsevier,2000.

Reference Books

1. C. L.Wadhwa: High Voltage Engineering, Wiley Eastern Ltd,2007.
2. Subir Ray: An Introduction to High Voltage Engineering, Prentice Hall of India,2013.

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5EEU07: POWER ELECTRONICS LAB

1 .Study the comparison of following power electronics devices regarding ratings, performance characteristics and applications: Power Diode, Power Transistor, Thyristor, Diac, Triac, GTO, MOSFET, MCT and SIT.

2. Determine V-I characteristics of SCR and measure forward breakdown voltage, latching and holding currents.

3 .Find V-I characteristics of TRIAC and DIAC.

4 .Find output characteristics of MOSFET and IGBT.

5. Find transfer characteristics of MOSFET and IGBT.

6. Find UJT static emitter characteristics and study the variation in peak point and valley point.

7 .Study and test firing circuits for SCR-R, RC and UJT firing circuits.

8. Study and test 3-phase diode bridge rectifier with R and RL loads. Study the effect of filters.

9 .Study and obtain waveforms of single-phase half wave controlled rectifier with and without filters. Study the variation of output voltage with respect to firing angle.

10. Study and obtain waveforms of single-phase half controlled bridge rectifier with R and RL loads. Study and show the effect of freewheeling diode.

11. Study and obtain waveforms of single-phase full controlled bridge converter with R and RL loads. Study and show rectification and inversion operations with and without freewheeling diode.

12. Control the speed of a dc motor using single-phase half controlled bridge rectifier and full controlled bridge rectifier. Plot armature voltage versus speed characteristics.

Reference/Suggested Books

1. O. P. Arora: Power Electronics Laboratory-Experiments and Organization, Narosa Pub.
2. P. B. Zbar: Industrial Electronics- A Text-Lab Manual, MGH.

5EEU08: MICROPROCESSOR LAB

1. Study the hardware, functions, memory structure and operation of 8085-Microprocessor kit.

2 .Program to perform integer division: (1) 8-bit by 8-bit (2) 16-bit by 8-bit.

3 .Transfer of a block of data in memory to another place in memory

4. Transfer of black to another location in reverse order.

5. Searching a number in an array.

6. Sorting of array in: (1) Ascending order (2) Descending order.

7. Finding party of a 32-bit number.

8. Program to perform following conversion (1) BCD to ASCII (2) BCD to hexadecimal.

9 .Program to multiply two 8–bit numbers

10. Program to generate and sum 15 Fibonacci numbers.

11. Program for rolling display of message “India”, “HELLO”.

12. To insert a number at correct place in a sorted array.

13. Reversing bits of an 8-bit number.

14 .Fabrication of 8-bit LED interfaces for 8085 kit through 8155 and 8255.

15. Data transfer on output port 8155 & 8255 & implementation of disco light, running light, and sequential lights on the above mentioned hardware.

16. Parallel data transfer between two DYNA-85 kit using 8253 ports.

17 .Generation of different waveform on 8253/8254 programmable timer.

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5EEU09: SYSTEM SIMULATION LAB

Basics of MATLAB matrices and vectors, matrix and array operations, Saving and loading data, plotting simple graphs, scripts and functions, Script files, Function files, Global Variables, Loops, Branches, Control flow, Advanced data objects, Multi-dimensional matrices, Structures, Applications in linear algebra curve fitting and interpolation. Numerical integration, Ordinary differential equation. (All contents is to be covered with tutorial sheets)

Simulink: Idea about simulink, problems based on simulink. (All contents is to be covered with tutorial sheets)Write a program to generate Machine Op- code table using two pass Assembler.

Reference/Suggested Books

1. Almos Gilat: MATLAB: An Introduction with Applications, Wiley India Ltd., 2004.
2. Ram N. Patel et. al.: Programming in MATLAB, Pearson

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5EEU10 PROFESSIONAL ETHICS AND DISASTERS MANAGEMENT

1 .**Objectives:** to help the students

- To appreciate the importance and values and ethics in implementing the technology and ensure sustainable development, happiness and prosperity.
- To understand the co-existence with nature and to be aware of potential natural and manmade disasters.

2. **Human Values**: Effect of Technological Growth and Sustainable Development. Profession and Human Values: Values crisis in contemporary society. Nature of values. Psychological Values, Societal Values and Aesthetic Values. Moral and Ethical values.

3 .**Professional Ethics**:

- Professional and Professionalism-Professional Accountability, Role of a professional, Ethic and image of profession.
- Engineering Profession and Ethics-Technology and society, Ethical obligations of Engineering professionals, Roles of Engineers in industry, society, nation and the world.
- Professional Responsibilities-Collegiality, Loyalty, Confidentially, Conflict of Interest, Whistle Blowing.

4 .**Disaster Management**: Understanding Disasters and Hazards and related issues social and environmental. Risk and Vulnerability. Types of Disasters, their occurrence/ causes, impact and preventive measures:
Natural Disasters- Hydro-meteorological Based Disasters like Flood, Flash Flood, Cloud Burst, Drought, Cyclone, Forest Fires; Geological Based Disasters like Earthquake, Tsunami, Landslides, Volcanic Eruptions.

5.**Manmade Disasters**: Chemical Industrial Hazards, Major Power Break Downs, Traffic Accidents, Fire Hazards, Nuclear Accidents. Disaster profile of Indian continent. Case studies. Disaster Management Cycle and its components.

In order to fulfill objectives of course,

(A) The institute shall be required to organize at least 3 expert lectures by eminent social workers/professional leaders.
(B) Each student shall compulsorily be required to:
I. Visit a social institution/NGO for at least 7 days during the semester and submit a Summary report.
II. Perform a case study of a disaster that has occurred in last decade and submit a Summary report.

Reference/Suggested Books

1. R Subramanian: Professional Ethics, oxford publishers.
2. Engineering Ethics: Concepts and cases by Charles E. Harris, Jr., Michael S. Pritchard, MichaelJ. Rabins. Cengage Learning, Delhi
3. Stephen H. Unger: Controlling Technology- Ethics and Responsible Engineers, John Willey and Sons.
4. Deborah Johnson: Ethical Issues in Engineering, Prentice Hall.
5. A. N. Tripathi: Human Values in the engineering Profession, Moniograph, Published by IIM Calcutta.
6. D. K. Sinha: Towards Basics of Natural Disaster Reduction, Researchco Book Center, Delhi.
7. Amita Sinvhal: Understanding Earthquake Disasters,MGH, New Delhi.
8. Selected Resources available on www.nidmindia.nic.in

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6EEU01: MODERN CONTROL THEORY

S.No.	CONTENTS	HOURS
1.	**Introduction:** Concept of Linear vector space Linear Independence, Bases & Representation, domain and range. Concept of Linearity, relaxedness, time invariance, causality.	5
	State Space Approach of Control System Analysis: Modern Vs conventional control theory, concept of state, state variable state vector, state space, state space equations, Writing state space equations of mechanical, Electrical systems, Analogous systems.	3
2.	State Space Representation using physical and phase variables, comparison form of system representation. Block diagram representation of state model. Signal flow graph representation.	5
	State space representation using canonical variables. Diagonal matrix. Jordan canonical form, Derivation of transfer functions from state-model.	3
3.	**Solution of State Equations:** Eigenvalues and Eigen vectors. Matrix. Exponential, State transition matrix, Properties of state transition matrix.	4
	Computation of State transition matrix concepts of controllability &observability, Pole placement by state feedback.	4
4.	**Digital Control Systems:** Introduction, sampled data control systems, signal reconstruction, difference equations.	4
	The z-transform, Z-Transfer Function. Block diagram analysis of sampled data systems, z and s domain relationship.	4
5.	Modeling of sample-hold circuit, steady state accuracy, stability in z-plane and Jury stability criterion, bilinear transformation.	4
	Routh-Hurwitz criterion on s-planes, digital PID controllers, Introduction to adaptive control	4

