CURRICULUM

OF

ELECTRICAL ENGINEERING
FOR
BACHELOR AND MASTER DEGREE PROGRAMS

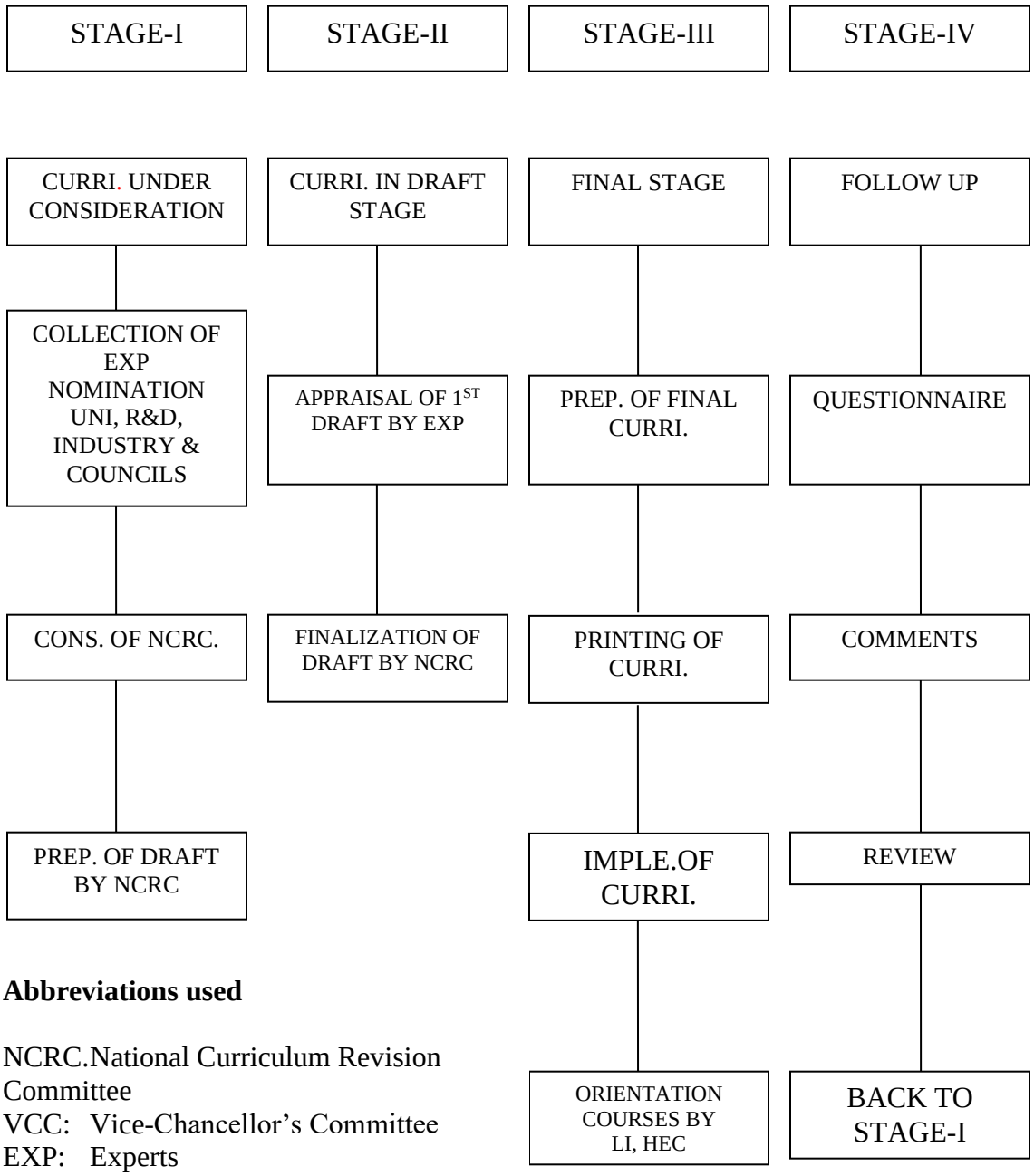
(Revised 2017)

HIGHER EDUCATION COMMISSION
ISLAMABAD

CURRICULUM DIVISION, HEC

CONTENTS

CURRICULUM DEVELOPMENT



Abbreviations used

NCRC.National Curriculum Revision Committee
VCC: Vice-Chancellor's Committee
EXP: Experts
COL: Colleges
UNI: Universities
PREP: Preparation
REC: Recommendations
LI: Learning Innovation
R&D: Research & Development
HEC: Higher Education Commission

Introduction

Curriculum and Learning Process

The genesis of any engineering program is the fusion of its stakeholders' perceptions. The academic curriculum of the program is designed to facilitate / ensure the achievement of program outcomes by all students. This is achieved by offering a balanced combination of technical and non-technical contents coupled with appropriate assessment and evaluation methods. This has a well-defined core of essential subjects supported by requisite compulsory as well as elective courses. It also invokes awareness and comprehension of societal problems amongst the students and motivating them to seek solutions for improving the quality of life. The theory content of the curriculum is supplemented with appropriate experimentation / laboratory work.

The program structure is covering the essential fundamental principles at the initial stages, leading to integrated studies in the final year of the program, in consonance with the approach and levels defined in various taxonomy levels, particularly in breadth & depth courses.

The hallmark of a curriculum is to infuse original thinking, resourcefulness and entrepreneurial spirits among students. This program is embodying foundation courses as well as the general and specialized professional content of adequate Breadth and Depth, including appropriate Humanities and Science components. The program scheme is designed to ensure acquisition of knowledge and skills, encouraging necessary exposure to inter-disciplinary areas.

The contents of each constituent courses of the curriculum has been updated to absorb recent technological and knowledge developments as per international practices and to meet the national needs. Efforts are also made that there should also be an effective relationship between the curricular content and practice in the field of specialization.

It is expected that the graduates are able to demonstrate professional ethics and competence in oral communication, scientific & quantitative reasoning, critical analysis, system design, logical thinking, creativity and capacity for life-long learning.

The delivery of subject matter and the assessment process employed is expected enabling the students to develop intellectual and practical skills effectively, as deemed essential in program outcomes assessment. Complex engineering problems which are not easily quantifiable, e.g. communication skills (oral / written), critical thinking, ethics, team work, etc. often require rubrics as a tool for their assessment (both in direct or indirect methods).

In addition to regular teaching / learning activities such as classroom interaction, Project based learning assignments, lab experimentation and faculty consultation, other aspects of student learning such as tutorial system, research / design projects, seminar / workshops and exposure to industrial practice should form an integral part of curriculum. Internal reviews of quality assurance procedures should be carried out periodically.

Proceedings of Preliminary Meeting of National Curriculum Revision Council in the discipline of Electrical Engineering

The preliminary meeting of National Curriculum Revision Committee (NCRC) in the discipline of Electrical Engineering for Bachelor's and Master's Degree programmes was held from March 27-29, 2017 (03 days) at the Higher Education Commission (HEC), Regional Centre, Peshawar. Experts from academia and industry participated in this meeting. HEC representation was ensured by Dr. Muhammad Idrees (Director, Academics Division, HEC, Pakistan). The list of the participants is as below:

1.	Prof. Dr. Muhammad Inayatullah Babar, Professor, Department of Electrical Engineering, University of Engineering & Technology, Peshawar.	Convener
2.	Engr. Dr. Muhammad Zubair Ahmad, Associate Professor /Associate Dean FEST, Faculty of Engineering, Science & Technology, Iqra University, Karachi.	Co-Convener
3.	Dr. Tayab Din Memon Associate Professor **(PEC Nominee)** Department of Electronic Engineering,	Secretary

	Mehran University of Engineering & Technology, Jamshoro.	
4.	Engr. Prof. Dr. Madad Ali Shah, Vice Chancellor, The Benazir Bhutto Shaheed University of Technology & Skill Development, Khairpur Mirs.	Member
5.	Dr. Hafiz Ashiq Hussain, Chairman / Associate Professor, Department of Electrical Engineering, HITEC University, Museum Road, Taxila.	Member
6.	Engr. Prof. Dr. Tahir Nadeem Malik Chairman, Department of Electrical Engineering, University of Engg & Technology, Taxila.	Member
7.	Engr. Prof. Dr. Mohammad Riaz Moghal, Dean, Faculty of Engineering & Technology, Mirpur University of Science & Technology, Allama Iqbal Road, Mirpur, AJK	Member
8.	Engr. Prof. Dr. Abdul Khaliq Dean, **(PEC Nominee)** Faculty of Engineering Center for Advance Studies in Engineering, 19, Ataturk Avenue, Islamabad.	Member
9.	Engr. Dr. Faisal Ahmad Khan Dean, **(PEC Nominee)** Faculty of Information & Communication Technology, BUITEMS, Quetta.	Member
10.	Prof. Dr. Azzam ul Asar Dean, Faculty of Engineering, CECOS University of IT &Emerging Sciences, F-5, Phase-VI, Hayatabad, Peshawar.	Member
11.	Dr. Imtiaz Ahmad Taj, Dean / Professor, Faculty of Engineering,	Member

	Department of Electrical Engineering, Capital University of Science & Technology, Kahuta Road, Zone-V, Islamabad.	
12.	Prof. Dr. Naeem Iqbal, HoD / Professor, Department of Electrical Engineering, PIEAS, Nilore, Islamabad.	Member
13.	Prof. Dr. Noor Muhammad Khan, HoD / Professor, Department of Electrical Engineering, Capital University of Science & Technology, Kahuta Road, Islamabad.	Member
14.	Prof. Dr. Aamir Hanif HoD / Professor, Department of Electrical Engineering, Wah Engineering College, University of Wah, The Mall, WahC antt.	Member
15.	Dr. Usman Zabit, HoD / Associate Professor, Department of Electrical Engineering, Riphah International University, Islamabad.	Member
16.	Dr. Syed. Muhammad Ghazanfar Monir, HoD / Associate Professor, Department of Electrical Engineering, Mohammad Ali Jinnah University, 22-E Block-6, PECHS, Karachi- 75400.	Member
17.	Dr. Muhammad Haneef, HoD / Assistant Professor, Department of Electrical Engineering, Foundation University, Rawalpindi Campus, New Lalazar, Rawalpindi.	Member
18.	Dr. Iftikhar Ahmad Khan, Professor, Department of Electrical Engineering, Sarhad University of Science & Information Technology, Ring Road, Peshawar.	Member

19.	Dr. Farid Gul, Professor, School of Electrical Engineering & Computer Science, NUST, Sector H-12, Kashmir Highway, Islamabad.	Member
20.	Prof. Dr. Abdul Fattah Chandio Professor, Quaid-e-Awam University of Engg, Science & Technology, Larkana Campus.	Member
21.	Prof. Dr. Aslam Pervez Memon, Professor, Department of Electrical Engineering, Quaid-e-Awam University of Engineering, Science & Technology, Nawabshah.	Member
22.	Prof. Dr. Mukhtiar Ahmed Mahar, Professor, Department Electrical Engineering, Mehran University of Engineering & Tech, Jamshoro	Member
23.	Dr. Ali Asghar Memon, Professor, Department Electrical Engineering, Mehran University of Engineering & Tech., Jamshoro	Member
24.	Prof. Dr. Muhammad Amir Professor, Faculty of Engineering & Technology, Department of Electrical Engineering, International Islamic University, Islamabad.	Member
25.	Dr. Qadeer ul Hasan Chief Engineer, Department of Electrical Engineering, COMSATS Institute of Information Technology, Park Road, ChakShahzad, Islamabad.	Member
26.	Dr. Muhammad Sarwar Ehsan, Associate Professor, Department of Electrical Engineering, University of Central Punjab, Johar Town, Lahore.	Member
27.	Dr. Muhammad Farhat Kaleem, Associate Professor,	Member

	Department of Electrical Engineering, University of Management & Technology, C-II, Johar Town, Lahore.	
28.	Engr. Dr. Muhammad Amjad, Associate Professor, Department of Electrical Engineering, The Islamia University of Bahawalpur, Baghdad Campus, Bahawalpur.	Member
29.	Dr. Tariq M. Jadoon, Associate Professor, Department of Electrical Engineering, Lahore University of Management Sciences, Opposite Sector U, DHA, Lahore.	Member
30.	Dr. Tauseef Tauqeer Associate Professor, Department of Electrical Engineering, Information Technology University, Arfa Software Technology Park, Lahore.	Member
31.	Dr. Muhammad Ali, Associate Professor, Department of Electrical Engineering, NED University of Engineering & Technology, University Road, Karachi.	Member
32.	Engr. Dr. Amjad Ali, Associate Professor, Department of Electrical Engineering, Sarhad University of Science & Information Technology, Ring Road, Peshawar.	Member
33.	Engr. Dr. NasimUllah, Associate Professor, Department of Electrical Engineering, CECOS University of IT & Emerging Sciences, F-5, Phase-VI, Hayatabad, Peshawar.	Member
34.	Dr. Muhammad Imran Aslam Associate Professor, **(PEC Nominee)**	Member

	Department of Electrical Engineering, NED University of Engineering and Technology, Karachi.	
35.	Dr. Imran Ullah Khan Associate Professor, Department of Electrical Engineering, Qurtuba University of Science & Information Technology, D. I. Khan, KPK.	Member
36.	Engr. Dr. M. Rizwan Amirzada, Assistant Professor, Department of Electrical Engineering, National University of Modern Languages, Room # 28, Ghazali Block, Islamabad.	Member
37.	Dr. Moazam Maqsood, Assistant Professor, Department of Electrical Engineering, Institute of Space Technology, 1-Islamabad Expressway, Rawat Toll Plaza, Islamabad.	Member
38.	Dr. Muhammad Rizwan Mughal, Assistant Professor, Department of Electrical Engineering, Institute of Space Technology, 1-Islamabad Expressway, Rawat Toll Plaza, Islamabad.	Member
39.	Engr. Dr. Hafiz M. Waseem Khalil, Assistant Professor, University College of Engg. & Technology, Department of Electrical Engineering, University of Sargodha, Sargodha.	Member
40.	Dr. Ali Nasir, Assistant Professor, Department of Electrical Engineering, University of Central Punjab, Lahore.	Member
41.	Dr. Muhammad Azhar Naeem Assistant Professor, Department of Electrical Engineering, University the Punjab, New Campus, Lahore.	Member

42.	Dr. Syed Ahmed Pasha, Assistant Professor, Department of Electrical Engineering, Air University, Service Road, Sector E-8, Islamabad.	Member
43.	Dr. Faheem Akhtar Chachar, Assistant Professor, Department of Electrical Engineering, Sukkur Institute of Business Administration (IBA), Airport Road, Sukkur.	Member
44.	Dr. Muhammad Mohsin Aman, Associate Professor, Department of Electrical Engineering, NED University of Engineering & Tech. University Road, Karachi.	Member
45.	Dr. Sarmad Ullah Khan Assistant Professor, Department of Electrical Engineering, CECOS University of IT &Emerging Sciences, Phase-VI, Hayatabad, Peshawar.	Member
46.	Dr. Faizullah Khan Assistant Professor, Department of Electrical Engineering, Baluchistan University of Information Technology, Engineering & Management Sciences, SSA-63, Takatu Campus, Quetta.	Member
47.	Dr. Muhammad Idrees Director Academics Division Higher Education Commission, Pakistan	Coordinator

NCRC Agenda

The agenda of NCRC for Electrical Engineering was as follows:

1. To revise/update the Electrical Engineering curriculum (2012) for Bachelors and Masters Degree Programs according to indigenous needs and to bring it at par with international standards on Outcomes Based Education (OBE).
2. To revise/update/add preface/ preamble and rationale of the subject.
3. To develop and revise suggested programme objectives, programme learning outcomes (PLOs), teaching methods and assessment criteria (formative & summative).
4. To incorporate/suggest latest reading materials/references (local & international) for every course.
5. To revise/update course contents keeping in view the uniformity across other disciplines and avoiding overlapping.
6. To make recommendations for promotion/development of the discipline, keeping in view the futuristic needs of the society and international trends.

The meeting started with recitation from the Holy Quran by the Prof. Dr. Muhammad Riaz Mughal. Dr. Muhammad Idrees, Director Curriculum, HEC welcomed the members. All the participants introduced themselves highlighting their qualification, experience and area of expertise. Keeping with the tradition, Dr. Muhammad Idrees, Director Academics Division, HEC, Islamabad offered the house to nominate the Convener, Co-Convener and Secretary of the NCRC for smooth functioning. Prof. Dr. M. Inayatullah Khan Babar, Professor, Electrical Engineering Department, UET, Peshawar, Dr. Engr. M. Zubair Ahmad, Associate Dean, Faculty of Engineering, Science & Tech, , Iqra University and Dr. Tayab Din Memon, Associate Professor, Department of Electronic Engineering, Mehran University, Jamshoro were selected unanimously as Convener, Co-convener and Secretary respectively.

In second session, Dr. Muhammad Idrees presented the agenda and objectives of the NCRC. He highlighted the importance of this meeting and emphasized for adaptation of general rules of curriculum development and revision like scope of the subject/programme, horizontal & vertical alignment, rule of flexibility and adaptability keeping in view the futuristic approach, market value/job market and societal needs. He also shared a template for

revising/updating the curricula according to paradigm shift of Outcome Based Education (OBE). The template was unanimously accepted to be followed. It was also agreed to add preamble, programme objectives, programme learning outcomes, teaching methodology and assessment segments in the curricula.