Text Books

S.No.	Name of author's /books/publisher	Year of Pub.
1.	I. J. Nagrath and M. Gopal: Control Systems Engineering, 3rd Ed, New Age Publication.	2008
2.	S. K. Bhattacharya: Control Systems Engineering, 3e, Pearson Publishers.	2009

Reference Books

S.No.	Name of author's /books/publisher	Year of Pub.
1.	Dhannesh N. Manik: Control System, Cengage Learning.	2010
2.	Richard C. Dorf, Robert H. Bishop: Modern Control Systems, Prentice-Hall.	2008
3.	M. Gopal: Digital Control and State Variable Methods, MGH.	2012
4.	B. C. Kuo: Digital Control System, Oxford.	1980
5.	C. H. Houpis and G. B. Lamont, Digital Control Systems, MGH.	1992
6.	Donald E. Kiv: Optimal Control Theory- An Introduction, Prentice Hall.	2005

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6EEU02: COMPUTER AIDED DESIGN OF ELECTRICAL MACHINES

S.No.	CONTENTS	CONTACT HOURS
1.	**Basic Principles of Electrical Machine Design:** Specifications, Factors affecting the design, Limitations, main dimension, loadings, output equation, factor affecting the size and rating,	4
	Electrical Engineering Materials: conducting, magnetic and insulating materials. Magnetic Circuit Calculation: Ohm's law for magnetic circuit, mmf required for air gap and iron parts, tapered teeth, real and apparent flux density, magnetizing current.	4
2.	**Heating and Cooling of Electrical Machines:** heat dissipation and heat flow equations, Newton's law of cooling, equations for temperature rise,	4
	Rating of Machines: Continuous, short and intermittent ratings, mean temperature rise, hydrogen cooling of turbo alternators, quantity of cooling medium	4
3.	**Computer Aided Design of Transformers:** Power and Distribution Transformers, core and yoke cross sections, square and stepped core, output equations, main dimensions, types & design of windings, optimization concepts.	8
4.	**Computer Aided Design of Synchronous Machines:** Turbo and Hydro alternators, choice of specific magnetic & electric loading, short circuit ratio and its effects air gap length, output equation, main dimensions, flow charts for design of synchronous machine, design of stator core & winding.	8
5.	**Computer Aided Design of Induction Machines**: Output equation, main dimensions, design criteria, flow charts for design of induction motor, air gap length, design of stator core and winding, rotor design.	8

Text Books

S.No.	Name of author's /books/publisher	Year of Pub.
1.	A. K. Sawhney: A Course in Electrical Machine Design, Dhanpat Rai & Sons.	1984
2.	B. Edikins: Generalized Theory of Electrical Machines.	1995

Reference Books

S.No.	Name of author's /books/publisher	Year of Pub.
1.	Fitzegerald: Electrical Machinery, Kingsley.	2002
2.	M. G. Say: The Performance and Design of AC Machines, Pitman & Sons.	1958
3.	R. K. Agrawal: Electrical Machine Design	2009

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6EEU03: SWITCHGEAR AND PROTECTION

S.No.	CONTENTS	HOURS
1.	**Static Relays:** Introduction to static relays, merits and demerits.	6
	Comparators: amplitude and phase comparators, duality between amplitude and phase comparators. Introduction to (a) amplitude comparators-circulating current type, phase splitting type and sampling type, (b) phase comparators-vector product type and coincidence type.	
	Static Over Current Relays: Introduction to instantaneous, definite time, inverse time and directional overcurrent relays	2
2.	**Static Differential Relays:** Brief description of static differential relay schemes single phase and three phase schemes. Introduction to static differential protection of generator and transformer.	5
	Static Distance Relays: Introduction to static impedance, reactance and mho relays.	3
3.	**Carrier Current Protection**: Basic apparatus and scheme of power line carrier system. Principle of operation of directional comparison and phase comparison carrier protection and carrier assisted distance protection.	4
	Distance Protection: Effect of power swings on the performance of distance protection. Out of step tripping and blocking relays, mho relay with blinders. Introduction to quadrilateral and elliptical relays.	4
4.	**Circuit Breakers-I**: Electric arc and its characteristics, arc interruption-high resistance interruption and current zero interruption. Arc interruption theories–recovery rate theory and energy balance theory.	4
	Restriking voltage and recovery voltage, develop expressions for restrikingvoltage and RRRV. Resistance switching, current chopping and interruption of capacitive current. Oil circuit breakers-bulk oil and minimum oil circuit breakers. Air circuit breakers. Miniature Circuit breaker (MCB).	4
5.	**Circuit Breakers-II**: Air blast, SF6 and vacuum circuit breakers. Selection of circuit breakers, rating of circuit breakers.	4
	Digital Protection: Introduction to digital protection. Brief description of block diagram of digital relay. Introduction to digital overcurrent, transformer differential and transmission line distance protection.	4

Text Books:

S.No.	Name of authors'/books/publisher:	Year of pub.
1.	BhaveshBhalja, R. P. Maheshari and Nilesh G. Chothani: Protection and Switchgear, Oxford.	2011
2.	Bhuvanesh A. Oza and Nair: Power System Protection and Switchgear, MGH.	2010

Reference Books:

S.No.	Name of authors'/books/publisher	Year of Pub.
1.	B. Ravindranath and M. Chander: Power system Protection and Switchgear, Wiley	1977
2.	B. Ram and D. N. Vishwakarma: Power System Protection and Switchgear, MGH	2001
3.	Y. G. Paithankar and S. R. Bhide: Fundamentals of Power System Protection, PHI.	2010
4.	T.S.M. Rao: Power System Protection- Static Relays with Microprocessor Applications, MGH.	1989

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6EEU04: ADVANCED POWER ELECTRONICS

S.No.	CONTENTS	CONTACT HOURS
1.	**AC Voltage Controllers:** Principle of On-Off Control, Principle of Phase control, Single Phase Bi-directional Controllers with Resistive Loads, Single Phase Controllers with Inductive Loads, Three Phase full wave AC controllers, AC Voltage Controller with PWM Control.	5
2.	**Cyclo-converters:** Basic principle of operation, single phase to single phase, three-phase to three-phase and three-phase to single phase cyclo-converters. Output equation, Control circuit.	8
3.	**Inverters:** Principle of Operation, Single-phase bridge inverters. Three phase bridge Inverters: 180 and 120 degree of conduction. VSI and CSI.	6
	Voltage control of Single Phase and Three Phase Inverters, Harmonic analysis, harmonic reduction techniques, Pulse width modulation techniques.	5
4.	**Resonant Pulse Inverter:** Series resonant inverter with unidirectional switches, parallel resonant inverter, class E resonant inverter, L-type and M-type ZCS resonant converter, ZVS resonant converter.	8
5.	**Power Supplies:** Switched Mode DC Power Supplies, fly-back converter, forward converter, half and full bridge converter, resonant DC power supplies, bi-directional power supplies.	4
	Resonant AC power supplies, bidirectional AC power supplies. Multistage conversions, Control Circuits: Voltage Mode Control, Current Mode Control.	4

Text Books

S.No.	Name of the authors/books/publishers	Year of pub.
1.	M. H. Rashid: Power Electronics: Circuits, Devices & Applications, Pearson Publishers.	2004
2.	Bimal Bose: Power Electronics & Motor Drives, Elsevier-2006.	2010

Reference Books

S.No.	Name of the authors/books/publishers	Year of pub.
1.	V. R. Moorthy: Power Electronics: Devices, Circuits and Industrial Applications, Oxford.	2005
2.	P. C. Sen: Power Electronics, MGH.	1987
3.	Ned Mohan, T. M. Undeland and W. P. Robbins: Power Electronics- Converters, Applications and Design, Wiley India Ltd, 2008.	2007
4.	R. Krishnan: electric motor drives- modeling, analysis and control, Pearson Edu.	2001

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6EEU05.x: SMART GRID TECHNOLOGY

S.No.	CONTENTS	HOURS
1.	**Introduction to Smart Grid:** Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits	5
	Difference between conventional & Smart Grid, Concept of Resilient &Self-Healing Grid, Present development & International policies in Smart Grid, Diverse perspectives from experts and global Smart Grid initiatives.	3
2.	**Smart Grid Technologies:** Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation ,Transmission systems: EMS, FACTS and HVDC, Wide area monitoring,	5
	Protection and Control, Distribution Systems: DMS, Volt/Var control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV).	3
3.	**Smart Meters and Advanced Metering Infrastructure:** Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives,	4
	AMI needs in the smart grid, Phasor Measurement, Unit (PMU), Intelligent Electronic Devices (IED) & their application for monitoring & protection.	4
4.	**Power Quality Management in Smart Grid:** Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources,	5
	Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.	3
5.	**High Performance Computing for Smart Grid Applications:** Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL),	4
	IP based Protocols, Basics of Web Service and CLOUD Computing to make Smart Grids smarter, Cyber Security for Smart Grid	4

Text Books

S.No.	Name of author's /books/publisher	Year of Pub.
1.	Vehbi C. Güngör, Dilan Sahin, TaskinKocak, SalihErgüt, ConcettinaBuccella, Carlo Cecati, and Gerhard P. Hancke: Smart Grid Technologies- Communication Technologies and Standards IEEE Transactions on Industrial Informatics, Vol. 7, No. 4, November 2011.	2011
2.	Xi Fang, SatyajayantMisra, GuoliangXue, and Dejun Yang: Smart Grid – The New and Improved Power Grid- A Survey, IEEE Transaction on Smart Grids,	2011

Reference Books

S.No.	Name of author's /books/publisher	Year of Pub.
1.	Stuart Borlase: Smart Grid-Infrastructure, Technology and Solutions, CRC Press	2012

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6EEU05.x POWER QUALITY

S.No.	CONTENTS	CONTACT HOURS
1.	**Introduction to Power Quality:**Power Quality, Voltage Quality, Concern about power quality, The power quality evaluation procedure-Need for a consistent Vocabulary, General classes of power quality problems, Transients, Long-Duration voltage variations, Short-Duration voltage variations, Voltage Imbalance, waveform distortion, voltage fluctuation, Power frequency variations, Power quality terms	8
2.	**Voltage Sags and Interruptions:** Sources of sags and interruptions-Estimating Voltage sag performance-Fundamental principles of protection-Solutions at the End-User level-Evaluating the economics of different ride_ through alternatives-Motor_ starting sags-Utility system fault_ clearing issues	8
3.	**Fundamentals of Harmonics:** Harmonic Distortion-Voltage versus current distortion Harmonic versus Transients-Power system Quantities under non sinusoidal conditions-Harmonic indices-Harmonic sources from commercial loads-Harmonic sources from industrial loads Locating harmonic sources-System response characteristics-Effects of harmonic distortion Inter harmonics	8
4.	**Applied Harmonics:** Harmonic Distortion Evaluation-Principles of Controlling Harmonics Where to control Harmonics? - Harmonic studies-Devices for controlling Harmonic Design Harmonic filter Design.	8
5.	**Power Quality Monitoring:** Monitoring considerations-Historical perspective of power quality measuring instruments-Power quality measurement equipment-Assessment of power quality measurement data-Application of intelligent systems-Power quality monitoring standards	8

Text Books

S.No.	Name of author's /books/publisher	Year of Pub.
1.	Electrical power systems quality-Roger C.Dugan- McGraw- Hills	2003
2.	Power quality- C.Sankaran, CRC Press	2002

Reference Books

S.No.	Name of author's /books/publisher	Year of Pub.
1.	M.H.J Bollen, 'Understanding Power Quality Problems: Voltage Sags and Interruptions'	1999

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6EEU06.x: POWER SYSTEM PLANNING

S.No	CONTENTS	HOURS
1	**Introduction**: Introduction of power planning, National and Regional Planning, structure of Power System, planning tools.Electricity Regulation, Electrical Forecasting, forecasting techniques modeling.	6
2	**Power system Reliability**: System Reliability, Reliability Planning Criteria for Generation, Transmission and Distribution, Grid Reliability, Reliability Target, Security Requirement, Disaster Management, Roadmap for Reliability and Quality.	8
3	**Generation Planning**: Objectives & Factors affecting Generation Planning, Generation Sources, Integrated Resource Planning, Generation System Model, Loss of Load (Calculation and Approaches), Outage Rate, Capacity Expansion, Scheduled Outage, Loss of Energy, Evaluation Methods. Interconnected System, Factors affecting interconnection under Emergency Assistance.	8
4	**Transmission & Distribution Planning**: Introduction, Objectives of Transmission Planning, Network Reconfiguration, System and Load Point Indices, Data required for Composite System Reliability. Radial Networks – Introduction, Network Reconfiguration, Evaluation Techniques, Interruption Indices, Effects of Lateral Distribution Protection, Effects of Disconnects, Effects of Protection Failure, Effects of Transferring Loads, Distribution Reliability Indices	8
5	**Demand Side Planning**: Computer aided planning, wheeling. Environmental effects, the greenhouse effect.Technological impacts. Insulation coordination. Reactive compensation.	5

S.No.	Name of authors'/books/publisher:	Year of pub.
1.	Power System Planning - R.L. Sullivan, Tata McGraw Hill Publishing Company Ltd	1977/1982
2.	X. Wang, J. R. Mc Donald: Modern Power System Planning, MGH.	1994
3.	S. Pabla: Electrical Power System Planning, Machmillan India Ltd.	2012

S.No.	Name of authors'/books/publisher:	Year of pub.
1.	M. Tllic, F. Faliana and L. Fink: Power System Restructuring Engineering and	2010
2.	L. L. Lie: Power System Restructuring and Deregulation, John Willey & Sons UK.	2001