Prof. Dr. Mohammad Inayatullah Khan Babar, briefed the participants about outcome of previous NCRC meetings, as he acted as Secretary of previous NCRC in the field of Electrical Engineering. He informed the participants that key objective of previous NCRC was to devise a curriculum that provides a unified framework (guidelines) to institutions offering degrees under the title of Electrical Engineering or under the title of the defined four variants. Dr. Muhammad Zubair Ahmad, Co-Convener and Dr. Tayab Din Memon, Secretary also briefed the participants. The house unanimously agreed to pursue the same track for development of Curriculum in field of Electrical Engineering. The house also agreed to devise mechanism for offering a generalized degree in the field of Electrical Engineering as a separate model in addition to existing models for offering degree in Electrical Engineering with any of the specialization streams.

In next session, the house openly discussed the nomenclature of the discipline, preface, objectives of the programmes, suggested programme learning outcomes (PLOs), methods of instruction and learning environment, assessment and operational framework. After long deliberation, the committee finalized the curriculum framework, the duration of the programme, number of semesters, number of weeks per semester, total number of credit hours, weightage of engineering and non- engineering courses and weightage of theory and practical of undergraduate 4-years programme for Electrical Engineering. Furthermore, list of courses (core & elective) and semester wise breakup of courses were also discussed thoroughly and the same was unanimously finalized.

In the afternoon session, admission criteria/intake criteria was discussed and finalized. After that the list of courses was distributed among the relevant groups composed of following committee members keeping in view the experience and expertise in the field for reviewing course objectives, adding course learning outcomes, updating list of contents,

adding teaching-learning methods and assessment, and updating bibliography/ references/ suggested books.

Table 1: List of Groups for Curriculum Design

<table>
<tr><td colspan="2">Prof. Dr Mohammad Inayatullah Babar (Convener)
Dr. Zubair Ahmed (Co-Convener)
Dr. Tayab Din Memon (Secretary)</td></tr>
<tr><td><u>GROUP – I</u>
<u>NON ENGINEERING</u>
1. Prof. Dr Noor Muhammad Khan (Group Convener)
2. Prof. Dr Ghazanfar
3. Dr Azhar Naeem
4. Dr Faisal Khan
5. Dr Ali Nasir</td><td><u>GROUP – IV</u>
<u>ENGINEERING (Electronics)</u>
1. Dr Fareed Gul (Group Convener)
2. Dr Touseef Touqeer
3. Dr Hafiz Waseem
4. Dr Rizwan Mughal
5. Dr Muhammad Amjad
6. Dr Muhammad Rizwan
7. Dr. Tayab Din Memon</td></tr>
<tr><td><u>GROUP - II</u>
<u>COMPUTING, FOUNDATION & COMMON CORE</u>
1. Prof. Dr Abdul Khaliq (Group Convener)
2. Prof. Dr Sarwar Ehsan
3. Dr Muhammad Zubair
4. Prof. Dr Aamir Hanif
5. Dr. Usman Zabit
6. Dr. Farhat Kaleem</td><td><u>GROUP - V ENGINEERING (COMMUNICATION)</u>
1. Dr Faizullah Khan (Group Convener)
2. Dr Moazam Maqsood
3. Dr Sarmadullah Khan
4. Dr Muhmmad Hanif
5. Dr Imranullah Khan
6. Dr Muhammad Imran Aslam
7. Dr Ahmed Pasha</td></tr>
<tr><td><u>GROUP - III</u>
<u>ENGINEERING (POWER)</u>
1. Prof. Dr Tahir Nadeem (Group Convener)
2. Prof. Ali Asghar Memon
3. Dr Muhammad Ali
4. Prof. Dr Mukhtiar Ahmed
5. Prof. Dr Aslam Pervaiz
6. Dr Faheem Akhtar
7. Dr Muhammad Mohsin
8. Dr Naseemullah
9. Dr Naeem Iqbal</td><td><u>Group VI– GENERALIZED DEGREE</u>
1. Prof. Dr Iftikhar Ahmad Khan (Group Convener)
2. Prof. Dr. Tariq Jadoon
3. Dr Qadeer ul Hassan
4. Prof. Dr Mohammad Riaz Moghal
5. Prof. Dr Madad Ali Shah
6. Prof. Dr Abdul Fatah Chandio
7. Prof. Dr Imtiaz Taj
8. Dr Ashiq Hussain
9. Prof. Dr Azzam ul Asar
10. Dr Amjad Ali
11. Prof. Dr Muhammad Amir</td></tr>
</table>

Dr. Muhammad Zubair Ahmad, Co-Convener, briefed each group about relevant tasks to be completed.

On the second day, short presentation related to task assigned to the groups, were presented by relevant group conveners in the light of feedback received on first day. Prof. Dr. Imtiaz Taj presented the sample plan for mapping courses to PLOs and introduced the concepts of assigning taxonomy levels for various course learning outcomes in the form of examples. After through deliberation, draft curriculum of the undergraduate (4-years) programme for Electrical Engineering was finalized. In the evening session, the courses of postgraduate programme were distributed among the members, who were well versed and involved in this programme. Dr. Tayab Din Memon, Secretary, coordinated the functions of each group.

On the third day, group conveners briefed the house about progress made by each focus group. The courses of postgraduate programme of Electrical Engineering were reviewed and it was decided that outlines of each postgraduate field of specialization will also be developed in due course of time. It was decided that the draft curriculum of Electrical Engineering would be circulated among the experts of field (local & foreign) and the feedback of the experts will be incorporated in final meeting.

In the end, Dr. Idrees thanked the Convener, Co-convener and Secretary and all members of the Committee for sparing their time and for their contribution to prepare the revised draft of the curriculum. He further stated that their efforts will go a long way in developing workable, useful and market oriented comprehensive degree programmes in Electrical Engineering. The Convener of the NCRC also thanked the members for their inputs in revising/updating the curriculum to make it more practical, competitive, efficient and realistic. The committee highly appreciated the efforts made by the officials of HEC Regional Centre, Peshawar for making arrangements to facilitate the committee and their accommodation. The meeting ended with the vote of thanks to HEC and Dr. Muhammad Idrees and his team from HEC for providing this academic and professional opportunity for national cause.

Minutes of National Curriculum Revision Committee (NCRC) Final Meeting in Electrical Engineering, held from July 17-19, 2017 at HEC Regional Centre, Lahore

The final meeting of National Curriculum Revision Committee (NCRC) in the discipline of Electrical Engineering for Bachelor's and Master's Degree programmes was held from 17-19 July, 2017 (03 days) at HEC, Regional Center, Lahore. Experts from academia and industry participated in the meeting. Dr. Muhammad Idrees (Director, Academics Division, HEC, Pakistan) coordinated the NCRC meeting. The list of the participants is as below:

1.	Prof. Dr. Muhammad Inayatullah Babar, Professor, Department of Electrical Engineering, University of Engineering & Technology, Peshawar.	Convener
2.	Engr. Dr. Muhammad Zubair Ahmad, Associate Professor /Associate Dean FEST, Faculty of Engineering, Science & Technology, Iqra University, Karachi.	Co-Convener
3.	Dr. Tayab Din Memon Associate Professor **(PEC Nominee)** Department of Electronic Engineering, Mehran University of Engineering & Technology, Jamshoro.	Secretary
4.	Engr. Prof. Dr. Madad Ali Shah, Vice Chancellor, The Benazir Bhutto Shaheed University of Technology & Skill Development, KhairpurMirs.	Member
5.	Dr. Hafiz Ashiq Hussain, Chairman / Associate Professor, Department of Electrical Engineering, HITEC University, Museum Road, Taxila.	Member
6.	Engr. Prof. Dr. Tahir Nadeem Malik Chairman, Department of Electrical Engineering, University of Engg & Technology, Taxila.	Member
7.	Engr. Prof. Dr. Mohammad Riaz Moghal, Professor, Department of Computer System Engineering	Member

	Mirpur University of Science & Technology, Allama Iqbal Road, Mirpur, AJK	
8.	Engr. Prof. Dr. Abdul Khaliq Dean, **(PEC Nominee)** Faculty of Engineering Center for Advance Studies in Engineering, 19, Ataturk Avenue, Islamabad.	Member
9.	Dr. Imtiaz Ahmad Taj, Dean / Professor, Faculty of Engineering, Department of Electrical Engineering, Capital University of Science & Technology, Kahuta Road, Zone-V, Islamabad.	Member
10.	Dr. Noor Muhammad Khan, HoD / Professor, Department of Electrical Engineering, Capital University of Science & Technology, Kahuta Road, Islamabad.	Member
11.	Prof. Dr. Aamir Hanif, HoD / Professor, Department of Electrical Engineering, Wah Engineering College, University of Wah, The Mall, WahCantt.	Member
12.	Dr. Syed. Muhammad Ghazanfar Monir, HoD / Associate Professor, Department of Electrical Engineering, Mohammad Ali Jinnah University, 22-E Block-6, PECHS, Karachi- 75400.	Member
13.	Dr. Muhammad Haneef, HoD / Assistant Professor, Department of Electrical Engineering, Foundation University, Rawalpindi Campus, New Lalazar, Rawalpindi	Member
14.	Dr. Aslam Pervez Memon, Professor, Department of Electrical Engineering, Quaid-e-Awam University of Engineering, Science & Technology, Nawabshah.	Member
15.	Prof. Dr. Mukhtiar Ahmed Mahar, Professor, Department Electrical Engineering, Mehran University of Engineering & Tech, Jamshoro	Member

16.	Dr. Ali Asghar Memon, Professor, Department Electrical Engineering, Mehran University of Engineering & Tech., Jamshoro	Member
17.	Prof. Dr. Muhammad Amir Professor, Faculty of Engineering & Technology, Department of Electrical Engineering, International Islamic University, Islamabad.	Member
18.	Dr. Qadeer ul Hasan Chief Engineer, Department of Electrical Engineering, COMSATS Institute of Information Technology, Park Road, Chak Shahzad, Islamabad.	Member
19.	Dr. Muhammad Sarwar Ehsan, Associate Professor, Department of Electrical Engineering, University of Central Punjab, Johar Town, Lahore.	Member
20.	Dr. Muhammad Farhat Kaleem, Associate Professor, Department of Electrical Engineering, University of Management & Technology, C-II, Johar Town, Lahore.	Member
21.	Engr. Dr. Muhammad Amjad, Associate Professor, Department of Electrical Engineering, The Islamia University of Bahawalpur, Baghdad Campus, Bahawalpur.	Member
22.	Dr. Tariq M. Jadoon, Associate Professor, Department of Electrical Engineering, Lahore University of Management Sciences, Opposite Sector U, DHA, Lahore.	Member
23.	Dr. Muhammad Ali Memon, Associate Professor, Department of Electrical Engineering, NED University of Engineering & Technology, University Road, Karachi.	Member
24.	Engr. Dr. Amjad Ali, Associate Professor, Department of Electrical Engineering, Sarhad University of Science & Information Technology, Ring Road, Peshawar.	Member

25.	Dr. Muhammad Imran Aslam Associate Professor, **(PEC Nominee)** Department of Electrical Engineering, NED University of Engineering and Technology, Karachi.	Member
26.	Engr. Dr. M. Rizwan Amirzada, Assistant Professor, Department of Electrical Engineering, National University of Modern Languages, Room # 28, Ghazali Block, Islamabad.	Member
27.	Dr. Moazam Maqsood, Assistant Professor, Department of Electrical Engineering, Institute of Space Technology, 1-Islamabad Expressway, Rawat Toll Plaza, Islamabad.	Member
28.	Dr. Muhammad Rizwan Mughal, Assistant Professor, Department of Electrical Engineering, Institute of Space Technology, 1-Islamabad Expressway, Rawat Toll Plaza, Islamabad.	Member
29.	Engr. Dr. Hafiz M. Waseem Khalil, Assistant Professor, University College of Engg. & Technology, Department of Electrical Engineering, University of Sargodha, Sargodha.	Member
30.	Dr. Ali Nasir, Assistant Professor, Department of Electrical Engineering, University of Central Punjab, Lahore.	Member
31.	Dr. Faheem Akhtar Chachar, Assistant Professor, Department of Electrical Engineering, Sukkur Institute of Business Administration (IBA), Airport Road, Sukkur.	Member
32.	Dr. Muhammad Mohsin Aman, Assistant Professor, Department of Electrical Engineering, NED University of Engineering & Tech. University Road, Karachi.	Member
33.	Dr. Faizullah Khan Assistant Professor, Department of Electrical Engineering, Baluchistan University of Information Technology, Engineering & Management Sciences, SSA-63, Takatu	Member

	Campus, Quetta.	
34.	Dr. Muhammad Idrees Director Academics Division Higher Education Commission, Pakistan	Coordinator

Following members participated in the preliminary meeting but could not attend final meeting owing to preoccupations.

1.	Engr. Dr. Faisal Ahmad Khan Dean, **(PEC Nominee)** Faculty of Information & Communication Technology, BUITEMS, Quetta.	Member
2.	Prof. Dr. Azzam ul Asar Dean, Faculty of Engineering, CECOS University of IT &Emerging Sciences, F-5, Phase-VI, Hayatabad, Peshawar.	Member
3.	Prof. Dr. Naeem Iqbal, HoD / Professor, Department of Electrical Engineering, PIEAS, Nilore, Islamabad.	Member
4.	Dr. Usman Zabit, HoD / Associate Professor, Department of Electrical Engineering, Riphah International University, Islamabad.	Member
5.	Dr. Iftikhar Ahmad Khan, Professor, Department of Electrical Engineering, Sarhad University of Science & Information Technology, Ring Road, Peshawar.	Member
6.	Dr. Farid Gul, Professor, School of Electrical Engineering & Computer Science, NUST, Sector H-12, Kashmir Highway, Islamabad.	Member
7.	Prof. Dr. Abdul Fattah Chandio Professor, Quaid-e-Awam University of Engg, Science & Technology, Larkana Campus.	Member
8.	Dr. Tauseef Tauqeer Associate Professor, Department of Electrical Engineering, Information Technology University, Arfa Software Technology Park,	Member

	Lahore.	
9.	Engr. Dr. Nasim Ullah, Associate Professor, Department of Electrical Engineering, CECOS University of IT & Emerging Sciences, F-5, Phase-VI, Hayatabad, Peshawar.	Member
10.	Dr. Muhammad Azhar Naeem Assistant Professor, Department of Electrical Engineering, University the Punjab, New Campus, Lahore.	Member
11.	Dr. Syed Ahmed Pasha, Assistant Professor, Department of Electrical Engineering, Air University, Service Road, Sector E-8, Islamabad.	Member
12.	Dr. Sarmad Ullah Khan Assistant Professor, Department of Electrical Engineering, CECOS University of IT &Emerging Sciences, Phase-VI, Hayatabad, Peshawar.	Member

Following members attended only the final meeting

1.	Engr. Prof. Dr. Jameel Ahmed**(PEC Nominee)** Dean & Professor, Faculty of Engineering & Applied Sciences Riphah International University, Islamabad.	Member
2.	Prof. Dr. Tahir Izhar Chairman / Professor, Faculty of Electrical Engineering University of Engineering & Technology, Lahore.	Member
3.	Prof. Dr. Khalid Mahmood-ul-Hasan Professor, Department of Electrical Engineering, University of Engineering & Technology, Lahore.	Member
4.	Dr. Farhan Mahmood Assistant Professor Department of Electrical Engineering, University of Engineering & Technology, Lahore.	Member

NCRC Agenda

The agenda of Final meeting of NCRC for Electrical Engineering was as follows:

7. To finalize the Electrical Engineering curriculum preliminary draft (2017) for Bachelors and Masters Degree Programs according to indigenous needs and to bring it at par with international standards on Outcomes Based Education (OBE).
8. To finalize vision, mission, preface and rationale of the subject curriculum.
9. To finalize programme objectives, programme learning outcomes (PLOs), teaching methods and assessment criteria (formative & summative).
10. To review and finalize latest reading materials/references (local & international) for every course.
11. To revise/finalize course contents keeping in view the uniformity across other disciplines and avoid overlapping.
12. To finalize recommendations for promotion/development of the discipline, keeping in view the futuristic needs of the society and international trends.

The meeting started with recitation from the Holy Quran. Mr. Nazir Hussain, Director General, Regional Center Lahore welcomed the members on behalf of the Chairman, Executive Director and the Director General Academics, HEC Islamabad and assured best of his support in making the stay of NCRC members comfortable. All the participants introduced themselves highlighting their qualification, experience and area of expertise. Dr. Muhammad Idrees, Director Academics Division, HEC, Islamabad requested the Convener, Co-Convener and Secretary of the preliminary NCRC to proceed further for smooth functioning of final NCRC.

In second session, Dr. Muhammad Idrees presented the agenda and objectives of the NCRC. He highlighted the importance of this meeting and emphasized for adaptation of general rules of curriculum revision like scope of the subject/programme, horizontal & vertical alignment, rule of flexibility and adaptability keeping in view the futuristic approach, market value/job market and societal needs. He also emphasized to follow template for finalizing the courses according to paradigm shift of Outcome Based Education (OBE).

Prof. Dr. Mohammad Inayatullah Khan Babar, Convener, briefed the participants about outcome of preliminary NCRC meeting. He shared the comments and feedback received from foreign experts in the relevant fields.

In next session, conveners of the sub committees presented the updated status of course outlines for respective domains. House openly discussed the revised objectives of the program with specific emphasis on outcome based education in line with global standards. Furthermore, list of courses (core & elective) in each domain was discussed thoroughly.

In the afternoon session, each committee was given task list and briefed about it by Dr. Muhammad Zubair Ahmad, Co-Convener. After that the list of courses was distributed among the sub committees, keeping in view the experience and expertise in the field for reviewing course objectives, revising course learning outcomes, updating list of contents, adding teaching-learning methods and assessment, and updating bibliography/ references/ suggested books.