Anil K. Mathur

6EEU06.x: POWER SYSTEM INSTRUMENTATION

S.No.	CONTENTS	CONTACT HOURS
1.	**Theory of Errors:** Accuracy and precision, systematic and random errors, limits of error, probable error and standard deviation. Gaussian error curves, combination of errors.	8
2.	**Transducers:** Construction & Operating Characteristics of active and digital transducers, Measurement of temperature, pressure, displacement, acceleration, noise level. Instrumentation for strain, displacement, velocity, acceleration, force, torque and temperature.	4 4
3.	**Signal Conditioning:** Instrumentation amplifiers, isolation amplifiers, analog multipliers, analog dividers, function generators, timers, sample and hold, optical and magnetic isolators. Frequency to voltage converters, temperature to current converters. Shielding and grounding.	5 3
4.	**Power System Instrumentation-I:** Measurement of voltage, current, phase angle, frequency, active power and reactive power in power plants. Energy meters and multipart tariff meters. Basic idea of LT & HT panel's.	8
5.	**Power System Instrumentation-II:** Capacitive voltage transformers and their transient behavior, Current Transformers for measurement and protection, composite errors and transient response.	8

Text Books:

S.No.	Name of authors'/books/publisher:	Year of pub.
1.	R. H. Cerni and L. E. Foster: Instrumentation for Engineering Measurements, John Wiley and Sons.	1962
2.	Curtis and D. Hohnson: Process Control Instrumentation Technology, John Wiley and sons.	2013

Reference Books:

S.No.	Name of authors'/books/publisher	Year of pub.
1.	R. Morrison: Instrumentation Fundamentals and Applications, John Wiley and Sons.	1984
2.	A. K. Sawhney: Advanced Measurements & Instrumentation, Dhanpat Rai & Sons	1994
3.	E.O. Decblin: Measurement System– Application & design, MGH.PHI.	1975
4.	W.D. Cooper and A.P. Beltried: Electronics Instrumentation and Measurement Techniques, Prentice Hall International.	1987
5.	A. S. Moris: Principles of Measurement & Instrumentation, Prentice Hall	1993

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6EEU07: ADVANCED POWER ELECTRONICS LAB

1. Study and test AC voltage regulators using triac, antiparallel thyristors and triac&diac.
2. Study and test single phase PWM inverter.
3. Study and test buck, boost and buck- boost regulators.
4. Study and test MOSFET chopper.
5. Study and test Zero voltage switching.
6. Study and test SCR DC circuit breaker.
7. Control speed of a dc motor using a chopper and plot armature voltage versus speed characteristic.
8. Control speed of a single-phase induction motor using single phase AC voltage regulator.
9. **(i).**Study single-phase dual converter.
   (ii). Study speed control of dc motor using single-phase dual converter.
10. Study one, two and four quadrant choppers (DC-DC converters).
11. Study speed control of dc motor using one, two and four quadrant choppers.
12. Study single-phase cycloconverter.

6EEU08: CONTROL SYSTEM LAB

1. Introduction to MATLAB Computing Control Software.
2. Defining Systems in TF, ZPK form.
3. **(a)** Plot step response of a given TF and system in state-space. Take different values of damping ratio and wn natural undamped frequency.
   (b) Plot ramp response.
4. For a given 2ndorder system plot step response and obtain time response specification.
5. To design 1st order R-C circuits and observe its response with the following inputs and trace the curve.
   (a) Step
   (b) Ramp
   (c) Impulse
6. To design 2nd order electrical network and study its transient response for step input and following cases.
   (a) Under damped system
   (b) Over damped System.
   (c) Critically damped system.
7. **(a)** Log Network
   (b) Lead Network
   (c) Log-lead Network.
8. To draw characteristics of ac servomotor
9. To perform experiment on Potentiometer error detector.
10. Check for the stability of a given closed loop system.
11. Plot bode plot for a 2ndorder system and find GM and PM.

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6EEU09: POWER SYSTEM PROTECTION LAB

1. To determine fault type, fault impedance and fault location during single line to ground fault.
2. To determine fault type, fault impedance and fault location during single line-to-line fault.
3. To determine fault type, fault impedance and fault location during double line to ground fault.
4. To study the operation of microcontroller based over current relay in DMT type and IDMT type.
5. To analyze the operation of microcontroller based directional over current relay in DMT type and IDMT type.
6. To study the microcontroller based under voltage relay.
7. To study the microcontroller based over voltage relay.
8. To study the operation of microcontroller based un-biased single-phase differential relay.
9. To study the operation of microcontroller based biased single-phase differential relay.
10. To study the operation of microcontroller un-based biased three phase differential relay
11. To study the operation of microcontroller based biased three phase differential relay.

6EEU10: ENTREPRENEURSHIP DEVELOPMENT

1. Definition of entrepreneur, qualities of a successful entrepreneur, Charms of being an entrepreneur, achievement- motivation, leadership and entrepreneurial competencies.
2. Decision-making, procedures and formalities for starting own business, financial support system.
3. Identification and selection of business opportunities and market survey, business plan. Implementation and customer satisfaction.
4. Business crises, problem-solving attitude, communication skill. Government policies for entrepreneurs.
5. Knowledge based enterprises, Scope of entrepreneur in present context, area of future entrepreneurship.
6. Marketing & Sales Promotion, Techno-Economic Feasibility Assessment by Preparation of Preliminary & Detailed project report.

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Syllabus VII Sem Electrical Engineering

7EEU1	Power System Analysis	3L:1T:0P	4 Credits

Percent and per unit quantities. Single line diagram for a balanced 3-phase system. Admittance Model: Branch and node admittances Equivalent admittance network and calculation of Y bus. Modification of an existing Y bus.
Impedance Model: Bus admittance and impedance matrices. Thevenin's theorem and Z bus. Direct determination of Z bus. Modification of an existing bus. Symmetrical fault Analysis: Transient on a Transmission line, short circuit of a synchronous machine on no load, short circuit of a loaded synchronous machine. Equivalent circuits of synchronous machine under sub transient, transient and steady state conditions. Selection of circuit breakers, Algorithm for short circuit studies. Analysis of three-phase faults.
Symmetrical Components: Fortescue theorem, symmetrical component transformation. Phase shift in star-delta transformers. Sequence Impedances of transmission lines, Synchronous Machine and Transformers, zero sequence network of transformers and transmission lines. Construction of sequence networks of power system. Fault Analysis: Analysis of single line to ground faults using symmetrical components, connection of sequence networks under the fault condition.
Unsymmetrical Fault Analysis: Analysis of line-to-line and double line to ground faults using symmetrical components, connection of sequence networks under fault conditions. Analysis of unsymmetrical shunt faults using bus impedance matrix method.
Load Flow Analysis: Load Flow problem, development of load flow equations, bus classification. Gauss Seidel, Newton Raphson, decoupled and fast decoupled methods for load flow analysis. Comparison of load flow methods.

Text/Reference Books	
1	J. J. Grainger, William, D. Stevenson Jr.: Power System Analysis, MGH.
2	T. K. Nagsarkar & M. S. Sukhija: Power System Analysis, Oxford University Press.
3	J. D. Glover, M. S. Sharma & T. J. Overbye: Power System Analysis and Design, Cengage Learning.
4	Nasser Tleis: Power System Modelling and Fault Analysis, Elsevier.
5	Kothari &Nagrath: Modern Power System Analysis, MGH.
6	Haadi Saadat: Power System Analysis.