On second day, Prof. Dr. Tariq Jadoon from LUMS presented the concept of joint degree of Computer Science and Electrical Engineering, keeping in view the growing global trends in the field of Electrical Engineering. At the end, a detailed discussion was done on the inclusion of the Computer Engineering stream in this curriculum. After rigorous discussion Prof. Dr. Tariq Jadoon volunteered himself to prepare a draft on the feasibility and technical aspects of inclusion of the Computing stream as part of degree of Electrical Engineering. Based on feedback from foreign experts and thorough discussion, majority of the house members recommended inclusion of Computer Engineering stream for Electrical Engineering degree program.

In the afternoon session, each subcommittee was assigned task to revise lists of graduate level courses for various streams as part Master Degree programs in the field of Electrical Engineering. Dr. Tayab Memon, Secretary, NCRC, briefed the conveners of sub committees about need to revise list in line with curriculum of top ranked universities in the world offering similar degree programs.

In the morning session on Third Day, Prof. Dr. Tariq Jadoon presented the detailed concept paper regarding the merit of inclusion of Computer engineering stream that was followed by the detailed discussion. After this discussion, it was unanimously resolved that computing stream should be included in the curriculum. Task of preparing detailed courses for the stream was assigned to sub-committee, already constituted for the generalized degree program with inclusion of relevant experts from Computer Engineering domain with Prof. Dr. Tariq Jadoon as focal person.

Prof. Dr. Jameel Ahmad, Prof. Dr. Madad Ali Shah and Prof. Dr. Imtiaz Taj voluntarily helped Co-Convener finalize drafts for Vision and Mission statements.

In afternoon session, each subcommittee convener presented the final status of revised courses along with revised list of graduate level courses for respective stream. After long deliberation, the committee finalized the nomenclature, framework/scheme of studies, the duration of the programme, number of semesters, number of weeks per semester, total number of credit hours, number of credit hours per semester, weightage of engineering and non- engineering courses and weightage of theory and practical of undergraduate 4-years programme for Electrical Engineering. Furthermore, list of courses (core & elective) and semester wise breakup of courses were also discussed thoroughly and the same was unanimously finalized.

In the end, Dr. Idrees thanked the Convener, Co-convener and Secretary and all members of the Committee for sparing their time and for their contribution to prepare the final draft of the curriculum. The Convener of the NCRC also thanked the members for their inputs in revising/updating the curriculum in line with global standards with specific emphasis on outcome based education. The committee highly appreciated the efforts made by the officials of HEC Regional Centre, Lahore for making arrangements to facilitate the committee and their accommodation. The meeting ended with the vote of thanks to HEC and Dr. Muhammad Idrees and his team from HEC for providing this academic and professional opportunity.

RECOMMENDATIONS

- HEC should encourage universities to offer courses related to foreign languages with special emphasis on English, being the most common foreign language.
- HEC should develop human resources in all public sector institutes offering engineering programs with focus on deficient areas in the field of Electrical Engineering.
- Inter universities collaboration should be facilitated by the HEC by providing a common platform to share ideas and initiate collaboration among institutes offering Electrical Engineering programs.
- HEC should help institutes develop a technical journal in the field of Electrical Engineering by providing special funds and other resources.
- For collaboration among national institutes, signing of Memorandum of Understanding and Memorandum of Agreement may be facilitated by HEC.
- HEC is requested to provide a series of effective trainings to faculty members regarding proper implementation of OBE.

- Full access of HEC digital library (i.e. IEEE, ACM, Science Direct, ISI Web of Knowledge) may be provided in all institutes offering Electrical Engineering Program.
- HEC should enhance funding to all the recognized institutions to promote research and development

VISION

The following vision statement defines the vision of the Higher Education Commission regarding development of electrical engineering programs in the universities:

"To transform electrical engineering programs of Pakistan into world leading programs having pivotal role in the development and prosperity of society"

MISSION STATEMENT

Following is the mission statement of NCRC of Electrical Engineering program about the curriculum development of the Electrical Engineering Program:

"To develop the curriculum of electrical engineering encompassing all the knowledge profiles at par with national and international standards that enables electrical engineers to solve engineering problems for the societal needs"

Program Educational Objectives (PEOs):

Program educational objectives (PEOs) are broad statements that describe what graduates are expected to achieve few years after graduation and must be well defined. It should be ensured that PEOs are aligned with the vision/mission of the institution and be known to everyone in the institution through institutional publications/website.

A process should be developed to assess the level of attainment of the PEOs to evaluate effectiveness of the academic program. It should include feedback from faculty, industry, alumni and other stakeholders for improvement.

Suggested Program Educational Objectives

The graduates of the program will develop into professional engineers who will:

PEO-01:Demonstrate excellence in profession through in depth knowledge and skills in the field of Electrical Engineering

PEO-02: Engage in continuous professional development and exhibit quest for learning

PEO-03: Show professional integrity and commitment to social and ethical responsibilities

Program Learning Outcomes (PLOs)

Program learning outcomes are the narrower statements that describe what students are expected to know and be able to do by the time of graduation. These relate to the knowledge, skills and attributes that students acquire at least to some acceptable minimum level while progressing through the program. Following are the suggested PLOs as a guideline. As per Pakistan Engineering Council guidelines, following are suggested Program Learning Outcomes of this program. In addition to these PLOs, the educational institution may also include any additional outcomes if need arises.

PLO-01: Engineering Knowledge: Ability to apply knowledge of mathematics, science and engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

PLO-02: Problem Analysis: Ability to identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

PLO-03: Design/Development of Solutions: Ability to design solutions for complex engineering problems and design systems, components, or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and electrical considerations.

PLO-04: Investigation: Ability to investigate complex engineering problems in a methodical way including literature survey, design and conduct of experiments, analysis and interpretation of experimental data, and synthesis of information to derive valid conclusions.

PLO-05: Modern Tool Usage: Ability to create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex engineering activities, with an understanding of the limitations.

PLO-06: The Engineer and Society: Ability to apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solution to complex engineering problems.

PLO-07: Environment and Sustainability: Ability to understand the impact of professional engineering solutions in societal and electrical contexts and demonstrate knowledge of and need for sustainable development.

PLO-08: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.

PLO-09: Individual and Team Work: Ability to work effectively, as an individual or in a team, on multifaceted and/or multidisciplinary settings.

PLO-10: Communication: Ability to communicate effectively, orally as well as in writing on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentations, make effective presentations, and give and receive clear instructions.

PLO-11: Project Management: Ability to demonstrate management skills and apply engineering principles to one's own work, as a member and/or leader in a team to manage projects in a multidisciplinary environment.

PLO-12: Lifelong Learning: Ability to recognize importance of, and pursue lifelong learning in the broader context of innovation and technological developments.

Specific details relating to the processes adopted for assessing, evaluating and reviewing the program outcomes should be provided. The institution can also present the internal quality assessment cycle adopted by its Quality Enhancement Cell (QEC).

Framework for Bachelor in Electrical Engineering

Duration:	4 years
Semester:	8
Number of weeks per semester:	18 (16 for teaching and 2 for examination)
Total number of Credit Hours (CH):	130-136
Number of CH per semester:	15– 18
Engineering Domain Courses:	65 - 70%
Non-Engineering Domain Course:	30 - 35%

INTAKE/ADMISSION CRITERIA

Engineering Education Regulations of Pakistan Engineering Council should be adhered to for admission criteria and intake policy. Generally, the following criteria should be observed.

- For Bachelor of Electrical Engineering: F.Sc. Pre-Engineering or equivalent securing at least 60% marks.
- Admission criteria for Master of Electrical Engineering: Bachelor degree in the relevant disciplines
- For further information PEC guidelines may be followed

Recommendations for Non-Engineering Courses

Knowledge Area	Sub Area	Name of Course	Theory Contact Hours	Practical Contact Hours	Credit Hours (CH)	Number of Subjects	Total Credit Hours
Humanities and Social Sciences	English	Functional English	2	0	2	3	7
		Communication Skills	2	0	2		
		Technical Report Writing	3	0	3		
	Culture	Islamic Studies / Ethics	2	0	2	2	4
		Pakistan Studies	2	0	2		
	Electives	Elective -I	3	0	3	2	6
		Elective-II	3	0	3		
Management Sciences	--	Elective I	3	0	3	2	6
		Elective II	3	0	3		
Natural Sciences	Math	Calculus & Analytical Geometry	3	0	3	4	12
		Linear Algebra	3	0	3		
		Differential Equations	3	0	3		
		Complex Variables and Transforms	3	0	3		
	Physics	Applied Physics	3	3	4	1	4
	Elective	Elective I	3	0/1	3/4	1	3 to 4
Total						15	42 to 43

Proposed Social Science Electives

- Professional Ethics
- Sociology for Engineers
- Critical Thinking
- Organizational Behavior
- Professional Psychology

Proposed Management Science Electives

- Principles of Management
- Engineering Management
- Engineering Economics
- Engineering Project Management
- Entrepreneurship
- Leadership and Personal Grooming

Proposed Natural Science Electives

- Multivariable Calculus
- Discrete Mathematics
- Numerical Analysis
- Chemistry
- Biology

or any related course appropriate for the program.

Recommendations for Electrical Engineering Degree with Specialization/Streams

Power System Engineering
Electronic Engineering
Telecommunication /Communication Engineering
Computer System Engineering

Knowledge Area	Name of Course	Theory Contact Hours	Practical Contact Hours	Credit Hours (CH)	Number of Subjects	Total Credit Hours
Computing	Introduction to Computing	1	3	2	3	10
	Programming Fundamentals	3	3	4		
	Computing Elective	3	3	4		
Electrical Engineering Foundation	Linear Circuit Analysis	3	3	4	9	28
	Electrical Network Analysis	3	3	4		
	Workshop Practice	0	3	1		
	Signals and Systems	3	3	4		
	Electronic Devices & Circuits	3	3	4		
	Digital Logic Design	3	3	4		
	Probability Methods in Engineering	3	0	3		
	Engineering Drawing	0	3	1		
	Electromagnetic Field Theory	3	0	3		
Electrical Engineering	Communication Systems	3	3	4	6	24
	Introduction to	3	3	4		

Core (Breadth)	Embedded System					
	Electrical Machines	3	3	4		
	Linear Control Systems	3	3	4		
	Breadth Core I	3	3	4		
	Breadth Core II	3	3	4		
Electrical Engineering Specialization Based Electives (Depth)	Depth Elective-I	3	3	4	5	19
	Depth Elective-II	3	3	4		
	Depth Elective-III	3	3	4		
	Depth Elective-IV	3	3	4		
	Depth Elective-V	3	0	3		
IDEE	IDEE-I	3	0	3	2	6 to 7
	IDEE-II	3	0/3	3 or 4		
Senior Design Project	Final Year Project-I	0	9	3	2	6
	Final Year Project-II	0	9	3		
	Industrial Training (Summer)	0	0	0	0	0
Total					27	92 to 93

Computing Elective:

- Data Structure and Algorithms **or** Any other Computing elective course

Recommended List of Breadth and Depth Elective Courses in Electrical Engineering (Power Systems Engineering)

- **Power System Analysis (Breadth Core I)**
- **Power Distribution and Utilization (Breadth Core II)**
- Instrumentation and Measurements
- Advanced Electrical Machines
- Power Generation
- Electrical Power Transmission
- Power Electronics
- Power System Protection
- Power System Operation & Control
- Electrical Machine Design and Maintenance
- High Voltage Engineering
- Renewable Energy Systems
- Digital Signal Processing
- Industrial Drives
- FACTS and HVDC Transmission
- Data Communication
- Smart Grid

Recommended List of Breadth and Depth Elective Courses in Electrical Engineering (Communication/Telecommunication Engineering)

- **Computer Communication Networks (Breadth Core I)**
- **Electronic Circuit Design (Breadth Core II)**
- Digital Communications
- Antennas and Wave Propagation
- Digital Signal Processing
- Instrumentation and Measurements
- Transmission and Switching systems
- Wireless and Mobile Communications
- Data Communication
- Satellite Communication
- Optical Communication
- RF and Microwave Engineering
- Navigation and Radar Systems
- Digital Image Processing
- Emerging Wireless Technologies and RF Planning
- Telecommunication policies and standards

Recommended List of Breadth and Depth Elective Courses in Electrical Engineering (Electronic Engineering)

- **Electronic Circuit Design (Breadth Core I)**
- **Power Electronics (Breadth Core II)**
- Instrumentation and Measurements
- Integrated Electronics
- Microelectronics Technology
- Optoelectronics
- VLSI Design
- Industrial Electronics
- Digital System Design
- Introduction to Nanotechnology
- Digital Signal Processing
- Wave Propagation and Antenna
- Solid State Devices
- Digital Control Systems
- RF and Microwave Engineering
- Biomedical Instrumentation
- Data Communication
- Medical Robotics

Recommended List of Breadth and Depth Elective Courses in Electrical Engineering (Computing)

- **Computer Communication Networks (Breadth Core I)**
- **Operating Systems (Breadth Core II)**
- Digital Signal Processing
- Digital Image Processing
- Data Communication
- Computer Graphics
- Computer Vision
- Image & Video Coding
- Digital Control
- Internet of Things (IoT)
- Network Protocols and Standards
- Network Security
- Network and System Programming
- Computer Organization
- Computer Architecture
- Digital Systems Design
- Embedded Systems
- Parallel Processing

Recommendations for General Electrical Engineering Degree

Knowledge Area	Name of Course	Theory Contact Hours	Practical Contact Hours	Credit Hours (CH)	Number of Subjects	Total Credit Hours
Computing	Introduction to Computing	**0**	3	1	3	9
	Programming Fundamentals	3	3	**4**		
	Data Structures and Algorithms	3	3	4		
Electrical Engineering Foundation	Linear Circuit Analysis	3	3	4	9	29
	Electrical Network Analysis	3	3	4		
	Workshop Practice	0	3	1		
	Signals and Systems	3	3	4		
	Electronic Devices & Circuits	3	3	4		
	Digital Logic Design	3	3	4		
	Introduction to Embedded System	3	3	4		
	Probability Methods in Engineering	3	0	3		
	Engineering Drawing	0	3	1		
Electrical Engineering Core (Breadth)	Analog and Digital Communication	3	3	4	11	43
	Electromagnetic Field Theory	3	0	3		
	Electrical Machines	3	3	4		
	Control Systems	3	3	4		
	Electronic Circuit Design	3	3	4		
	Instrumentation and Measurements	3	3	4		
	Digital Signal Processing	3	3	4		
	Computer Communication Networks	3	3	4		
	Power Generation, Transmission and Distribution	3	3	4		
	Power System Analysis and protection	3	3	4		
	Power Electronics	3	3	4		
Electrical Engineering Specialization Based	Technical Elective	3	0/3	3 or 4	1	3 to 4

Electives						
IDEE	IDEE	3	0/3	3 or 4	1	3 to 4
Senior Design Project	Final Year Project-I	0	9	3	2	6
	Final Year Project-II	0	9	3		
	Industrial Training (Summer)	0	0	0	0	0
Total					27	93 to 95

Suggested Scheme of Studies (Semester Wise)

Bachelor in Electrical Engineering

Semester-1

Course No.	Course Title	Lec.-CH	Lab- CH	Total- CH
1	Functional English	2	0	2
2	Calculus and Analytical Geometry	3	0	3
3	Linear Circuit Analysis	3	1	4
4	Introduction to Computing	1	1	2
5	Islamic Studies	2	0	2
6	Applied Physics	3	1	4
	Total	14	3	17

Semester-2

Course No.	Course Title	Lec.- CH	Lab - CH	Total- CH
1	Differential Equations	3	0	3
2	Natural Sciences Elective-I	3	0	3
3	Workshop Practice	0	1	1
4	Pakistan Studies	2	0	2
5	Programming Fundamentals	3	1	4
6	Electronic Devices and Circuits	3	1	4
	Total	14	3	17

Semester-3

Course No.	Course Title	Lec. -CH	Lab - CH	Total – CH
1	Complex Variables and Transforms	3	0	3
2	Communication Skills	2	0	2
3	Digital Logic Design	3	1	4
4	Engineering Drawing	0	1	1
5	Computing Elective	3	1	4
6	Electrical Network Analysis	3	1	4
	Total	14	3	18

Semester-4

Course No.	Course Title	Lec.- CH	Lab -CH	Total – CH
1	Humanities and Social Sciences Elective-I	3	0	3
2	Linear Algebra	3	0	3
3	Introduction to Embedded Systems	3	1	4

4	Probability Methods in Engineering	3	0	3
5	Signals and Systems	3	1	4
	Total	14	3	18

Semester-5

Course No.	Course Title	Lec. - CH	Lab - CH	Total- CH
1	Electrical Machines	3	1	4
2	Electromagnetic Field Theory	3	0	3
3	Communication Systems	3	1	4
4	Linear Control Systems	3	1	4
5	IDEE-I	3	0	3
	Total	15	3	18

Semester-6

Course No.	Course Title	Lec.- CH	Lab - CH	Total – CH
1	Technical Writing	3	0	3
2	Humanities and Social Sciences Elective-II	3	0	3
3	Breadth Core-I	3	1	4
4	Breadth Core-II	3	1	4
5	Management Sciences Elective-I	3	0	3
	Total	15	3	17

Semester-7

Course No.	Course Title	Lec. - CH	Lab - CH	Total –CH
1	Depth Elective I	3	1	4
2	Depth Elective II	3	1	4
3	Management Sciences Elective II	3	0	3
4	IDEE-II	3	0/1	3/4
5	Final Year Project – I	0	2	2
	Total	12	4/5	16/17

Semester-8

Course No.	Course Title	Lec. - CH	Lab - CH	Total – CH
1	Depth Elective – III	3	1	4
2	Depth Elective –IV	3	1	4
3	Depth Elective – V	3	0	3
4	Final Year Project – II	0	4	4
	Total	09	6	15

Total Credit Hours 135/136

Courses Outline for Non-Engineering Courses

Functional English

Contact Hours:
Theory = 32
Practical = 0
Total = 32

Credit Hours:
Theory = **2.0**
Practical = **0.0**
Total = **2.0**

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	Practice English correctly in speaking and writing.	Affective	A2	10
2.	Follow English vocabulary and skills to use it in professional life.	Affective	A3	10
3.	Identify common errors usually made by the learners of English as second language.	Affective	A4	10

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☐	7	Environment and Sustainability:	☐
2	Problem Analysis:	☐	8	Ethics:	☐
3	Design/Development of Solutions:	☐	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☑
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

Grammar:

- Sentence structure
- Analysis of phrase, clause and sentence structure.
- Punctuation and capitalization.