7EEU2	Economic Operation of Power System	3L:1T:0P	4 Credits

Economics of Power Generation: Introduction, cost of electrical energy, expression for cost of electrical energy, depreciation, power plant cost analysis, economics in plant selection, Selection of types of generation and types of equipment, factors effecting Economic generations and distributions, generating cost, economics of different types of generating plants
Economical Operations of Thermal Power Plants: Methods of loading turbo generators, input, output and heat rate characteristics, incremental cost, two generations units, large no of units, sequence of adding units, effects of transmission losses, economic scheduling considering transmission losses, coordination equations, penalty factors
Hydro Thermal coordination: Advantages of combined operation, base load peak load operation requirement, combined working of run-off river and steam plant Reservoirs, hydroelectric plants and thermal plants (long term operational aspects), short term hydro thermal coordination, coordination equations, scheduling methods and applications.
Parallel Operations of Generators: Conditions, synchronizing current and power, Parallel Operations of Generators: Conditions, synchronizing current and power.
Economics for Electrical Engineers: Concepts of physical and financial efficiencies of electrical goods and services, supply and demand, break even and minimum cost analysis, linear and nonlinear breakeven, min cost analysis.

Text/Reference Books	
1.	J. Wood & B. F. Wollenburg: Power Generation, Operation and Control, John Wiley. 2013
2.	D. P. Kothari & I. J. Nagrath: Modern Power System Analysis, MGH.
3.	O. I. Elgerd: Electric Energy System Theory, MGH. 1983
4.	P. Kundur: Power System Stability and Control, MGH. 1994
5.	Arthur R. Bergen and Vijay Vittal: Power System Analysis, Second Edition. PHI. 1999
6.	C. L. Wadhwa: Electrical Power Systems, Newage International (P) Ltd. 2000

7EEU3	Power System Engineering	3L:0T:0P	3 Credits

Economic Operation of Power Systems: Introduction, system constraints, optimal operation of power systems. Input output, heat rate and incremental rate curves of thermal generating units. Economic distribution of load between generating units within a plant. Economic distribution of load between power stations, transmission loss equation. Introduction to unit commitment and dynamic programming.
Power System Stability-I: Power angle equations and power angle curves under steady state and transient conditions. Rotor dynamics and swing equation (solution of swing equation not included). Synchronizing power coefficient. Introduction to steady state and dynamic stabilities, Steady state stability limit.
Power System Stability-II: Introduction to transient stability. Equal area criterion and its application to transient stability studies under basic disturbances. Critical clearing angle and critical clearing time. Factors affecting stability and methods to improve stability.
Excitation Systems: Introduction of excitation systems of synchronous machines, types of excitation systems, Elements of various excitation systems and their control (functional block diagrams and their brief description)-DC excitation systems, AC excitation systems, brushless excitation system. Interconnected Power Systems: Introduction to isolated and interconnected powers systems. Reserve capacity of power stations, spinning and maintenance reserves. Advantages and problems of interconnected power systems. Power systems interconnection in India.
Tap Changing transformer, phase angle control and phase shifting transformer. Series compensation of transmission lines, location and protection of series capacitors, advantages and problems. Introduction to power system security. Introduction to voltage stability.

Text/Reference Books	
1.	J. Nagrath and D.P. Kothari: Power System Engineering 2/e, MGH. 2011
2.	J. J. Grainger and W. D. Stevenson: Power System Analysis, MGH. 2003
3.	B. R. Gupta: Power System Analysis and Design, Third Edition, S. Chand & Co. 2008
4.	C. L. Wadhwa: Electrical Power Systems, New age international Ltd. Third Edition 2009
5.	B. R. Gupta: Generation of Electrical Energy, S. Chand Publication. 2009

7EEU4	Electric Drives and Control	3L:01T:0P	3 Credits

Dynamics of Electric Drives: Fundamental torque equations, speed-torque conventions and multi-quadrant operation, Nature and classification of load torques, steady state stability, load equalization, close loop configurations of drives.
DC Drives: Speed torque curves, torque and power limitation in armature voltage and field control, Starting, Braking: Regenerative Braking, dynamic braking and plugging. Speed Control- Controlled Rectifier fed DC drives, Chopper Controlled DC drives.
Induction Motor Drives-I: Starting, Braking-Regenerative braking, plugging and dynamic braking. Speed Control: Stator voltage control, variable frequency control from voltage source, Voltage Source Inverter (VSI) Control.
Induction Motor Drives-II: Variable frequency control from current source, Current Source Inverter (CSI) Control, Cyclo-converter Control, Static rotor resistance control, Slip Power Recovery- Stator Scherbius drive, Static Kramer drive.
Synchronous Motor Drive: Control of Synchronous Motor-Separately Controlled and VSI fed Self-Controlled Synchronous Motor Drives. Dynamic and Regenerative Braking of Synchronous Motor with VSI. Control of Synchronous Motor Using Current Source Inverter (CSI).

Text/Reference Books	
1.	G. K. Dubey: Fundamentals of Electrical Drives, Narosa Publishing House, New Delhi. 2002
2.	B. K. Bose: Power Electronics and Motor Drives, Elsevier. 2010
3.	V. Subrahmanyam: Electric Drives- Concepts and Applications, MGH. 2011
4.	Theodore Wildi: Electrical Machines, Drives and Power Systems, Pearson 2007
5.	S. K. Pillai: A First Course on Electrical Drives, Wiley Eastern limited, India. 1989

7EEU5.1	HVdc Transmission System	3L:0T:0P	3 Credits

dc Transmission Technology: Comparison of AC and dc Transmission (Economics, Technical Performance and Reliability). Application of DC Transmission. Types of HVdc Systems. Components of a HVdc system. Line Commutated Converter and Voltage Source Converter based systems.
Analysis of Line Commutated and Voltage Source Converters:Line Commutated Converters (LCCs): Six pulse converter, Analysis neglecting commutation overlap, harmonics, Twelve Pulse Converters. Inverter Operation. Effect of Commutation Overlap. Expressions for average dc voltage, AC current and reactive power absorbed by the converters. Effect of Commutation Failure, Misfire and Current Extinction in LCC links. Voltage Source Converters (VSCs): Two and Three-level VSCs. PWM schemes: Selective Harmonic Elimination, Sinusoidal Pulse Width Modulation. Analysis of a six-pulse converter. Equations in the rotating frame. Real and Reactive power control using a VSC.
Control of HVdc Converters: Principles of Link Control in a LCC HVdc system. Control Hierarchy, Firing Angle Controls – Phase-Locked Loop, Current and Extinction Angle Control, Starting and Stopping of a Link. Higher level Controllers Power control, Frequency Control, Stability Controllers. Reactive Power Control. Principles of Link Control in a VSC HVdc system: Power flow and dc Voltage Control. Reactive Power Control/AC voltage regulation.
Components of HVdc systems: Smoothing Reactors, Reactive Power Sources and Filters in LCC HVdc systems DC line: Corona Effects. Insulators, Transient Over-voltages. dc line faults in LCC systems. dc line faults in VSC systems. dc breakers. Monopolar Operation. Ground Electrodes.
Stability Enhancement using HVdc Control: Basic Concepts: Power System Angular, Voltage and Frequency Stability. Power Modulation: basic principles – synchronous and asynchronous links. Voltage Stability Problem in AC/dc systems.
MTdc Links: Multi-Terminal and Multi-Infeed Systems. Series and Parallel MTdc systems using LCCs. MTdc systems using VSCs. Modern Trends in HVdcTechnology. Introduction to Modular Multi-level Converters.

Text/Reference Books	
1.	K. R. Padiyar, “HVDC Power Transmission Systems”, New Age International Publishers, 2011.
2.	J. Arrillaga, “High Voltage Direct Current Transmission”, Peter Peregrinus Ltd., 1983.
3.	E. W. Kimbark, “Direct Current Transmission”, Vol.1, Wiley-Interscience, 1971

7EEU5.2	Line Commutated and Active Rectifiers	3L:0T:0P	3 Credits

Diode rectifiers with passive filtering, Half-wave diode rectifier with RL and RC loads; 1-phase full-wave diode rectifier with L, C and LC filter; 3-phase diode rectifier with L, C and LC filter; continuous and discontinuous conduction, input current waveshape, effect of source inductance; commutation overlap.
Thyristor rectifiers with passive filtering, Half-wave thyristor rectifier with RL and RC loads; 1-phase thyristor rectifier with L and LC filter; 3-phase thyristor rectifier with L and LC filter; continuous and discontinuous conduction, input current waveshape.
Multi-Pulse converter, Review of transformer phase shifting, generation of 6-phase ac voltage from 3-phase ac, 6- pulse converter and 12-pulse converters with inductive loads, steady state analysis, commutation overlap, notches during commutation.
Single-phase ac-dc single-switch boost converter Review of dc-dc boost converter, power circuit of single-switch ac-dc converter, steady state analysis, unity power factor operation, closed-loop control structure.
Ac-dc bidirectional boost converter, Review of 1-phase inverter and 3-phase inverter, power circuits of 1-phase and 3-phase ac-dc boost converter, steady state analysis, operation at leading, lagging and unity power factors. Rectification and regenerating modes. Phasor diagrams, closed-loop control structure.
Isolated single-phase ac-dc fly-back converter, Dc-dc fly-back converter, output voltage as a function of duty ratio and transformer turns ratio. Power circuit of ac-dc fly-back converter, steady state analysis, unity power factor operation, closed loop control structure.

Text/Reference Books	
1.	G. De, “Principles of Thyristorise Converters”, Oxford & IBH Publishing Co, 1988.
2.	J.G. Kassakian, M. F. Schlecht and G. C. Verghese, “Principles of Power Electronics”, AddisonWesley, 1991.
3.	L. Umanand, “Power Electronics: Essentials and Applications”, Wiley India, 2009.
4.	N. Mohan and T. M. Undeland, “Power Electronics: Converters, Applications and Design”, John Wiley & Sons, 2007.
5.	R. W. Erickson and D. Maksimovic, “Fundamentals of Power Electronics”, Springer Science & Business Media, 2001

7EEU5.3	Digital Control Systems	3L:0T:0P	3 Credits

Discrete Representation of Continuous Systems: Basics of Digital Control Systems. Discrete representation of continuous systems. Sample and hold circuit. Mathematical Modelling of sample and hold circuit. Effects of Sampling and Quantization. Choice of sampling frequency. ZOH equivalent.
Discrete System Analysis: Z-Transform and Inverse Z Transform for analyzing discrete time systems. Pulse Transfer function. Pulse transfer function of closed loop systems. Mapping from s-plane to z plane. Solution of Discrete time systems. Time response of discrete time system.
Stability of Discrete Time System: Stability analysis by Jury test. Stability analysis using bilinear transformation. Design of digital control system with dead beat response. Practical issues with dead beat response design.
State Space Approach for discrete time systems: State space models of discrete systems, State space analysis. Lyapunov Stability. Controllability, reach-ability, Reconstructability and observability analysis. Effect of pole zero cancellation on the controllability & observability.
Design of Digital Control System: Design of Discrete PID Controller, Design of discrete state feedback controller. Design of set point tracker. Design of Discrete Observer for LTI System. Design of Discrete compensator.
Discrete output feedback control: Design of discrete output feedback control. Fast output sampling (FOS) and periodic output feedback controller design for discrete time systems.

Text/Reference Books	
1.	K. Ogata, “Digital Control Engineering”, Prentice Hall, Englewood Cliffs, 1995.
2.	M. Gopal, Digital control and state variable methods. Tata McGraw Hill New Delhi, 2001.
3.	G. F. Franklin, J. D. Powell and M. L. Workman, “Digital Control of Dynamic Systems”, Addison-Wesley, 1998.
4.	B.C. Kuo, “Digital Control System”, Holt, Rinehart and Winston, 1980.
5.	V. I. George and C.P. Kurian, Digital Control Systems, Cengage publishers. New Delhi, 2012.

7EEU7	Power System Modelling and Simulation Lab	0L:01T:3P	2 Credits

Part A:

1. Fault analysis (for 3 to 6 bus) and verify the results using MATLAB or any available software for the cases: (i) LG Fault (ii) LLG Fault (iii) LL Fault and (iv) 3-Phase Fault

2. Load flow analysis for a given system (for 3 to 6 bus) using (i) Gauss Seidal (ii) Newton Raphson (iii) Fast Decoupled Method and verify results using MATLAB or any available software

3. Study of voltage security analysis

4. Study of overload security analysis and obtain results for the given problem using MATLAB or any software.

5. Study of economic load dispatch problem with different methods. Study of transient stability analysis using MATLAB/ETAP Software

Part B:

1. Simulate Swing Equation in Simulink (MATLAB)

2. Modeling of Synchronous Machine.

3. Modeling of Induction Machine.

7EEU8	Electric Drives and Control Lab	0L:01T:2P	1 Credits

1. Study and test the firing circuit of three phase half-controlled bridge converter.

2. Study and obtain waveforms of 3 phase half-controlled bridge converter with R and RL loads.

3. Study and test the firing circuit of 3-phase full controlled bridge converter.

4. Study and obtain waveforms of 3-phase full controlled bridge converter with R and RL loads.

5. Study and test 3-phase AC voltage regulator.

6. Control speed of dc motor using 3-phase half-controlled bridge converter. Plot armature voltage versus speed characteristic.

7. Control speed of dc motor using 3-phase full controlled bridge converter. Plot armature voltage versus speed characteristic.

8. Control speed of a 3-phase induction motor in variable stator voltage mode using 3-phase AC voltage regulator.

9. Control speed of a 3-phase BLDC motor.

10. Control speed of a 3-phase PMSM motor using frequency and voltage control

11. Control speed of universal motor using AC voltage regulator.

12. Study 3-phase dual converter.

13. Study speed control of dc motor using 3-phase dual converter.

14. Study three-phase cycloconverter and speed control of synchronous motor using cycloconverter.

15. Control of 3-Phase Induction Motor in variable frequency V/f constant mode using 3-phase inverter

7EEU9	Industrial Economics and Management	0L:01T:2P	1 Credits

Money Banking and Trade: Functions of money, supply & demand for money, money price level &inflation, black money, meaning, magnitude & consequences. Functions of Commercial banks, banking system in India, shortcomings and improvements. Function of RBI, monetary policy-making, objectives and features. Sources of public revenue, principles of taxation, direct and indirect taxes, Theory of international trade, balance of trade and payment, Foreign exchange control, devaluation New economic policy: Liberalization, extending privatization, globalization.

Management Principles: Management functions, responsibilities of management to society, development of management thought. Nature of planning, decision making, management by

objectives, Line and staff authority relationships, decentralization and delegation of authority, span of management.
Production Management: Production planning and control, inventory control, quality control and Total quality management. ISO standards Related to quality/Environment/safety etc. Tools of Project Management: CPM, PERT, project information systems. Marketing functions, management of sales and advertising marketing research.
Human Resource Management: Function, application of industrial psychology for selection, training and recruitment. Communication process, media channels and barriers to effective communication, theories of motivation, leadership.
Finance and Account Management: Engineering Economics: Investment decision, present worth, annual worth and rate of return methods. Payback time. Need for good cost accounting system, cost control techniques of financial control, financial statements, financial ratios, breakeven analysis, budgeting and budgetary control.