Vocabulary

Comprehension (Reading and Listening):

- Answers to questions on a given text.
- Answering questions about carefully selected conversations, documentaries, commentaries, interviews and movie clips.
- Discussions: General topics and every-day conversation

Recommended books:

- Practical English Grammar by A. J. Thomson and A. V. Martinet. Fourth edition. Oxford University Press. ISBN 978-0-19-431342-1.
- Practical English Grammar Exercises 1 by A. J. Thomson and A. V. Martinet. Third edition. Oxford University Press. ISBN 978-0-19-431349-0.
- Reading. Upper Intermediate. Brain Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 453402 2.
- Intermediate Listening Comprehension: Understanding and Recalling Spoken English by Patricial Dunkel and Phyllis L. Lim, Third Edition. ISBN 1 4130 1257 4.
- High School English Grammar& Composition by P.C.Wren & H.Martin
- Exploring the World of English by Saadat Ali Shah. Ilmi Kitab Khana

Communication Skills

Contact Hours:
Theory = 32
Practical = 0
Total = 32

Credit Hours:
Theory = **2.0**
Practical = **0.0**
Total = **2.0**

SUGGESTED COURSE LEARNING OUTCOMES:

Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	Communicate effectively using intermediate-to-advanced level English.	Affective	A3	PLO-10
2.	Participate in group discussions by attentive listening, questioning to clarify ideas, eliciting responses, or disagreeing in a constructive way.	Affective	A4	PLO-10

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):

The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☐	7	Environment and Sustainability:	☐
2	Problem Analysis:	☐	8	Ethics:	☐
3	Design/Development of Solutions:	☐	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☑
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

Business Writing

- Seven Cs of Communication
- Business Writing Styles
- Business Memos
- Business Emails
- Tenders and Quotations

- Billing and Invoicing
- Common Writing Errors
- Useful Vocabulary and Phrases
- Personal Documents

Oral Communication

- Verbal and non-verbal communication
- Conducting meetings
- Small group communication
- Taking minutes.

Presentation skills

- Presentation strategies
- Defining the objective, scope and audience of the presentation
- Material gathering and material organization strategies
- Time management
- Opening and Concluding
- Use of audio-visual aids
- Delivery and presentation.

Activities Involved

- Interactive session of the students for communication skills followed by assessment with defined rubrics.

Recommended Books

- Practical English Grammar by A. J. Thomson and A. V. Martinet. Fourth edition. Oxford University Press. ISBN 978-0-19-431342-1.
- Practical English Grammar Exercises 1 by A. J. Thomson and A. V. Martinet. Third edition. Oxford University Press. ISBN 978-0-19-431349-0.
- A Practical Guide to Business Writing: Writing in English for Non-Native Speakers by Khaled Mohamed Al Maskari. Wiley. ISBN 978 1 118 41079 0
- Writing. Intermediate by Marie-Chrisitine Boutin, Suzanne Brinand and Francoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 019 4354057
- The blue book of Grammar and Punctuation by Jane Straus, 11th Edition, 2014, John Willey, ISBN 978-1118785560 – 8

Technical Report Writing

Contact Hours:
Theory = 48
Practical = 0
Total = 48

Credit Hours:
Theory = **3.0**
Practical = **0.0**
Total = **3.0**

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	Demonstrate proficiency in writing memos, proposals, covering letter, enquiry letter, job application letter, acceptance letter, business letter, short report, long report etc.	Affective	A3	PLO-10
2.	Use a standard word processing software along with a referencing tool for report writing	Affective	A3	PLO-5

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☐	7	Environment and Sustainability:	☐
2	Problem Analysis:	☐	8	Ethics:	☐
3	Design/Development of Solutions:	☐	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☑
5	Modern Tool Usage:	☑	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

Introduction to Technical Report Writing

- What is a report?
- Purpose of Technical Report Writing
- Characteristics of Technical Report Writing
- Kinds of Reports

7C's of Communication and Resume Writing

- The Traditional Resume
- The Functional Resume

Technical Writing Process

- The Pre-writing Stage
- The Writing Stage
- The Post-writing Stage

Technical Writing Style

- Writing Clear Sentences
- Writing Clear Paragraphs
- Revising for Clarity
- Organizing Clearly

Technical Writing Applications

- Memorandums(Memo Format)
- The Basic Elements of the Memo Format

Different Parts of a Technical Report (Formatting)

- Title Page
- Letter of Transmittal
- Abstract/Summary
- Introduction
- Background
- History, location, methodology, etc.
- Results
- Discussion of Results
- Conclusion
- Recommendations
- Figures and Tables
- Appendix
- Bibliography

Writing Research Proposal

- Parts
- Format

Writing Research/Term Paper

- Style
- Consistency
- Clarity
- Language

Informal Report

- Informal Introductions
- Summary
- Background
- Conclusions and Recommendations
- Discussion
- Uses of Informal Reports

Formal Report

- The Elements of a Formal Format

- Arrangement of Formal Elements
- Front Material
- Format Devices in the Body of the Formal Format
- End Material

Recommendation and Feasibility Reports

- Planning the Recommendation Report
- Writing and Presenting the Recommendation Report

Plagiarism

Exposure to Different Sample Technical Reports

Practice of Technical Report Writing

Activities

- A project activity involving report writing that includes all components of a technical report for a particular project offered in any engineering course. Citations must be incorporated using a standard referencing software.
- Assessment of the project would be carried out on the basis of defined rubrics covering all aspects of the technical report.

Recommended Books

- Technical Report Writing Today by Daniel G. Riordan, Wadsworth Publishing, 10th Edition, ISBN 9781133607380
- Scenarios for Technical Communication by Teresa C. Kynell and Wendy Krieg Stone. ISBN 978-0205275243
- Communication for Engineering Students by J. W. Davies, ISBN 978-0582256484
- Science Research Writing for Non-Native Speakers of English by Hilary Glasman-Deal, Imperial College Press. ISBN 978 1 84816 309 6
- Effective communication for Science and Technology by J V Emden, Palgrave 2001, ISBN 9780333775462

Calculus and Analytical Geometry

Contact Hours:
Theory = 48
Practical = 0
Total = 48

Credit Hours:
Theory = **3.0**
Practical = **0.0**
Total = **3.0**

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	Express the ideas of rate of change and derivatives using the concept of limits and continuity	Cognitive	C1	PLO-1
2.	Comprehend the learning of vector calculus and analytical geometry in multiple dimensions.	Cognitive	C2	PLO-1
3.	Apply derivatives and integrals for solving different problems arising in engineering sciences.	Cognitive	C3	PLO-1

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☐	8	Ethics:	☐
3	Design/Development of Solutions:	☐	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

Limits and Continuity

- Introduction to Limits
- Rates of Change and Limits
- One-Sided Limits, Infinite Limits
- Continuity, Continuity at a Point, Continuity on an interval

Differentiation

- Definition and Examples
- Relation Between Differentiability and Continuity
- Derivative as slope, as rate of change (graphical representation).
- The Chain Rule
- Applications of Ordinary Derivatives

Integration

- Indefinite Integrals
- Different Techniques for Integration

- Definite Integrals
- Riemann Sum, Fundamental Theorem of Calculus
- Area Under the Graph of a Nonnegative Function
- Improper Integrals

Transcendental Functions

- Inverse functions
- Logarithmic and Exponential Functions
- Inverse Trigonometric Functions
- Hyperbolic Functions and Inverse Hyperbolic Functions
- More Techniques of Integration

Analytical Geometry

- Three Dimensional Geometry
- Vectors in Spaces
- Vector Calculus
- Directional Derivatives
- Divergence, Curl of a Vector Field
- Multivariable Functions
- Partial Derivatives
- Conic Sections
- Parameterizations of Plane Curves
- Vectors in Plane, Vectors in space
- Dot Products, Cross Products
- Lines and Planes in Space
- Spherical, Polar and Cylindrical Coordinates.
- Vector-Valued Functions and Space Curves
- Arc-Length and Tangent Vector
- Curvature, Torsion and TNB Frame
- Fubini's Theorem for Calculating Double Integrals
- Areas Moments and Centers of Mass
- Triple Integrals and volume of a region in space

Recommended Books

- Thomas' Calculus by J. R. Hass, C. D. Heil and M. D. Wier, 14th edition, Pearson, ISBN 978 0134438986
- Essential Calculus by James Stewart, 2nd Edition, ISBN 978-1133112297
- Advanced Engineering Mathematics by Erwin Kreyszig, 10th Ed. Willey 2014. ISBN 978-0-470-91361-1

Linear Algebra

Contact Hours:
Theory = 48
Practical = 0
Total = 48

Credit Hours:
Theory = **3.0**
Practical = **0.0**
Total = **3.0**

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	Interpret the vector equations and linear transformations.	Cognitive	C1	PLO-1
2.	Illustrate how to solve a system of linear equations that appears in different engineering applications.	Cognitive	C2	PLO-1
3.	Apply the basic knowledge of vector spaces, eigen value and eigen vectors.	Cognitive	C3	PLO-1
4.	Implement key concepts developed in the course using a mathematical simulation software.	Cognitive	C3	PLO-5

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☐	8	Ethics:	☐
3	Design/Development of Solutions:	☐	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☑	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course Outline:

System of Linear Equations and Matrices

- Introduction to system of linear equations
- Matrix form of system of Linear Equations
- Gaussian Elimination method
- Gauss-Jorden Method
- Consistent and inconsistent systems
- Homogeneous system of equations

Vector Equations

- Introduction to vector in plane
- Vector in RP^n
- Vector form of straight line
- Linear Combinations
- Geometrical interpretation of solution of Homogeneous and Non-homogeneous equations

Applications of Linear Systems

- Traffic Flow Problem
- Electric circuit Problem
- Economic Model

Linear transformations

- Introduction to linear transformations
- Matrix transformations
- Domain and range of linear transformations
- Geometric interpretation of linear transformations
- Matrix of linear transformations

Inverse of a matrix

- Definition of inverse of a matrix
- Algorithm to find the inverse of matrices
- LU factorization

Determinants

- Introduction to determinants
- Geometric meaning of determinants
- Properties of determinants
- Crammer Rule
- Cofactor method for finding the inverse of a matrix

Vector Spaces

- Definition of vector spaces
- Subspaces
- Spanning set
- Null Spaces and column spaces of linear transformation
- Linearly Independent sets and basis
- Bases for Null space and Kernal space
- Dimension of a vector space

Eigen Values and Eigen vectors

- Introduction to Eigen value and Eigen vectors
- Computing the Eigen values
- Properties of Eigen values
- Diagonalization
- Applications of Eigen values

Recommended Books:

- Linear Algebra and its applications by David C. Lay. 4th Edition, Addison Wesley, ISBN 978 0 321 38517 8
- Linear Algebra and its Applications by Gilbert Strang, 4th Edition, ISBN 978-0030105678

Differential Equations

Contact Hours:
Theory = 48
Practical = 0
Total = 48

Credit Hours:
Theory = **3.0**
Practical = **0.0**
Total = **3.0**

SUGGESTED COURSE LEARNING OUTCOMES:

Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	Comprehend the fundamental concepts of differential equations.	Cognitive	C2	PLO-1
2.	Solve first and second order differential equations and partial differential equations using the concepts developed in the course.	Cognitive	C3	PLO-1
3.	Apply the concepts of ordinary derivatives and partial derivatives for modeling of physical systems.	Cognitive	C3	PLO-1

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):

The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☐	8	Ethics:	☐
3	Design/Development of Solutions:	☐	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

First Order Differential Equations

- Variables separable forms,
- Homogenous equations,
- Non-homogenous equations,
- Exact equations,
- Linear equations,
- Solution by substitutions,

Applications of First Order DE's

- Modeling with the first order differential equations
- Orthogonal trajectories
- Population dynamics
- Applications of linear equations
- Applications of non-linear equations

Higher Order Linear Differential Equations

- Introduction and preliminary theory,
- Initial-value and boundary-value problems,
- Homogenous and non-homogenous equations,
- Method of undetermined coefficients,
- Method of variation of parameters,
- Power series solution

Applications of the Second Order Differential Equations

- Spring mass problems,
- RLC Circuit

Partial Differential Equations

- Basic concepts,
- Vibrating string,
- Wave equation,
- Separation of variables,
- Heat equation solution by separation of variables

Recommended books:

- Advanced Engineering Mathematics by Erwin Kreyszig, 10th Ed. Willey 2014. ISBN 978-0-470-91361-1.

Numerical Analysis

Contact Hours:
Theory = 48
Practical = 0
Total = 48

Credit Hours:
Theory = **3.0**
Practical = **0.0**
Total = **3.0**

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	Apply different numerical methods to perform polynomial interpolation, curve fitting, differentiation, integration, and estimation of algebraic nonlinear equations.	Cognitive	C3	1
2.	Solve ordinary differential equations and compute optimum points in optimization problems using numerical techniques.	Cognitive	C4	1
3.	Apply a simulation tool to implement various numerical methods.	Cognitive	C3	5

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☐	8	Ethics:	☐
3	Design/Development of Solutions:	☐	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☑	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

Introduction to Numerical Analysis

- Introduction
- Measuring Errors
- Sources of Errors
- Propagation of Errors

Solution of Nonlinear Equations

- Bisection Method
- Newton Raphson Method
- Secant Method
- False Position Method

Regression and Interpolation

- Linear Regression
- Nonlinear Regression
- Adequacy of Regression

- Direct Method Interpolation
- Newton's Method of Interpolation
- Lagrange Interpolation
- Spline Interpolation

Numerical Differentiation and Integration

- Numerical Differentiation
- Continuous Functions
- Discrete Functions
- Numerical Integration
- Trapezoidal Rule
- Simpson's $^1/_3$Rule
- Simpson's $^3/_8$ Rule
- Gauss Quad Rule
- Improper Integrals

Initial Value Problems for Ordinary Differential Equations

- Elementary Theory of Initial Value Problems
- Euler's Method
- Finite Differential Method
- Runge Kutta Methods
- Shooting Method
- Higher Order Differential Equations

Numerical Optimization

- Golden Section Search Method
- Newton's Method
- Direct Search Method
- Gradient Search Method
- Simplex Method

Recommended Books:

- Numerical Analysis by Richard L. Burden
- Numerical Methods with Applications by Autar K. Kaw

Complex Variables and Transforms

Contact Hours:
Theory = 48
Practical = 0
Total = 48

Credit Hours:
Theory = **3.0**
Practical = **0.0**
Total = **3.0**

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	Identify the complex number system, complex functions and integrals of complex functions	Cognitive	C1	1
2.	Express the concept of limit and differentiability of complex valued functions and the properties of various transforms	Cognitive	C2	1
3.	Apply various transforms for solving problems in engineering sciences.	Cognitive	C3	1

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☐	8	Ethics:	☐
3	Design/Development of Solutions:	☐	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

Introductory Concepts

- Introduction to Complex Number System
- Argand diagram
- De Moivre's theorem and its Application Problem Solving Techniques

Analyticity of Functions

- Complex and Analytical Functions,
- Harmonic Function, Cauchy-Riemann Equations.
- Cauchy's theorem and Cauchy's Line Integral.
- Power series, Taylor series, Laurent series
- Residual integration

Singularities

- Singularities, Poles, Residues.
- Contour Integration.

Laplace transform

- Laplace transform definition,
- Laplace transforms of elementary functions

- Properties of Laplace transform, Periodic functions and their Laplace transforms,
- Inverse Laplace transform and its properties,
- Convolution theorem,
- Inverse Laplace transform by integral and partial fraction methods,
- Heaviside expansion formula,
- Solutions of ordinary differential equations by Laplace transform,
- Applications of Laplace transforms

Fourier series and Transform

- Fourier theorem and coefficients in Fourier series,
- Even and odd functions,
- Complex form of Fourier series,
- Fourier transform definition,
- Fourier transforms of simple functions,
- Magnitude and phase spectra,
- Fourier transform theorems,
- Inverse Fourier transform,

Solution of Differential Equations

- Series solution of differential equations,
- Validity of series solution, Ordinary point,
- Singular point, Forbenius method,
- Indicial equation,
- Bessel's differential equation, its solution of first kind and recurrence formulae,
- Legendre differential equation and its solution,
- Rodrigues formula

Recommended Books

- Advanced Engineering Mathematics by Erwin Kreyszig, 10th Ed. Willey 2014. ISBN 978-0-470-91361-1.

Applied Physics

Contact Hours:
Theory = 48
Practical = 48
Total = 96

Credit Hours:
Theory = **3**
Practical = **1**
Total = **4**

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	Illustrate the electromagnetic and mechanical phenomena mathematically.	Cognitive	C2	PLO-1
2.	Interpret basic electric circuits used in science and engineering.	Cognitive	C3	PLO-1

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☐	8	Ethics:	☐
3	Design/Development of Solutions:	☐	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

Force and Motion

- Motion along a straight line.
- Vectors.
- Motion in 2 and 3 dimensions.
- Force
- Friction

Waves

- Vibrations and Oscillations
- Simple Harmonic Motion
- Wave Motion and Sound

Mechanics

- Work and Energy
- Kinetic and Potential energy
- Conservation of energy.
- Center of mass and rotation
- Linear momentum.
- Torque and angular momentum.
- Equilibrium and elasticity.

- Gravitation.

Thermodynamics

a. Thermal Equilibrium and zeroth law

b. First and second law of thermodynamics

Electric Charge

- Introduction to electric charge
- Conductors and Insulators
- Coulomb's Law
- Quantization and Conservation of Charge.

Electric Fields

- Introduction to Electric Field
- A point charge in electric field
- A dipole in electric field

Gauss' Law

- Electric Flux
- Gauss' Law and its Applications

Electric Potential

- Electric potential and Electric potential energy
- Potential due to a point charge
- Potential due to group of charges
- Potential due to an electric dipole
- Potential due to continuous charge distribution

Capacitance

- Introduction to capacitance
- Capacitors in parallel and series
- Energy stored in an electric field
- Dielectric

Current and Resistance

- Introduction to electric current
- Effects of Electric Current
- Sources of Electricity
- Current density
- Resistance and Resistivity
- Ohm's Law
- Power in electric circuits
- Semiconductors and super conductors

Circuits

- Introduction to electric circuits
- Pumping charges
- Work, energy and EMF
- Single and Multi-loop circuits
- The ammeter and voltmeter

Electromagnetism

- Introduction to magnetic fields
- The Hall effect
- Magnetic field on a current carrying wire
- Torque on a current loop
- Electromagnetic Induction

Recommended Books:

- University Physics by Hugh D. Young and Roger A. Freedman, 14th Edition.
- Fundamentals of Physics Extended by D. Halliday, R. Resnick, J. Walker. 10th edition.
- Fundamentals of Electromagnetic Phenomenon by D. Corson & Lorrain.

Professional Ethics

Contact Hours:
Theory = 48
Practical = 0
Total = 48

Credit Hours:
Theory = **3.0**
Practical = **0.0**
Total = **3.0**

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	Describe why legal and professional definitions of ethics exist; Identify the benefits that are expected to arise for engineers from acting ethically as well as specific consequences of acting unethically in the society.	Cognitive	C1	8
2.	Analyze the ethical dilemmas arising at workplace; identify possible actions that can be taken in response to a given ethical dilemma, and illustrate the probable consequences of these actions.	Affective	A4	8
3.	Present an engineering catastrophe caused by not conforming to the code of ethics, report the flaws and give recommendations.	Affective	A3	8

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☐	7	Environment and Sustainability:	☐
2	Problem Analysis:	☐	8	Ethics:	☑
3	Design/Development of Solutions:	☐	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

Introduction

- Introduction to Ethics
- The Nature of Engineering Ethics
- Legal, Professional and Historical Definitions
- Origin of Professional Ethics

Value of Ethics

- Value of Engineering Ethics
- Contemporary and Historical Reasons
- Why an Ethical Engineer?
- Ethics in Different Fields of Work

Ethical Dilemmas

- Common Ethical Dilemmas
- Resolution of Ethical Dilemmas
- Possible Actions in Response to Dilemmas
- Probable Consequences of these Actions

Case Studies

- Any Religious, National, or International Law Dealing with Engineering Ethics
- Code of Ethics/Conduct of any Professional Society
- Historical and Professional Reasons of Existence of Multiple Definitions of Ethics
- Benefits of Acting Ethically and Consequences of Acting Unethically

Recommended Books:

- Engineering Ethics Concepts & Cases by Charles E Harris, 5th Edition, Cengage 2014, ISBN 9781285671130.
- Kenneth Blanchard, Professional Ethics, 4th Edition

Sociology for Engineers

Contact Hours:
Theory = 48
Practical = 0
Total = 48

Credit Hours:
Theory = **3.0**
Practical = **0.0**
Total = **3.0**

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	Define the basic concepts and theoretical models of sociology. Distinguish between the major fields of contemporary sociology.	Cognitive	C2	6
2.	Analyze the basic social issues caused by unethical behavior of engineers and determine the impact of unethical engineer's work on the society as a whole.	Affective	A4	6
3.	Discuss the social dilemmas involving engineers, formulate possible actions that can be taken in response to a social issue, and evaluate the probable consequences of those actions.	Affective	A3	6

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☐	7	Environment and Sustainability:	☐
2	Problem Analysis:	☐	8	Ethics:	☐
3	Design/Development of Solutions:		9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☑	12	Lifelong Learning:	☐

Course outline:

Introduction and Fundamentals

- Introduction to Sociology
- Nature, Scope, and Importance of Sociology

Methods of Sociological Research

- Culture, Society and Socialization
- Groups, Organizations, Deviance and Crime

The Basis of Society

- Social Interaction Processes

Major Perspectives in Sociology

Social Stratification

- Factors of Social Stratification
- Caste, Power, Prestige, and Authority

Macro-sociology and Social Change

- Politics and Government

- Social Processes of Globalization

Engineers and Sociology

- Understanding Social Responsibilities of an Engineer
- Engineers Bringing Social Change

Community Development Involving Engineers

- Meaning, Scope and Subject Matter of Community Development
- Processes of Community Development
- Role of Engineers in Community Development

Case Studies Regarding Sociology Concerning Engineers

Recommended Books:

- Sociology by John J. Macionis, 16th edition, Pearson Education, ISBN 978 0134206318

Engineering Economics

Contact Hours:
Theory = 48
Practical = 0
Total = 48

Credit Hours:
Theory = **3.0**
Practical = **0.0**
Total = **3.0**

SUGGESTED COURSE LEARNING OUTCOMES:

Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	Apply the appropriate engineering economics analysis method(s) for problem solving i.e. present worth, annual cost, rate of return, payback, break-even, benefit-cost ratio.	Cognitive	C3	11
2.	Evaluate the cost effectiveness of individual projects using the methods learnt, draw inferences for investment decisions, and compare the life cycle cost of multiple projects.	Cognitive	C4	11
4.	Compute the depreciation of an asset using standard depreciation techniques to assess its impact on present or future value	Cognitive	C2	11

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):

The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☐	7	Environment and Sustainability:	☐
2	Problem Analysis:	☐	8	Ethics:	☐
3	Design/Development of Solutions:	☐	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☑
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

Engineering economics decision

- Role of engineers in business
- Economic decisions v/s design decisions
- Large scale engineering projects and types of strategic economic decisions
- Fundamental principles of engineering economics

Interest Rate and Economic Equivalence

- Interest: The Cost of Money
- Economic Equivalence
- Development of Formulas for Equivalence Calculation
- Unconventional Equivalence Calculations

Understanding Money and Its Management

- Nominal and Effective Interest Rates
- Equivalence Calculations with Effective Interest Rates and with Continuous Payments
- Changing Interest Rates
- Debt Management
- Investing in Financial Assets

Present-Worth Analysis

- Project Cash Flows
- Initial Project Screening Methods: payback Screening and Discounted Cash Flow Analysis
- Variations of Present-Worth Analysis
- Comparing Mutually Exclusive Alternatives

Annual Equivalent-Worth Analysis

- Annual Equivalent-Worth Criterion
- Capital Costs versus Operating Costs
- Applying Annual-Worth Analysis
- Life-Cycle Cost Analysis
- Design Economics

Rate-of-Return Analysis

- Rate of Return and Methods of Finding It
- Internal Rate-of-Return Criterion
- Mutually Exclusive Alternatives

Cost Concepts Relevant to Decision Making

- General Cost Terms; Classifying Costs for Financial Statements
- Cost Classifications for Predicting Cost Behavior
- Future Costs for Business Decisions
- Estimating Profit from Production

Depreciation and Corporate Taxes

- Asset Depreciation: Economic versus Accounting
- Book and Tax Depreciation Methods (MACRS)
- Depletion
- Income Tax Rate to be used in Economic Analysis
- The Need for cash Flow in Engineering Economic Analysis

Developing Project Cash Flows

- Cost-Benefit Estimation for Engineering Projects
- Developing Cash Flow Statements

Project Risk and Uncertainty

- Origins of Project Risk
- Methods of Describing Project Risk: Sensitivity, Break-Even and Scenario Analysis

Special Topics in Engineering Economics

- Replacement Decisions
- Capital Budgeting Decisions
- Economic Analysis in the Service Sector

Recommended Books:

- Contemporary Engineering Economics by Chan S. Park, 6th edition, Pearson 2015, ISBN: 978-0134105598
- Engineering Economic Analysis by Donal G. Newnan, Jerome P. Lavelle, Ted G. Eschenbach, 12th edition, Oxford University Press, ISBN: 978-0199339273
- Engineering Economy by Leland T. Blank and Anthony Tarquin

Engineering Project Management

Contact Hours:	**Credit Hours:**
Theory = 48	Theory = **3.0**
Practical = 0	Practical = **0.0**
Total = 48	Total = **3.0**

SUGGESTED COURSE LEARNING OUTCOMES:

Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	Understand a sustainable lifestyle and why a sustainable society is important for the environment.	Affective	A1	7
2.	Compare competency in various project management knowledge areas, including, Risk, Quality, Stakeholder, Time and Cost management.	Cognitive	C2	11
3.	Solve the complex tasks of time and cost estimation using project scheduling and controlling techniques including Critical Path Method and Earned Value Management.	Cognitive	C3	11
4.	Integrate various Knowledge areas of project management in order to prepare a project plan on a simulation level using modern tool e.g. MS Project.	Affective	A2	5

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☐	7	Environment and Sustainability:	☑
2	Problem Analysis:	☐	8	Ethics:	☐
3	Design/Development of Solutions:	☐	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☑	11	Project Management:	☑
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

- **Introduction to Project Management**
  - Project, program management and project management
  - Historical perspective of project management
  - Project characteristics, objectives, scope and requirements
  - Introduction to existing PM Bodies of Knowledge
- **Project Quality Management**
  - History of Quality Management
  - Defining Quality
  - Relationship between project management and quality management
  - Quality Management Frameworks
- **Project Stakeholder Management**
  - The Roles of Project Manager and Sponsor
  - Project team selection
  - Skills and competencies of project manager
  - How to develop and manage project teams successfully
  - Stakeholder management
- **Project Cost Management**
  - Cost Estimation in projects
    - Cost components in projects and methods for cost estimation in projects
  - Cost Control in Projects
    - Estimation of outstanding work
    - Engineering Economics (Earned value management)
- **Project HRM and Communication Management**
  - Effective organization and communication
  - The emergence of project management in developing company
  - Project matrix and project based organizations
  - Building and managing effective project team
- **Project Risk Management**
  - Definitions and concepts including risk, risk management, business and project risk, probability and impact.
  - Generic risk management processes.
- **Project Time Management**

- Introduction to Project Scheduling
- Critical Path Method
  - Network representation of projects, critical activities, and critical path.

- **Project Scope and Integration Management**
  - Selecting the Suitable Project for the Organization
  - Conducting Feasibility Study
  - Phases of project and the different activities carried out in each phase.
  - Lifecycle models and examples
  - Project management methodologies and processes
  - Traditional, structured and agile approach to project delivery
- **Project Closure**
  - Project Evaluation
    - Defining project and project management success
    - Success Criteria for Projects
    - Project Audits
  - Project Termination
    - When to terminate a project
    - The verities of project termination
    - The termination process
- **Environmental and sustainable development projects**
  - Importance of Sustainable development
  - Sustainability and project management
  - Evaluation of sustainable development projects from various sectors

Recommended Books:

- Project Management: A System Approach to Planning Scheduling and Controlling by Harold Kerzner, 11th edition, John Willey 2013, ISBN: 978-1-118-02227-6
- Project Management: A managerial approach 7th edition, Jack R. Meredith and Samuel J. Mantel, Jr. John Wiley and Sons, Inc. Project Management for Business, ISBN: 13 978-0-470-22621-6
- Engineering and Technology: Principles and Practice 3rd Edition, by John M. Nicholas and Herman Steyn, Elsevier Publications ISBN: 978-0-7506-8399-9
- Project Management: A Strategic Planning Approach by Paul Gardiner, 2nd Edition, Palgrave Macmillan, 2017,ISBN 9780230545106

Entrepreneurship

Contact Hours:
Theory = 48
Practical = 0
Total = 48

Credit Hours:
Theory = **3.0**
Practical = **0.0**
Total = **3.0**

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	Develop a business plan with an appropriate business model	Cognitive	C5	11
2.	Demonstrate the ability to provide a self-analysis in the context of an entrepreneurial career	Affective	A4	9
3.	Demonstrate the ability to find an attractive market that can be reached economically	Affective	A3	6

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☐	7	Environment and Sustainability:	☐
2	Problem Analysis:	☐	8	Ethics:	☐
3	Design/Development of Solutions:	☐	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

Venture Opportunity, Concept, and Strategy

- Introduction
- Business Model
- Strategies

Venture Formation and Planning

- Risk and Return
- The Business Plan
- Types of Ventures
- Legal Formation and Intellectual Property

Financing

- The financial plan
- Sources of Capital

Detailed Functional Planning

- Marketing and Sales Plan
- Acquiring and Organizing Resources
- Management of Operations

Recommended Books:

- Technology Ventures: From Idea to Enterprise by Thomas Byers, Richard Dorf, Andrew Nelson, 4th Edition, McGrawHill 2015, ISBN 9780073523422
- The Startup Owner's Manual: The Step-By-Step Guide for Building a Great Company by Steve Blank, Bob Dorf, K & S Ranch 2012, ISBN 9780984999309
- The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses by Eric Ries, Penguin Books 2011, ISBN 9780307887894

Computing and Core Courses Outline

Introduction to Computing

Contact Hours:
Theory = 16
Practical = 48
Total = 64

Credit Hours:
Theory = **1.0**
Practical = **1.0**
Total = **2.0**

Prerequisites: None

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	Identify the components of a computer system, demonstrate basic proficiency in computer and commonly used computer applications	C	3	1
2.	Explain the fundamentals of operating systems, databases, computer networks and internet.	C	2	1
3.	Ability to write, debug and execute programs in C language.	C	3	1

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☐	7	Environment and Sustainability:	☐
2	Problem Analysis:	☐	8	Ethics:	☐
3	Design/Development of Solutions:	☐	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

Basic computer and network organization. Introduction to operating systems. Introduction to word processing, spreadsheets and presentation softwares. Introduction to mathematical software such as MATLAB. Program, languages, and compilation process Development of flowchart and corresponding pseudo codes. Introduction to simple program coding, executing and debugging involving input / output.

Practical:

Demonstration of computer and networking hardware and peripherals. Operating system (linux, windows etc) and application software installation (open office, MATLAB etc). Use of word processing, spread sheet and presentation software such as open office, latex etc. Solution of simple mathematical problems using MATLAB. Simple projects involving input/output using Arduino, Raspberry-Pi etc.

Assessment (Theory)

Assignments
Quizzes
Mid Term
Final

Assessment (Lab)

Weekly lab reports
Viva voce
Project work

Text and Reference books:

i. Peter Norton's Introduction to Computers.
ii. Internet Resources

Programming Fundamentals

Contact Hours:
Theory = 48
Practical = 48
Total = 96

Credit Hours:
Theory = **3.0**
Practical = **1.0**
Total = 4**.0**

Prerequisites: Introduction to Computing

Course outcome:

SUGGESTED COURSE LEARNING OUTCOMES:

Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	Build logic of a program, design an algorithm and make a flow chart to represent the solution of problem	Cognitive	3	3
2.	Design and Implement the solution of problem using loops, arrays, functions, structures	Cognitive	5	3
3.	Analyze different programs to compute the output and identify logical and syntax errors	Cognitive	4	2

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☑	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:
Fundamental data types. Basic programming structs. Functions and Arrays. Pointers and Structures. File I/Os.

Practical:
Programming in C using simple programs, single and multidimensional arrays, functions and pointers, file i/o

Teaching Methodology

- Lecturing
- Written Assignments
- Laboratory work

Assessment (Theory)

Assignments
Quizzes
Mid Term
Final

Assessment (Lab)

Weekly lab reports
Viva voce
Project work

Text and Reference books:

1. Kernighan and Riechie, " The C programming language", Latest Edition.
2. Deitel and Deitel, *C++, How to Program* , Prentice Hall. ISBN 9780134448848

Data Structure and Algorithms

Contact Hours:
Theory = 48
Practical = 48
Total = 96

Credit Hours:
Theory = **3.0**
Practical = **1.0**
Total = 4**.0**

Prerequisites: Programming Fundamentals

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	Classify and analyze different categories of data structures and algorithms.	C	3	2
2.	Implement common searching and sorting algorithms	C	3	2

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☐	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

Data types, Arrays, Records, Set structure, Abstract Data Types**,** Sequential allocation, Linked allocation. Stacks (Sequential as well as Linked Implementation) Queues. (Sequential as well as Linked Implementation), Linked Lists, Recursive versus Iterative Algorithms, Applications, Towers of Hanoi, Linked Lists, Traversal, Insertion, Deletion, Doubly linked lists, Root Node,
Terminal Node, Branch Node, Level of a Node, Degree of a node. , Binary Tree, Tree traversal, (In-order/Pre-order/Post-order traversal), Conversion of tree into binary tree/ Bin tree into a Heap,. Traversing and searching in a tree, Insertion: Deletion, Heap, Heap-sort, Graphs. Adjacency Matrix, Traversal, DFS, BFS, Path lengths, Shortest Path **Searching & Sorting Algorithms,** Insertion sort, Selections sort, Merge sort, Radix sort, Hashing.

Practical:
Programming in C using simple programs, single and multidimensional arrays, functions and pointers, file i/o

Teaching Methodology

- Lecturing
- Written Assignments
- Laboratory work
-

Assessment (Theory)

- **Assignments**
- **Quizzes**
- **Mid Term**
- **Final**

Assessment (Lab)

- **Weekly lab reports**
- **Viva voce**
- **Project work**

Text and Reference books:

1. Horowitz Sahni, "Fundamentals of Data Structures in C++", 1999.
2. Lipshutz, "Data Structures", Schaum Outline Series, 1999.
3. Weiss, "Data structures and algorithm analysis in C++".
4. A. M. Tanenbaum, "Data structures using C and C++", 2001.