Syllabus VIII Sem Electrical Engineering

8EEU1.1	Artificial Intelligence	3L:0T:0P	3 Credits

Introduction to Artificial Intelligence: Intelligent Agents, State Space Search, Uninformed Search, Informed Search, Two Players Games, Constraint Satisfaction Problems
Knowledge Representation: Knowledge Representation and Logic, Interface in Propositional Logic, First Order Logic, Reasoning Using First Order Logic, Resolution in FOPL
Knowledge Organization: Rule Based System, Semantic Net, Reasoning in Semantic Net, Frames, Planning
Knowledge Systems: Rule Based Expert System, Reasoning with Uncertainty, Fuzzy Reasoning
Knowledge Acquisition: Introduction to Learning, Rule Induction and Decision Trees, Learning Using neural Networks, Probabilistic Learning, Natural Language Processing
Control Strategies: Concept of heuristic search, search techniques depth first search, Breath first search, Generate & test hill climbing, best first search

Text/Reference Books	
1.	Saroj Kaushik: Artificial Intelligence, Cengage Learning., 2007.
2.	Elaine Rich and Kevin Knight: Artificial Intelligence 3/e, MGH, 2004.
3.	Padhy: Artificial Intelligence & Intelligent Systems, Oxford 2005
4.	S. Rajsekaran & G. A. Vijayalakshmi Pai: Neural Networks, Fuzzy Logic and Genetic Algorithm- Synthesis and Applications, Prentice Hall of India. 2003.
5.	Dan. W Patterson: Artificial Intelligence and Expert Systems 1990

8EEU1.2	Machine Learning	3L:0T:0P	3 Credits

Supervised Learning (Regression/Classification) • Basic methods: Distance-based methods, Nearest-Neighbours, Decision Trees, Naive Bayes • Linear models: Linear Regression, Logistic Regression, Generalized Linear Models • Support Vector Machines, Nonlinearity and Kernel Methods • Beyond Binary Classification: Multi-class/Structured Outputs, Ranking
Unsupervised Learning • Clustering: K-means/Kernel K-means • Dimensionality Reduction: PCA and kernel PCA • Matrix Factorization and Matrix Completion • Generative Models (mixture models and latent factor models)
Evaluating Machine Learning algorithms and Model Selection, Introduction to Statistical Learning Theory, Ensemble Methods (Boosting, Bagging, Random Forests)
Sparse Modeling and Estimation, Modeling Sequence/ Time-Series Data, Deep Learning and Feature Representation Learning
Scalable Machine Learning (Online and Distributed Learning) A selection from some other advanced topics, e.g., Semi-supervised Learning, Active Learning, Reinforcement Learning, Inference in Graphical Models, Introduction to Bayesian Learning and Inference.
Recent trends in various learning techniques of machine learning and classification methods for IOT applications. Various models for IOT applications.

Text/Reference Books	
1.	Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.
2.	Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer 2009 (freely available online)
3.	Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2007.
4.	Tom Mitchell, “Machine Learning”, New York, NY: McGraw-Hill, 1997

8EEU1.3	Soft Computing Techniques	3L:0T:0P	3 Credits

Introduction to Soft Computing and Neural Networks: Evolution of Computing - Soft Computing Constituents – From Conventional AI to Computational Intelligence. Adaptive Networks – Feed forward Networks – Supervised Learning
FUZZY LOGIC: Fuzzy Sets, Operations on Fuzzy Sets, Fuzzy Relations, Membership Functions: Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference Systems, Fuzzy Expert Systems, Fuzzy Decision Making.
NEURAL NETWORKS: Machine Learning Using Neural Network, Adaptive Networks, Feed forward Networks, Supervised Learning Neural Networks, Radial Basis Function Networks: Reinforcement Learning, Unsupervised Learning Neural Networks, Adaptive Resonance architectures, Advances in Neural networks
GENETIC ALGORITHMS: Introduction to Genetic Algorithms (GA), Applications of GA in Machine Learning: Machine Learning Approach to Knowledge Acquisition.
Fuzzy Inference Systems – Fuzzy Logic – Fuzzy Expert Systems – Fuzzy Decision-Making Neuro-Fuzzy Modeling: Adaptive Neuro-Fuzzy Inference Systems – Coactive Neuro-Fuzzy Modeling – Classification and Regression Trees.
Hybrid AI Techniques: Neuro- Fuzzy, Fuzzy-rough set systems, Neuro-Fuzzy-GA systems and case studies around Hybrid systems.

Text/Reference Books	
1.	David E. Goldberg, Genetic Algorithms in Search, Optimization and Machine Learning", Addison Wesley.
2.	George J. Klir and Bo Yuan, "Fuzzy Sets and Fuzzy Logic-Theory and Applications", Prentice Hall.
3.	Mitchell Melanie, "An Introduction to Genetic Algorithm", Prentice Hall, 1998.
4.	Simon Haykin, "Neural Networks: A Comprehensive Foundation", Prentice Hall.
1.	Jyh:Shing Roger Jang, Chuen:Tsai Sun, EijiMizutani, Neuro:Fuzzy and Soft Computing, Prentice:Hall of India, 2003.

8EEU2.1	FACTS Devices and their Applications	3L:0T:0P	3 Credits

Problems of AC transmission systems, power flow in parallel paths and meshed system, factors limiting loading capability, Stability consideration. Power flow control of an ac transmission line. Basic types of facts controllers. Advantages of FACTS technology.
Voltage-Sourced Converters: Basic concept of voltage-sourced converters, single and three phase bridge converters. Introduction to power factor control. Transformer connections for 12-pulse, 24 pulse and 48 pulse operations. **Static Shunt Compensators:** Mid-point and end point voltage regulation of transmission line, and stability improvement. Basic operating principle of Static Synchronous Compensators (STATCOM). Comparison between STATCOM and SVC.
Static Series Compensators: Concept of series capacitive compensation, voltage and transient stabilities, power oscillation and sub synchronous oscillation damping. Introduction to thyristors switched series capacitor (TSSC), thyristor-controlled series capacitor (TCSC), and static synchronous series compensator, - operation, characteristics and applications.
Static Voltage and Phase Angle Regulators: Voltage and phase angle regulation. Power flow control and improvement of stability by phase angle regulator. Introduction to thyristor-controlled voltage and phase angle regulators (TCVR and TCPAR) (ii) Introduction to thyristor controlled braking resistor and thyristor-controlled voltage limiter.
UPFC: Unified Power Flow Controller (UPFC), basic operating principles, conventional transmission control capabilities. Comparison of UPFC to series compensators and phase angle regulator. Applications of UPFC. **IPFC:** Interline Power Flow Controller (IPFC), basic operating principles and characteristics. Applications of IPFC.