LINEARC CIRCUIT ANALYSIS

Contact Hours:
Theory =48
Practical = 48
Total = 96

Credit Hours:
Theory = **3.0**
Practical = **1.0**
Total = **4.0**

Pre-requisite: None

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	Apply circuit reduction techniques such as series, parallel and source conversions and circuit solving techniques like Mesh and Node Analysis to analyze for steady state solutions for both sinusoidal AC and DC.	Cognitive	2	1
2.	Analyze for transients in RC and RL circuits for DC.	Cognitive	4	1
3.	Apply phasor techniques for the solution of steady state AC response including voltage, current, power and power factor.	Cognitive	3	1
4	Conduct experiments in laboratory in order to interpret experimental data and observe its conformance with analyzed results of circuits.	Psychomotor	2	4

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☐	8	Ethics:	☐
3	Design/Development of Solutions:	☐	9	Individual and Team Work:	☐
4	Investigation:	☑	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

- Electric quantities, electric signals, electric circuits
- Kirchhoff's laws, circuit elements. Resistance, series parallel combination, voltage and current dividers, resistive bridges
- Nodal analysis, loop analysis, linearity and superposition, source transformation, one ports, circuit theorems, power calculations. dependent sources, circuit analysis with dependent sources
- The operational amplifier, basic op-amp configurations, ideal op-amp circuit analysis, summing and difference amplifiers, amplifier types

- Capacitance, inductance (including mutual inductance), natural response of RC and RL circuits. Response to DC forcing function
- AC fundamentals; RMS or effective, average and maximum values of current & voltage for sinusoidal signal wave forms.

Lab Work Outline:

Learn the use of basic instruments in electrical engineering such as function generators, power supplies, oscilloscopes. Design and implement circuits using R, RL and RC and verify the node voltages and loop currents using instruments. Verify Circuit-theorems using lab instruments. Verify circuit transformations using lab instruments. Complex Engineering Problem using OP-AMP as black box.

Teaching Methodology

- Lecturing
- Written Assignments
- Web resources

Assessment (Theory)

Assignments
Quizzes
Mid Term
Final

Assessment (Lab)

Weekly lab reports
Viva voce
Project work

Recommended books:

1. S. Franco, "Electric Circuits Fundamentals", Oxford University Press, (Latest Edition).
2. R E Thomas, A J Rosa and G J Toussaint, "The Analysis and Design of Linear Circuits" John Wiley, 6th Edition, 2009
3. C Alexander and M Sadiku, "Fundamentals of Electric Circuits", McGraw- Hill, 4th Edition, 2008
4. J D Irwin and R M Nelms, "Basic Engineering Circuit Analysis", Wiley, 9th Edition, 2008
5. W Hayt, J Kemmerly and S Durbin, "Engineering Circuit Analysis", McGraw- Hill, 7th Edition, 2007.

ELECTRICAL NETWORK ANALYSIS

Contact Hours:
Theory =48
Practical = 48
Total = 96

Credit Hours:
Theory = **3.0**
Practical = **1.0**
Total = 4**.0**

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	Analyze AC circuits in time domain and frequency domain.	Cognitive	4	1
2.	Analyze balanced three phase systems	Cognitive	4	1
3.	Use simple electric circuit models to examine the behavior of complex networks.	Cognitive	3	1
4	Construct circuits on breadboards and perform electrical measurements and analyze using modern engineering tools.	Psychomotor	2	5

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☑	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☑	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:
Prerequisites: Linear Circuit Analysis

Objective: To equip the students with the knowledge and techniques of analyzing electrical networks.

Course Outline:
Current and voltage transients, RLC circuits with DC and AC excitation, Transient response and step response of second order circuits., resonant circuit: series and parallel resonance in AC circuit, Q-Factor, analog filters, introduction to phasor representation of

alternating voltage and current, single-phase circuit analysis, star-delta transformation for DC and AC circuits, three phase circuits, power in three phase circuits and different methods of its measurements. Two-port networks and their interconnections. Application of Laplace transform in circuit analysis.

Lab Work Outline:
Design and implement RLC circuits and observe resonance and impedance characteristics. Verify the node voltages and loop currents in RLC circuits using instruments. Verify Circuit-theorems using lab instruments. Verify circuit transformations using lab instruments. Learn the use of Circuit Simulation computer package such as, SPICE, Observe transient and steady state response in RL, RC and RLC circuits using SPICE, MATLAB/SIMULINK.

Teaching Methodology

- Lecturing
- Web Resources/ Videos

Assessment (Theory)

Assignments
Quizzes
Mid Term
Final

Assessment (Lab)

Weekly lab reports
Viva voce
Project work

Recommended Books:

1. S. Franco, "Electric Circuits Fundamentals", Oxford University Press, (Latest Edition).
2. V.V. Burg, "Network Analysis", (Latest Edition)
3. R E Thomas, A. J. Rosa and G. J. Toussaint, "The Analysis and Design of Linear Circuits" John Wiley, 6th Edition, 2009
4. C. Alexander and M. Sadiku, "Fundamentals of Electric Circuits", McGraw- Hill, 4th Edition, 2008
5. J. D. Irwin and R. M. Nelms, "Basic Engineering Circuit Analysis", Wiley, 9th Edition, 2008
6. W. Hayt, J. Kemmerly and S. Durbin, "Engineering Circuit Analysis", McGraw-Hill, 7th Edition, 2007.

WORKSHOP PRACTICE

Contact Hours:
Theory =00
Practical = 48
Total = 48

Credit Hours:
Theory = **0.0**
Practical = 1**.0**
Total = 1**.0**

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	**ACQUIRE** the basic knowledge of Electric circuit, its components. Electrical Power System, process of Electrical power Generation, Transmission and Distribution.	Cognitive	1	1
2.	**To Explain** Electrification System, how to get Electric supply both single and three phase from the Transformer, its protection.	Cognitive	2	2
3.	**ACQUIRE** the basic knowledge about Electric Shocks, types and its effects on the human body. First Aid procedures.	Cognitive	1	1
4.	**To Solve** simple electric wiring circuits for electrification of buildings, Selection of different components.	Cognitive	2	2

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☐	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course Outline:
Introduction to various technical facilities in the workshop including mechanical and electrical equipment. Concepts in electrical safety, safety regulations, earthing concepts, electric shocks and treatment. Use of tools used by electricians, wiring regulations, types of cables and electric accessories including switches, plugs, circuit breakers, fuses etc., symbols for electrical wiring schematics e.g. switches, lamps, sockets etc., drawing

and practice in simple house wring and testing methods, wiring schemes of two-way and three-way circuits and ringing circuits, voltage and current measurements. Electric soldering and soldering tools; soldering methods and skills, PCB designing, transferring a circuit to PCB, etching, drilling and soldering component on PCB testing.

Teaching Methodology

- Lab instructions/Lecturing
- Class Assignments

Assessment (Lab)

Weekly lab reports
Viva voce
Project work

Recommended Books:

1. Choudhury, "Elements of Workshop Technology", Vol. 1, MPP.
2. Chapman, "Workshop Technology", Part-I,II,III, CBS.

PROBABILITY METHODS IN ENGINEERING

Contact Hours:
Theory =48
Practical = 0
Total = 48

Credit Hours:
Theory = **3.0**
Practical = **0.0**
Total = **3.0**

Pre-requisite:
Calculus and Analytic Geometry

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	EXPLAIN basic probability concepts and their use in different problems	Cognitive	2	2
2.	COMPARE different types of random variables and their usage in science and engineering	Cognitive	4	2
3.	APPLY basic statistical techniques such as regression, curve fitting to engineering data	Cognitive	3	4

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☐	7	Environment and Sustainability:	☐
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☐	9	Individual and Team Work:	☐
4	Investigation:	☑	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

- Basic probability concepts, conditional probability, Bayes' theorem
- Random variable, probability density function, cumulative distribution function
- Specific random variable discrete as well as continuous
- Moments and moment generating function
- Law of large numbers
- Basic statistical concepts, samples and sampling distributions
- Parameter estimation, hypothesis testing and curve fitting

Teaching Methodology

- Lecturing
- Written Assignments
- Web resources

Assessment (Theory)

Assignments
Quizzes
Mid Term
Final

Recommended books:

- Alberto Leon-Garcia: Probability and Random Processes for Electrical Engineering. Prentice Hall, Inc. New Jersey, 3rd ed. 2008.
- Peyton Z. Peeble Jr.: Probability and Random Variables and Random Signal Principles. McGraw Hill, 4th ed. 2001.
- Richard L. Scheaffer and James T. McClave: Probability and Statistics for Engineers. Brooks/Cole, 5th ed. 2011.

SIGNALS AND SYSTEMS

Contact Hours:
Theory =48
Practical = 48
Total = 96

Credit Hours:
Theory = **3.0**
Practical = **1.0**
Total = **4.0**

Pre-requisite:
Complex Variables and Transforms

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	APPLY the time domain and frequency domain representation and transformation techniques on the continuous-time signals, systems	Cognitive	2	2
2.	Analyze and design continuous time systems using laplace transforms.	Cognitive	3	3
3.	REPRODUCE logical codes for simulation of different signals and their transforms using modern platform and software tools.	Cognitive	3	5

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☐	7	Environment and Sustainability:	☐
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☑	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☑	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

- Continuous time and discrete time signals
- Periodic signals, even and odd signals, exponential and sinusoidal signals, the unit impulse and unit step functions
- Continues time and discrete time systems
- Linear time invariant (LTI) systems, difference equation, causality, BIBO stability, convolution and correlation

- discrete time Fourier transforms, time and frequency characterization of signals and systems
- Analysis and design of continuous time systems using Laplace transforms.
- The sampling theorem, aliasing, sampling the discrete time signals

Lab Work Outline:

Develop and understanding of signal systems and transforms using MATLAB

Teaching Methodology

- Lecturing
- Written Assignments
- Web resources

Assessment (Theory)

Assignments
Quizzes
Mid Term
Final

Assessment (Lab)

Weekly lab reports
Viva voce
Project work

Recommended books:

- A. V. Oppenheim, A. S. Willsky and S. H. Nawab, "Signals and Systems", 2nd Edition, Prentice Hall, 1996
- M. J. Roberts, "Fundamentals of Signals and Systems", McGraw-Hill, 2007
- B. P. Lathi, "Linear Systems and Signals", 2nd Edition, Oxford, 2004
- S. Haykin and B. Van Veen, "Signals and Systems", 2nd Edition, Wiley, 2002
- C. L. Phillips, J. M. Parr and E. A. Riskin, "Signals, Systems, and Transforms", 4th Edition, Prentice Hall, 2007.

Electronics Devices & Circuits

Contact Hours:
Theory =48
Practical = 48
Total = 96

Credit Hours:
Theory = **3.0**
Practical = **1.0**
Total = **4.0**

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	Describe and explain the basic construction, operation and characteristics of semiconductor devices	Cognitive	2	1
2.	Apply the acquired knowledge to solve small scale circuits consisting of semiconductor devices	Cognitive	3	1
3.	Illustrate dc and ac response of small signal amplifier circuits using device models	Cognitive	3	2

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☐	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

Semiconductor Devices

Semiconductor Diode Introduction, Semiconductors, Energy Levels, n-type and p-type materials, Semiconductor Diode, Characteristics of Diode, Diode Equivalent Circuits
Transitions, Recovery, Specification, Notations, Testing of Diode, Zener Diode, Light Emitting Diodes, Numerical Problems.

Diode Applications

Introduction, Load Line Analysis, Parallel and Series Configurations, Gates, Sinusoidals, Half Wave/Full Wave Rectifiers, Clipper and Clamper Circuits, Zener Diodes, Voltage-Multiplier Circuits and Applications, Numerical Problems.

Bipolar Junction Transistors

Bipolar Junction Transistors Introduction, Bipolar Junction Transistors, Construction and Operation, and Amplification analysis, Common-Emitter, Common-Base and Common Collector Configurations of BJT, Limits of Operation, Specification, Testing, Casing and Terminal Identification of BJTs, Numerical Problems.

DC Biasing-BJTs

Introduction, Operating Point, Fixed-Bias, Emitter Bias, Voltage Divider Bias Configurations, Collector Feedback , Emitter-Follower, Common-base and Miscellaneous Configurations, Design Operations, Current Mirror and Current Source Circuits, PNP Transistors, transistor Switching Networks, Bias Stabilization, Numerical Problems.

BJT AC Analysis

Introduction, AC Domain, BJT Modeling, re-Model, CE-Fixed Configuration, Voltage Divider Bias, CE Emitter-Bias, Emitter-Follower, Common-Base, Collector Feedback and Collector Feedback Configurations, Current Gain, RL and RS, Two Port Systems, Cascaded Systems, Darlington and Feedback Pair, Hybrid Equivalent Model, Hybrid π Model, Variations of Transistor Parameter, Numerical Problems.

Teaching Methodology

- Lecturing
- Written Assignments
- Bi-weekly evaluation quizzes

Assessment

Mid Term (25%)

- Written (Long Questions, Short Questions) 100%

Final Term (50%)

- Written (Long Questions, Short Questions) 100%

Sessional Marks (25%)

- Quizzes 50%
- Assignments 50%

Text book:

- Electronic Devices and Circuit Theory, H. Boylestad and L. Nashelsky, ISBN-10: 0135026490

Reference book:

- Electronic Devices, Thomas L. Floyd, ISBN-10: 0132359235

- Electronics Principles, Alberto P Malvino ISBN: 978-0073373881

ENGINEERING DRAWING

Contact Hours:
Theory =00
Practical = 48
Total = 48

Credit Hours:
Theory = **0.0**
Practical = 1**.0**
Total = 1**.0**

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	Ability to draw basic drawing objects	Psychomotor	3	5
2.	Ability to read basic engineering drawing	Cognitive	3	1
3	Apply engineering drawing skills using Auto CAD tool.	Psychomotor	2	5

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☐	8	Ethics:	☐
3	Design/Development of Solutions:	☑	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☑	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

Types of lines and usage, dimensioning, orthographic first angle projection, orthographic third angle projection, introduction to computer aided drawing, isometric projection, sectional drawing and assembly drawing. Reading and preparing electrical engineering drawings such as wiring diagram, power system layout diagram, PCB drawing etc

Teaching Methodology

- Lab instructions/Lecturing
  Lab Assignments

Assessment (Lab)

Weekly lab reports
Viva voce
Project work

Recommended Books:

1. Shawna Lockhart, "Tutorial Guide to AutoCAD", Prentice Hall.
2. A. C. Parkinson, "First Year Engineering Drawing".
3. N.D. Bhatt, Engineering Drawing.

DIGITAL LOGIC DESIGN

Contact Hours:
Theory =48
Practical = 48
Total = 96

Credit Hours:
Theory = **3.0**
Practical = **1.0**
Total = **4.0**

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	**PERFORM** gate level minimization using K-map and combinational logic by employing analysis and design procedure.	Cognitive	3	1
2.	**DERIVE** equations from truth / state table in order to design synchronous sequential logic which includes latches, flip-flops and state reduction.	Cognitive	3	1
3.	**DESIGN** a valid ALU using verilog language and Xilinx ISE platform.	Cognitive	5	3

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☐	8	Ethics:	☐
3	Design/Development of Solutions:	☑	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

- Number Systems, Boolean Algebra, Logic Simplification, Combinational Logic, Sequential Logic, Latches, Flip-Flops and their applications. Adders, Multiplexers, Counters, Shift Registers, and simple Arithmetic Logic Unit (ALU). Design and implementation of combinational circuits in Verilog, Introduction to FPGA.

Practical:

- Basic logic gates, hardware implementation of combinational logic circuits such as multiplexers and de-multiplexers, encoders/decoders, ALU; implementation of sequential circuits such as flip-flops, registers, shift registers, counters and other digital

circuits. Complex engineering problem such as ALU Design in Verilog and its implementation in FPGA.

Teaching Methodology

- Lecturing
- Written Assignments

Assessment (Theory)

Assignments
Quizzes
Mid Term
Final

Assessment (Lab)

Weekly lab reports
Viva voce
Project work

Text and Reference books:

1. M. Morris Mano and Micheal D. Ciletti, "Digital Design with an introduction to the Verilog HDL", Prentice Hall, 5th Edition.
2. Morris Mano and Charles R. Kime, "Logic and Computer Design Fundamentals", Prentice Hall. Latest Edition
3. Tocci and Widmer, "Digital Systems: Principles and Applications". Prentice Hall. Latest Edition

INTRODUCTION TO EMBEDDED SYSTEMS

Contact Hours:	**Credit Hours:**
Theory =48	Theory = **3.0**
Practical = 48	Practical = **1.0**
Total = 96	Total = **4.0**

PRE-REQUISITE:

Digital Logic Design, Programming Fundamentals

SUGGESTED COURSE LEARNING OUTCOMES:

Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	**DESCRIBE** AVR based microcontroller architecture, its internal registers, and instruction set	Cognitive	2	1
2.	**PERFORM** timer programming, serial port programming and interrupt programming both in C and assembly language	Cognitive	3	1
3.	**DESIGN** and **IMPLEMENT** microcontroller based project for input voltage based speed control of a motor.	Psychomotor	5	3

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):

The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☐	8	Ethics:	☐
3	Design/Development of Solutions:	☑	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

- Scope and ubiquitous presence of embedded systems. Microprocessor and Microcontroller (AVR) Architecture. Internal Registers, Machine code, Addressing modes and Instruction Set, C and the Compiler, Debugging Software and Hardware, Threads, Tasks and Simple Scheduling, Branching, Interrupt handling, I/O and Communication Ports programming, Digital and Analog I/O Peripherals, A/D and D/A interfacing, Simulation design and debugging. Application using PWM.

Practical:

- Learn to read datasheets/manuals in order to develop practical applications. Assembly and C language based microcontroller (PIC or Raspberry Pi) interfacing for interrupt and data based applications involving LED/ LCD, GPIO ports, communication ports, A/D, and D/A interfacing. Example project can be input voltage based speed control of DC Motor / stepper motor using PWM.

Teaching Methodology

- Lecturing
- Written Assignments

Assessment (Theory)

Assignments
Quizzes
Mid Term
Final

Assessment (Lab)
Weekly lab reports
Viva voce
Project work

Text and Reference books:

4. Muhammad Ali Mazidi, Rolin D. McKinlay, and Danny Causey, "PIC Microcontroller and Embedded Systems: Using Assembly and C for PIC18", Pearson.
5. Frank Vahid and Tony D. Givargis, "Embedded System Design: A Unified Hardware/Software Introduction", John Wiley & Sons.
6. Muhammad Ali Mazidi, Sarmad Naimi, and Sepehr Naimi, "The AVR Microcontroller and Embedded Systems: Using Assembly and C" published by Pearson Custom Electronics Technology

ELECTROMAGNETIC FIELD THEORY

Contact Hours:
Theory = 48
Practical = 0
Total = 48

Credit Hours:
Theory = **3.0**
Practical = **0**
Total = **3.0**

Pre-requisite: MULTIVARIABLE CALCULUS

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	Describe the basic vector algebra and calculus, orthonormal and non-orthonormal coordinate systems, introduces the concepts of gradients, divergence and curl operations.	Cognitive	2	1
2.	Analyze the theory of electrostatics in general and apply them in various situations.	Cognitive	4	1
3.	Analyze the theory of magnetostatics in general and apply them in various situations.	Cognitive	4	1
4	Describe time dependent fields, coupled electric and magnetic field intensities are discussed in order to develop electromagnetic model.	Cognitive	2	1

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☐	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:
Vector algebra, coordinate systems and transformations, Vector calculus, electrostatic fields in materials, electrostatic boundary value problems, resistance and capacitance calculation. Magneto-static fields, magneto-static fields and materials, inductance calculation. Faraday's Law, displacement current and Maxwell's equation.

Teaching Methodology

- Lecturing
- Written Assignments

Assessment (Theory)

Assignments
Quizzes
Mid Term
Final

Recommended books:

7. William Hayt and John A. Buck, “Engineering Electromagnetics”, McGrawHill, ISBN: 0073104639, Latest Edition.
8. Sadiku, Matthew N, “Elements of Electromagnetics”, Oxford University Press, ISBN: 0195103688, Latest Edition.
9. J. D. Kraus, "Electromagnetics", John Wiley & Sons, Latest edition.
10. David K. Cheng, "Fundamentals of Engineering Electromagnetics", Addison Wesley.

COMMUNICATION SYSTEMS

Contact Hours:
Theory = 48
Practical = 48
Total = 96

Credit Hours:
Theory = **3.0**
Practical = **1.0**
Total = **4.0**

Pre-requisite: SIGNALS AND SYSTEMS, PROBABILITY METHODS IN ENGINEERING

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	Use theorems such as Parseval's theorem and tools such as Fourier transform to represent and quantify signals in time and frequency domain as well as understand the characteristics of distortion-less communication channel	Cognitive	3	2
2.	Describe the basic theory, compare advantages and disadvantages, identify and compute parameters, the performance metrics, and explain the working of the different types of analog transceiver designs using time and frequency domain analysis	Cognitive	2	2
3.	Apply principles of Analog to Digital conversion and design Quantizers under various constraints	Cognitive	2	3
4	Build and troubleshoot various electronic circuits for analog modulation and demodulation and understand their working in order to apply theory into practice.	Psychomotor	2	5

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☐	7	Environment and Sustainability:	☐
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☑	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☑	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:
Amplitude Modulation: Baseband and carrier communications, Double Sideband (DSB), Single Sideband (SSB), Vestigial Sideband (VSB), Superhetrodyne AM Receiver, Carrier Acquisition, Television, Angle Modulation: Instantaneous frequency, Bandwidth of FM/PM, Generation of FM/PM, Demodulation of FM/PM.
Noise: Mathematical representation, Signal to Noise Ratio, Noise in AM, FM, and PM systems
Pulse Modulation**:** Sampling and Quantization, Pulse Amplitude Modulation, Pulse Position and Pulse Width Modulation, Quantization Noise, Signal to Quantization Noise Ratio, Pulse code Modulation, Delta Modulation, Frequency Shift Keying, Phase Shift Keying.

Teaching Methodology

- Lecturing
- Written Assignments
- Term Project
- Report Writing

Assessment (Theory)

Assignments
Quizzes
Mid Term
Final

Assessment (Lab)

Weekly lab reports
Viva voce
Project work

Recommended books:

11. Simon Haykin, "Communication Systems", John Wiley, Latest Edition.
12. B. P. Lathi and Zhi Ding, "Modern Digital and Analog Communication Systems", Oxford University Press, Latest Edition.

ELECTRICAL MACHINES

Contact Hours:
Theory = 48
Practical = 48
Total = 96

Credit Hours:
Theory = **3.0**
Practical = **1.0**
Total = **4.0**

Prerequisites: Electrical Network Analysis

SUGGESTED COURSE LEARNING OUTCOMES:

Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	Apply the concepts of magnetic fields to analyze magnetic circuits and principle of operation of a transformer, and compute various parameters of transformer.	Cognitive	3	2
2.	Compute the various parameters of ac motors and generators, their equivalent circuits, rotating magnetic field, the induced voltage and torque, phasor diagrams and the relationships between speed, power, torque and, applications.	Cognitive	3	2
3.	Compute the various parameters of DC generators and motors, their equivalent circuits, the relationships between speed, power, torque, and applications.	Cognitive	3	3

	Perform experiments in a laboratory enabling the students to gain insight into the functioning of transformer, ac and dc machines.	Psychomotor	2	5

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☐	7	Environment and Sustainability:	☐
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☑	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☑	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course Outline:

Introduction to Electrical Machinery Principles (1 CH): Magnetic field and circuits, Faraday's and Lenz's law, magnetization curves characteristics of hard and soft magnetic materials, losses.

Single Phase Transformers (12 CH): Introduction and fundamental concepts, working principle, types, construction, ideal transformer, operation and equivalent circuit, voltage regulation, losses, open and short circuit test, efficiency, instrument and auto transformers, name plate ratings and applications.

DC Generator and Motor (13 CH): Introduction and fundamental concepts, working principle, types, construction, operation, EMF equations, torque equations, characteristics, commutation, armature reaction, speed and voltage regulation, losses, open and short circuit test, no load and blocked rotor test, name plate ratings and applications.

Induction and Synchronous Machines (22 CH): Introduction and fundamental concepts, working principle, rotating magnetic field, magneto motive force and flux distribution, types, construction, operation, EMF equations, torque equations, speed and voltage regulation, losses, open and short circuit test, no load and blocked rotor test, name plate ratings and applications.

Special Purpose Motors: Introduction to Single phase Induction Motors, Switched Reluctance motors, Hysteresis motors, Stepper, brushless DC motors.

Teaching Methodology

- Lecturing
- Written Assignments

Assessment (Theory)

Assignments
Quizzes
Mid Term
Final

Assessment (Lab)

Weekly lab reports
Viva voce
Project work

Recommended books:

1. Stephen J. Chapman, "Electric Machinery Fundamentals", McGraw-Hill. (Latest Edition)
2. Fitzgerald, Kingsley and Umans, "Electric Machinery", McGraw-Hill. (Latest Edition)
3. Hindmarsh, "Electrical Machines", McGraw-Hill. (Latest Edition)
4. Theodore Wildi "Electrical Machines, Drives, and Power Systems"

LINEAR CONTROL SYSTEMS

Contact Hours:
Theory = 48
Practical = 48
Total = 96

Credit Hours:
Theory = **3.0**
Practical = **1.0**
Total = **4.0**

Pre-requisite: SIGNAL AND SYSTEMS

SUGGESTED COURSE LEARNING OUTCOMES:

Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	Develop a mathematical model using input/output Differential equations, Transfer Functions and State Space for Linear Time Invariant electrical and mechanical systems.	Cognitive	3	2
2.	Analyze the stability of Linear Time Invariant complex engineering systems using Routh's Criteria, Root Locus, Bode plots and State Space analysis.	Cognitive	3	2
3.	Design a compensator to achieve desired closed loop response for a system using, Root Locus, Bode plots and State Space.	Cognitive	5	3
	Use Matlab and Simulink for modeling and simulation of complex engineering systems.	Psychomotor	2	5

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☐	7	Environment and Sustainability:	☐
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☑	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☑	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:
Modeling of electrical, mechanical and biological control systems. Open and closed-loop systems, Block diagrams. Second order systems. Step and impulse response. Performance criteria. Steady state error. Sensitivity, s-plane system stability. Analysis and design with the root loci method. Frequency domain analysis, Bode plots, Nyquist criterion, gain and phase margins, Nichols charts. State-space method, state equations, flow graphs, stability, compensation techniques. Simulation and Controller design using MATLAB such as linear quadratic guassian, linear quadratic regulator, h-controller etc.

Teaching Methodology

- Lecturing
- Written Assignments

Assessment (Theory)

Assignments
Quizzes
Mid Term
Final

Assessment (Lab)

Weekly lab reports
Viva voce
Project work

Recommended books:

1. Steffani, Savant, Shahian and Hostetter, "Design of Feedback Control Systems" 4th Edition, Saunders College Publications.
2. Katsushiko, Ogata, "Modern Control Engineering," McGraw-Hill, `5th Edition
3. R. C. Dorf and R. H. Bishop, "Modern Control Systems," 12th Edition
4. B. C. Kuo, "Automatic Control Systems" 7th Edition

Electrical Engineering (Power System Stream) Courses Outline

POWER SYSTEMS ANALYSIS

Contact Hours:
Theory =48
Practical = 48
Total = 96

Credit Hours:
Theory = **3.0**
Practical = **1.0**
Total = **4.0**

PREREQUISITE
Electrical Network Analysis

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

S. No.	CLO	Domain	Taxonomy level	PLO
1.	Comprehend the fundamental concepts and importance of electrical power system in socio- economic development.	Cognitive	1	1
2.	Analyze Load Flow, Fault with reference to stability analysis of power system	Cognitive	2	2
3.	An experience on IEEE Test Systems & Small Industrial Power System using MATLAB or advanced tool.	Cognitive	2	2

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☐	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

OBJECTIVES
This course has been designed to introduce the importance of analyzing various aspects of power system. It covers power flow studies, fault analysis, and stability studies in power networks. This forms the basis for studying the courses Power System Operation & Control and Power System Protection.

COURSE OUTLINE

Introduction:

- Structure & Growth of Electrical Power Systems,
- Per unit system of calculations,
- One Line Diagram, Impedance & Reactance Diagram,
- Bus Impedance and Admittance Matrices---Formation, Modifications and Importance.

Load Flow Solution:

- Scope of Load Flow in Electrical Power System,
- Load Flow Problem Formulation & Solution Methodologies,
- Gauss Siedel, Newton Raphson and Fast Decoupled Method and
- Load Flow Control.

Fault Analysis:

- Importance of the Fault Analysis in Electrical Power System,
- Faults and their Types,
- Symmetrical Fault Analysis (SFA): SFA using Thevenin's Theorem and Z-bus, Short Circuit MVA,
- Unsymmetrical Fault Analysis (UFA): Symmetrical Components, Sequence Impedances, Sequence Networks of Loaded Generator, Line-to-Ground (L-G) fault, Line-to-Line (L-L) Fault and Line-to-Line-Ground (L-L-G) Fault analysis of unloaded generator and Power system.

Power System Stability

- Stability Problem --- Scope and Significance,
- Steady State & Transient Stability,
- Power Flow Relationship for Cylindrical & Salient Pole Machines,
- Derivation of Swing Equation,
- Equal Area Criterion, Solution of Swing Equation, Factors Effecting Stability,
- Use of Digital Computer Methods for the Stability Studies

RECOMMENDED BOOKS:

1. Hadi Saadat, "Power System Analysis", McGraw-Hill International Editions.
2. Glover and Sarma "Power System Analysis"
3. Greinger and William D. Stevensons Jr, " Power System Analysis", McGraw Hill, Latest Ed.
4. B. M. Weedy ,B. J. Cory, N. Jenkins, Janaka B. Ekanayake, GoranStrbac "Electric Power Systems", John Wiley

ELECTRICAL POWER DISTRIBUTION AND UTILIZATION

Contact Hours:
Theory =48
Practical = 48
Total = 96

Credit Hours:
Theory = **3.0**
Practical = **1.0**
Total = **4.0**

PREREQUISITE
Electrical Network Analysis

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

S. No.	CLO	Domain	Taxonomy level	PLO
1.	To understand power substation and equipment.	Cognitive	4	1
2.	To understand the cable selection process and design the cable size for a given location	Cognitive	5	3
3.	To understand the luminarie selection process and design the lighting scheme for a given location	Cognitive	5	3
4.	Carryout soil resistivity and earthing resistance measurement in a practical ground	Psychomotor	4	4

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☐	8	Ethics:	☐
3	Design/Development of Solutions:	☑	9	Individual and Team Work:	☐
4	Investigation:	☑	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

COURSE OUTLINE:

Introduction to distribution system:

- Urban, suburban and rural distribution systems.
- Primary, secondary and tertiary voltages, distribution conductors & cables, Kelvin's law,

- Radial and ring main systems, application of distribution transformers,
- Estimation of load, load characteristics, substation switchgears and bus bar arrangements,
- Calculation of voltage drop and regulation in distribution feeders.

Power Cables:

- Cable Construction, Types of Cables, Insulating materials,
- Conducting materials,
- Capacitance of a Cable, Dielectric Power Loss,
- Thermal Characteristics of Cables, Cable Installation,
- Cable Selection Criteria, Calculation of Current Rating of Cables,
- Voltage drop calculation, Cable Fault Localization.

Grounding and Earthing:

- Distribution transformer neutral,
- Earthing resistance,
- Earthing practice in L.V. networks,
- Electrical Safety.

Power Factor:

- Disadvantages and causes of low power factor,
- methods for improvement,
- application of shunt capacitors in distribution network.

Electrochemical Processes:

- Main types of batteries and their working,
- battery charging, electroplating, electrolysis and electrometallurgical process.
- Cathodic protection of poles, gas pipes, oil pipes and water structures.

Heating and Welding:

- Electric heating, resistance, induction and dielectric heating, electric furnaces,
- microwave and infrared heating,
- electric welding, resistance welding and its types.

Fundamentals of Illumination:

- Basic lighting terminologies and laws of illumination
- Requirements for good lighting,
- Illumination schemes for various situations (street lighting, commercial/industrial lighting, stadium/flood/stage/spot lighting, etc.),
- Types of lamps, their working and relative merit,
- Building lighting design.

Modern trends in Power Distribution & utilization.

RECOMMENDED BOOKS

1. TuranGonen, "Electrical Power Distribution System", CRC Press.
2. M. L. Anand, "A Text Book of Electrical Power", Latest Edition

ADVANCED ELECTRICAL MACHINES

Contact Hours:
Theory =48
Practical = 48
Total = 96

Credit Hours:
Theory = **3.0**
Practical = **1.0**
Total = **4.0**

PREREQUISITES
Electrical Machines

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

S. No.	CLO	Domain	Taxonomy level	PLO
1.	To understand the fundamentals of electrical machines.	Cognitive	C1	1
2.	To evaluate the performance and characteristics of electrical machines.	Cognitive	C3	4
3	To analyze an equivalent parameters performance of electrical machines.	Cognitive	C4	4

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☐	8	Ethics:	☐
3	Design/Development of Solutions:	☐	9	Individual and Team Work:	☐
4	Investigation:	☑	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

COURSE OUTLINE

Three Phase Transformers:

- Construction, Equivalent circuit,
- voltage regulation and efficiency,

- types of connections,
- tap changer and parallel operation.

DC and AC Machine Windings:

- Details of different armature windings in AC machines
- and comparison with the windings of DC machines

Three Phase Induction Machines:

- Production of rotating field and torque, construction,
- synchronous speed, slip and its effect on rotor frequency and voltage,
- equivalent circuit calculations, power and torque, speed regulation,
- synchronous impedance method and ampere turn method for voltage regulation,
- losses, efficiency and power factor,
- torque-speed characteristic,
- starting and speed control, induction generator.

Three Phase Synchronous Machines:

- Operation, Equivalent circuit,
- parallel operation, ratings,
- torque speed characteristics,
- power factor correction,
- starting of synchronous motors,
- speed control, voltage regulation.