Text/Reference Books	
1.	K. R. Padiyar: Flexible AC Transmission Systems
2.	N. G. Hingorani, L. Gyugyi: Understanding FACTS: IEEE Press Book.
3.	Yong Hua Song, Allan T Johns: Flexible AC Transmission Systems FACTS
4.	Xiao Ping Zhang, Christian Rehtanz, Bikash Pal: Flexible AC Transmission Systems.
5.	R. Mohan & R. M. Mathur: Thyristor-based FACTS Controllers for Electrical Transmission Systems, John Wiley

8EEU2.2	Wind and Solar Energy Systems	3L:0T:0P	3 Credits

Physics of Wind Power History of wind power, Indian and Global statistics, Wind physics, Betz limit, Tip speed ratio, stall and pitch control, Wind speed statistics-probability distributions, Wind speed and power-cumulative distribution functions.
Wind Generator Topologies Review of modern wind turbine technologies, Fixed and Variable speed wind turbines, Induction Generators, Doubly-Fed Induction Generators and their characteristics, Permanent Magnet Synchronous Generators, Power electronics converters. Generator-Converter configurations, Converter Control.
The Solar Resource Introduction, solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability.
Solar Photovoltaic Technologies-Amorphous, monocrystalline, polycrystalline; V-I characteristics of a PV cell, PV module, array, Power Electronic Converters for Solar Systems, Maximum Power Point Tracking (MPPT) algorithms. Converter Control.
Network Integration Issues Overview of grid code technical requirements. Fault ride-through for wind farms - real and reactive power regulation, voltage and frequency operating limits, solar PV and wind farm behavior during grid disturbances. Power quality issues. Power system interconnection experiences in the world. Hybrid and isolated operations of solar PV and wind systems.
Solar Thermal Power Generation Technologies, Parabolic trough, central receivers, parabolic dish, Fresnel, solar pond, elementary analysis.

Text/Reference Books	
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.		
8EEU2.3	Electrical Energy Conservation and Auditing	3L:0T:0P	3 Credits

Energy Scenario: Commercial and Non-commercial energy, primary energy resources, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario, energy pricing, energy sector reforms, energy and environment, energy security, energy conservation and its importance, restructuring of the energy supply sector, energy strategy for the future, air pollution, climate change. Energy Conservation Act-2001 and its features.
Basics of Energy and its Various Forms: Electricity tariff, load management and maximum demand control, power factor improvement, selection & location of capacitors, Thermal Basics-fuels, thermal energy contents of fuel, temperature & pressure, heat capacity, sensible and latent heat, evaporation, condensation, steam, moist air and humidity & heat transfer, units and conversion.
Energy Management & Audit: Definition, energy audit, need, types of energy audit. Energy management (audit) approach understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments. Material and Energy balance: Facility as an energy system, methods for preparing process flow, material and energy balance diagrams.
Energy Efficiency in Electrical Systems: Electrical system: Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors, performance assessment of PF capacitors, distribution and transformer losses. Electric motors: Types, losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors.
Energy Efficiency in Industrial Systems: Overview of grid code technical requirements. Fault ride-through for wind farms - real and reactive power regulation, voltage and frequency operating limits, solar PV and wind farm behavior during grid disturbances. Power quality issues. Power system interconnection experiences in the world. Hybrid and isolated operations of solar PV and wind systems.
Energy Efficient Technologies in Electrical Systems: Maximum demand controllers, automatic power factor controllers, energy efficient motors, soft starters with energy saver, variable speed drives, energy efficient transformers, electronic ballast, occupancy sensors, energy efficient lighting controls, energy saving potential of each technology.

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

	Auditors Book-3, Electrical Utilities (available online)
3.	S. C. Tripathy, "Utilization of Electrical Energy and Conservation", McGraw Hill, 1991.
4.	Success stories of Energy Conservation by BEE, New Delhi. (www.bee-india.org)

8EEU3.1	Industrial Electrical Systems	3L:0T:0P	3 Credits

Electrical System Components: LT system wiring components, selection of cables, wires, switches, distribution box, metering system, Tariff structure, protection components- Fuse, MCB, MCCB, ELCB, inverse current characteristics, symbols, single line diagram (SLD) of a wiring system, Contactor, Isolator, Relays, MPCB, Electric shock and Electrical safety practices.
Residential and Commercial Electrical Systems: Types of residential and commercial wiring systems, general rules and guidelines for installation, load calculation and sizing of wire, rating of main switch, distribution board and protection devices, earthing system calculations, requirements of commercial installation, deciding lighting scheme and number of lamps, earthing of commercial installation, selection and sizing of components.
Illumination Systems: Understanding various terms regarding light, lumen, intensity, candle power, lamp efficiency, specific consumption, glare, space to height ratio, waste light factor, depreciation factor, various illumination schemes, Incandescent lamps and modern luminaries like CFL, LED and their operation, energy saving in illumination systems, design of a lighting scheme for a residential and commercial premises, flood lighting.
Industrial Electrical Systems I: Connection, industrial substation, Transformer selection, Industrial loads, motors, starting of motors, SLD, Cable and Switchgear selection, Lightning Protection, Earthing design, Power factor correction – kVAR calculations, type of compensation, Introduction to PCC, MCC panels. Specifications of LT Breakers, MCB and other LT panel components.
Industrial Electrical Systems II: DG Systems, UPS System, Electrical Systems for the elevators, Battery banks, Sizing the DG, UPS and Battery Banks, Selection of UPS and Battery Banks.
Industrial Electrical System Automation: Study of basic PLC, Role of in automation, advantages of process automation, PLC based control system design, Panel Metering and Introduction to SCADA system for distribution automation.

Text/Reference Books	
1.	S. L. Uppal and G. C. Garg, "Electrical Wiring, Estimating & Costing", Khanna publishers, 2008.
2.	K. B. Raina, "Electrical Design, Estimating & Costing", New age International, 2007.
3.	S. Singh and R. D. Singh, "Electrical estimating and costing", DhanpatRai and Co., 1997.

4.	Web site for IS Standards.
5.	H. Joshi, “Residential Commercial and Industrial Systems” McGraw Hill Education, 2008.

8EEU3.2	Electrical and Hybrid Vehicles	3L:0T:0P	3 Credits

Introduction: Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, and mathematical models to describe vehicle performance.
Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.
Electric Trains: Electric Drive-trains: Basic concept of electric traction, introduction to various electric drivetrain topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.
Energy Storage: Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems
Energy Management Strategies: Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies. Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

Text/Reference Books	
1.	C. Mi, M. A. Masrur and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2011.
2.	S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies", Springer, 2015.
3.	M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004
4.	T. Denton, "Electric and Hybrid Vehicles", Routledge, 2016.

8EEU3.3	Power System Dynamics and Control	3L:0T:0P	3 Credits

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.
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.
Modeling of Synchronous Machines and Associated Controllers Modeling of synchronous machine: Physical Characteristics. Rotor position dependent model. D-Q Transformation. Model with Standard Parameters. Steady State Analysis of Synchronous Machine. Short Circuit Transient Analysis of a Synchronous Machine. Synchronization of Synchronous Machine to an Infinite Bus. Modeling of Excitation and Prime Mover Systems. Physical Characteristics and Models. Excitation System Control. Automatic Voltage Regulator. Prime Mover Control Systems. Speed Governors.
Modeling of other Power System Components Modeling of Transmission Lines and Loads. Transmission Line Physical Characteristics. Transmission Line Modeling. Load Models - induction machine model. Frequency and Voltage Dependence of Loads. Other Subsystems – HVDC and FACTS controllers, Wind Energy Systems.
Stability Analysis Angular stability analysis in Single Machine Infinite Bus System. Angular Stability in multimachine systems – Intra-plant, Local and Inter-area modes. Frequency Stability: Centre of Inertia Motion. Load Sharing: 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.
Stability Analysis Planning Measures. Stabilizing Controllers (Power System Stabilizers). Operational Measures-Preventive Control. Emergency Control.

Text/Reference Books	
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.