Introduction to Special Purpose Motors

RECOMMENDED BOOKS:

1. Stephen J. Chapman, "Electric Machinery Fundamentals", McGraw-Hill. (Latest Edition)
2. T. J Miller, “Electronic Control of Switched Reluctance Motor”, Latest Book.
3. Charles I. Hubert, “ Electric Machines”, Maxwell Macmillan (Latest edition)

POWER GENERATION

Contact Hours:
Theory =48
Practical = 00
Total = 48

Credit Hours:
Theory = **3.0**
Practical = **0.0**
Total = **3.0**

SUGGESTED COURSE LEARNING OUTCOMES:

Upon successful completion of the course, the student will be able to:

S. No.	CLO	Domain	Taxonomy level	PLO
1.	To understand basic operation of different types of power plants	Cognitive	1	1
2.	Selection of power plants based on the site, cost and performance	Cognitive	2	1

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):

The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☐	8	Ethics:	☐
3	Design/Development of Solutions:	☐	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

COURSE OUTLINE:

Power Stations:

- Introduction,
- Types of power Station,
- Choice of type of Generator, Cost of Electrical Energy

Hydro Electric Stations –

- Introduction, Types of Hydro Electric Power Stations,
- Principle of working of a Hydro Electric Plant, Power Station Structure and Layout,
- Types of Turbine and their characteristics,

- Arrangements and location of Hydro Electric Stations,
- Types of Hydro Electric Plants and Dam, Characteristics of Generators,
- Costs of Hydro Electric Stations,

Steam Power Plants –

- Introduction, Main Parts and working of a steam Station,
- Plant Layout,
- Rankin Cycle and its types,
- Types of Boiler and their characteristics,
- characteristics of steam turbines,
- Design of a steam Power Station,
- Steam station auxiliaries,
- Cost of Steam Station

Gas Turbines –

- Introduction, Main Parts of Gas turbine plant,
- Plant Layout, Principle of Operation,
- Characteristics of Gas Turbine plants,
- Gas Turbine Power Plant operation and Control,
- Combined Cycles Cost of Gas Turbine Stations

Diesel Electric Station:

- Introduction of Diesel Engine,
- Principle of working,
- characteristics of diesel engines,
- sizes and dimensions of generator sets,
- Coordination of Engine and Generator Characteristics,
- Use of Diesel Sets as Alternative Power Plant,
- cost of diesel Plants.

Nuclear Power Stations –

- Introduction, Nuclear Reaction, Main Parts of Nuclear Power Stations,
- Plant Layouts,
- Principle of Nuclear Energy,
- Nuclear reactor and reactor control,
- Types of Power Reactor,
- Comparison of various types of reactor,
- Economics of Nuclear Power Stations.

MHD Generators:

- Gaseous conductors, analysis and design of MHD generator,
- Problems associated with MHD generation, possible configuration.

Introduction to renewable energy generation.

- Renewable energy resources

RECOMMENDED BOOKS:

1. M. V. Deshpande, "Elements of Electrical Power Station Design", 2010, PHI Publishers
2. M. M. El Wakil, "Power Plant Technology", McGraw Hill International Editions, Electrical and Mechanical Engineering Series.
3. Arche W. Culp "Principles of Energy Conversion", Latest Edition.

ELECTRICAL POWER TRANSMISSION

Contact Hours:	**Credit Hours:**
Theory =48	Theory = **3.0**
Practical = 48	Practical = **1.0**
Total = 96	Total = **4.0**

PREREQUISITE:

Electrical Network Analysis

SUGGESTED COURSE LEARNING OUTCOMES:

Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	To develop the necessary theoretical knowledge for basic and advanced concepts in Electrical Power Transmission	Cognitive	2	1
2.	To analyze and develop the electrical models for short, medium and long transmission lines.	Psychomotor	4	2
3.	Analysis of the mechanical parameters and design of transmission lines and towers.	Psychomotor	4	2

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):

The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☐	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

COURSE OUTLINE:

Power Systems Overview:

- Power system infrastructure,
- transmission and sub-transmission system,
- AC/DC system,
- standard voltages for transmission and sub transmission

- Conductor types & Power Cables.

Primary Parameters of Transmission Line:

- Resistance, Skin effect,
- Line inductance based on flux considerations.
- Inductance of single phase 2-wire line,
- Inductance of composite conductor line, use of tables.
- Inductance of 3-phase line with equilateral and un-symmetrical spacings,
- Transposition, inductance of bundled conductors.
- Capacitance of two-wire and 3-phase line,
- Effect of earth on capacitance; capacitance of bundled conductors, parallel circuit lines.

Steady State Analysis of Transmission Lines:

- Representation of lines in terms of ABCD parameters for short,
- Medium and long transmission lines,
- Voltage and current waves,
- SIL loading, power flow through the line, power transmission capability,
- Voltage regulation, Ferranti effect,
- Series and shunt compensation for long transmission line.

Insulators for Overhead Transmission lines:

- Insulator material, types of insulators,
- voltage distribution over insulator string,
- string efficiency, methods of improving the string efficiency, testing of insulators.

Corona:

- The phenomenon of corona, disruptive critical voltage and visual critical voltage,
- conditions effecting corona loss,
- power loss due to corona, radio interference due to corona.

Transient Analysis of Transmission Line:

- Sources of internal and external over voltages,
- Lightening mechanism, switching surges,
- Travelling waves on Transmission lines, open end & short circuited line, line terminated through resistance, line connected to a cable,
- reflection & refraction at T-Junction,
- attenuation of travelling waves.
- Arcing horns, expulsion tube surge arrestors, MOA surge arrestors.

Mechanical Design of Overhead Lines:

- Line supports, sag and tension calculations,
- total length of conductor,
- supports at different levels,
- mechanical degree of safety,
- effect of wind pressure & ice loading,

- conductor vibration & use of dampers.

HVDC Transmission:

- Scope, advantages & disadvantages,
- current technologies and future trends for HVDC

RECOMMENDED BOOKS:

1. Turan Gonen, "Electrical Power Transmission System Engineering --- Analysis & Design", John Wiely& Sons.
2. Electrical Transmission and Distribution Reference Book by Central Station Engineers, Westinghouse

POWER ELECTRONICS

Contact Hours:
Theory =48
Practical = 48
Total = 96

Credit Hours:
Theory = **3.0**
Practical = **1.0**
Total = **4.0**

PREREQUISITE:
Electronic Devices & Circuits

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

S. No.	CLO	Domain	Taxonomy level	PLO
1.	To understand the fundamentals of power semiconductor devices	Cognitive	1	1
2.	UNDERSTAND the basic principles of uncontrolled and controlled rectifiers and their ANALYSIS under different loading conditions	Cognitive	4	2
3.	ANALYZE and DESIGN converters for operation in steady state Continuous and Discontinuous Conduction Mode	Cognitive	4	3
4.	APPLY the knowledge of converter to DESIGN in lab environment working individually and as a group	Psychomotor	3	5

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☑	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐

5	Modern Tool Usage:	☑	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

COURSE OUTLINE:

1. **Introduction**
   a. Principles of power electronics converters and application
   b. Converter circuit components and their effects
   c. Converter control aspects

2. **Power Electronic Devices**
   a. Power Diodes
   b. Power Transistors
   c. Types of Thyristers
   d. Triggering devices
   e. Construction
   f. Characteristics, operations, losses, ratings,
   g. Control and protection of thyristors

3. **Power Converters**

Rectifiers

a. Single phase uncontrolled rectifiers
b. Single phase semi-controlled rectifiers
c. Single phase Fully controlled rectifiers
d. Three-phase uncontrolled rectifiers
e. Three-phase semi controlled rectifiers
f. Three-phase fully controlled rectifiers

Inverters

a. Single-phase inverters
b. Three-phase inverters

AC-AC Converters

a. Single-phase-to-single-phase cyclo-convertors
b. Matrix converters
c. AC voltage regulators

DC-DC converters

a. Buck converter
b. Boost converter
c. Buck-boost converters
d. Isolated converters
e. Forward converters
f. Fly back converters

4. **Power Electronics Applications**
    a. Switching mode power supplies
    b. Power electronics control of Electrical Machines
    c. Power system utilities

TEXT AND REFERENCE BOOKS:

- Ned Mohan, William P. Robbins and Tore M. Undeland, "Power Electronics: Converters, Applications and Design," Media Enhanced, Third Edition, 2003, John Wiley & Sons, Latest Edition.
- Robert W. Erickson and Dragan Maksimovic, "Fundamentals of Power Electronics," Springer, Latest Edition.
- Muhammad H. Rashid "Power Electronics: Circuits, Devices & Applications" Prentice Hall, Latest Edition.
- Daniel Hart, "Power Electronics," McGraw-Hill, Latest Edition.

POWER SYSTEM PROTECTION

Contact Hours:
Theory =48
Practical = 48
Total = 96

Credit Hours:
Theory = **3.0**
Practical = **1.0**
Total = **4.0**

PREREQUISITE
Power System Analysis

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

S. No.	CLO	Domain	Taxonomy level	PLO
1.	**ACQUIRE** the basic knowledge of protection system attributes and **UNDERSTAND** the concepts of various protection schemes.	Cognitive	3	1
2.	**SOLVE** and **EVALUATE** the protection schemes for a power system	Cognitive	5	2
3.	**DESIGN** a protection scheme for a given problem and run its simulation.	Psychomotor	2	3
4.	**ANALYZE** the behavior of various protection systems and ensure protection coordination on simulation software (like ETAP)	Psychomotor	4	3

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☑	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

COURSE OUTLINE

Protective Relays –

- Need for protective relaying in power systems,
- basic attributes of protective relaying, principles and characteristics of protective relaying,
- theory and classification of relays,
- Instrument Transformers, CT burden and accuracy classes.

Over-Current Protection:

- Inverse characteristics of Over-current relays (OCR),
- inverse definite minimum time (IDMT) relays,
- primary and backup protection,
- relay coordination, application of IDMT relays,
- direct over-current relays (D-OCR),
- application of D-OCR, protection of a three phase feeder.

Differential Protection:

- Dot convention and CT placement,
- Simple Differential Protection,
- Zone of Protection of the Differential Relay,
- Percentage Differential Relay,
- Earth Leakage Protection

Protection of Transformers –

- Transformer faults,
- differential Protection of a three-winding transformer,
- Inrush current and differential protection,
- Bucholz relays,
- Over-fluxing in transformer.

Protection of Generators –

- Faults in stator and rotor windings,
- Protective devices for stator, rotor, and prime mover of a generator,
- Abnormal operating conditions (unbalanced loading, over-speeding, loss of excitation and loss of prime mover) and their protection.

Protection of Transmission Lines –

- Drawbacks of over-current protection,
- Distance protection,

- Zones of protection.

Fuses and Circuit Breakers:

- Fuses Introduction,
- Principle of circuit interruption,
- Circuit Breaker-Types and characteristics,
- Ratings of circuit breakers.

RECOMMENDED BOOKS:

1. Fundamentals of Power System Protection by Y.G. Paithankar and S.R. Bhide
2. Protective Relaying; Principles and Applications, by J. Lewis Blackburn, Thomas J. Domin.

POWER SYSTEM OPERATION AND CONTROL

Contact Hours:
Theory =48
Practical = 48
Total = 96

Credit Hours:
Theory = **3.0**
Practical = **1.0**
Total = **4.0**

PREREQUISITE:
Power System Analysis

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

S. No.	CLO	Domain	Taxonomy level	PLO
1.	UNDERSTAND the basic concepts associated with the physical aspects of power system operational planning.	Cognitive	1	1
2.	UNDERSTAND the Economic Dispatch, Unit Commitment, Hydrothermal Coordination, and power system control with reference to following: • Significance, basic concepts and definitions. • Mathematical modeling • Application to small power systems with hand calculation & using MATLAB	Cognitive	2	1
3.	INTRODUCE IEEE Test Systems & Small Industrial Power System using MATLAB or Advance Tool.	Cognitive	2	2

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):

The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☐	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

COURSE OUTLINE

Power System Operational Planning:

- Introduction & brief overview on steps in Power System Operational Planning.

Characteristics of power generation units:

- Thermal Machines Cost Characteristics: input-output curve, incremental curve,
- specific cost curve, format to represent characteristics curves, how curves are obtained,
- Hydel Machines cost curves.

Economic Dispatch (ED):

- Concepts & Mathematical formulation,
- solution methodologies,
- ED using Economic dispatch using Equal incremental cost Criteria (EICC) neglecting network loss, and including network loss using B-Coefficients.

Unit commitment (UC):

- Concepts, Constraints,
- Mathematical formulation, Solution Methodologies,
- Priority List schemes for unit commitment.

Hydro Thermal Coordination (HTC):

- Concepts, Constraints, Mathematical formulation,
- Scheduling Problems,
- HTC Solution using Constant Hydro,
- Constant Thermal and Running Hydro Plant at its Maximum Efficiency.

Frequency Control:

- Power System Control,
- Load –frequency Control problem, Generator & load model,
- Prime Mover Model,
- Automatic Generation Control (AGC)

Voltage Control (VC):

- Voltage control problem importance and concepts, Problem,
- Methods for voltage control.

SCADA:

- SCADA System overview, architecture, protocols, and application to power system control.

RECOMMENDED BOOK:

1. Power Generation, Operation and Control by Allen J. Wood & Bruce F. Wallenberg , John Wiley & Sons, Inc.

ELECTRICAL MACHINE DESIGN AND MAINTENANCE

Contact Hours:
Theory =48
Practical = 48
Total = 96

Credit Hours:
Theory = **3.0**
Practical = **1.0**
Total = **4.0**

PREREQUISITE:
Electrical Machines

COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

S. No.	CLO	Domain	Taxonomy level	PLO
1.	To understand related circuits and design parameters of electrical machines.	Cognitive	2	3
2.	To analyze the equations related to electrical machines design.	Cognitive	4	3
3	APPLY techniques to meet requirement of maintenance and troubleshooting of machines.	Psychomotor	4	4

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☐	7	Environment and Sustainability:	☐
2	Problem Analysis:	☐	8	Ethics:	☐
3	Design/Development of Solutions:	☑	9	Individual and Team Work:	☐
4	Investigation:	☑	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

COURSE OUTLINE

Machine Design:

- Industrial standardization, national and international standards,
- codes and testing laboratories, manufacturing and operating systems,
- design considerations for electrical machines

- properties and applications of materials for magnetic machine insulation system and its design considerations,
- thermal time constant,
- cooling systems of transformers and rotating machines, duty cycles,
- ratings and temperature-rise,
- mechanical design considerations,
- specific loading and output equations of power transformer and induction motor,
- design of transformer or induction motor,
- introduction to computer aided design (CAD) and computer aided manufacturing (CAM).

Installation, Maintenance and Troubleshooting of Machines:

- Safety precautions,
- troubleshooting and emergency repairs.
- Installation, commissioning, testing, maintenance, and troubleshooting of (i) power transformers and (ii) induction motors. (iii) AC generators.

RECOMMENDED BOOKS

1. S. Rao, "Commissioning, Operation and Maintenance of Electrical Equipment", Khanna Publisher, India, Latest Edition.
2. M. G. Say, "Alternating Current Machines", Pitman Publishing Ltd.

HIGH VOLTAGE ENGINEERING

Contact Hours:	**Credit Hours:**
Theory =48	Theory = **3.0**
Practical = 48	Practical = **1.0**
Total = 96	Total = **4.0**

SUGGESTED COURSE LEARNING OUTCOMES:

Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	RECOGNIZE various types of insulating materials and their applications in high-voltage equipment.	Cognitive	3	1
2.	Explain the breakdown mechanisms in solid, liquid and gaseous dielectrics.	Cognitive	1	2
3.	ANALYZE the performance of high-voltage generation and measurement devices.	Cognitive	5	2
4.	Demonstrate understanding of the testing methods of insulating materials and power apparatus as per international standards.	Psychomotor	4	5

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):

The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☐	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☑	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

COURSE OUTLINE:

Introduction:

- Importance of High Voltage in all fields of daily life and medical applications.

Breakdown Mechanisms:

- Dielectric strength of solids, liquids and gases,
- Breakdown of solids, liquids and gases (Town send and streamer breakdown).
- Break down of unstable states of matter.
- Role of high voltage in production of unstable states of matter

Generation of High Voltages:

- Transformer,
- Series and Cascaded transformer connections,
- Bracketing in Transformer and its purpose,
- Series and Parallel Resonant Transformer, Tesla Coil, Transformer with rectifier,
- Voltage Multiplier Circuits, Walton Multiplier, Deltatron Multiplier,
- Electrostatic Voltage Generators (Van de Graff Generator, Sames Generator, Kelvin Water dropper, Whimshurst Machine)

Significance and Methods of Generation of Impulse:

- Introduction to Impulse, Standard Impulse used for testing.
- Construction and working of MARX and Good-Let Generators for impulses.
- Impulse Current Generators.

Measurement of High Voltages:

- Direct & Indirect Measurement of high voltages and its significance in a particular situation.
- Direct Measurement: HV probe, Potential Transformer, Ammeter in series with high resistance, Voltage divider
- Indirect Measurement: Spark gaps, Electrostatic Voltmeters, Electrodynamic Voltmeter, Hall Effect Sensor, Electro Optical Measurements.

Grounding and Earthing in Low and High Voltage Systems:

- Basics and importance of grounding in low as well as high voltage devices and systems.
- Touch and step potentials in a HV lab.

Leakage Current in Insulation:

- Introduction to leakage current, its types and components
- Methods of measuring and minimizing leakage current.

Insulation Materials:

- Different types of polymeric & Ceramic Insulation materials and their X-tics w.r.t electrical, mechanical, optical, acoustical and environmental resistance.

High Voltage Testing Techniques:

- Destructive, non-destructive, routine, fatigue, quantitative, qualitative, physical and chemical tests on different insulation materials.
- Health analysis of insulation systems.

Design Planning and Layout of HV Labs:

- Classification of HV lab on small, medium and large scale.
- Typical facilities required in a HV lab.
- Designing a lab layout and equipment on customized demand.

HVDC:

- Scope trends technologies and future of HVDC.
- Advantages and issues in HVDC systems. HVDC distribution Systems.

Applications of High Voltage:

- Applications of high voltage in medical, research and daily life activities.

RECOMMENDED BOOKS:

1. High Voltage Engineering by Y. Kuffel, J. Kuffel and W. S. Zaingi 2nd ed.
2. High Voltage Engineering by M.S. Naidu, V. Kamaraju, 4th ed
3. High Voltage Engineering by Muhammad Naeem Arbab 1st ed
4. High Voltage Engineering by J. R. Lucas 1st ed.

RENEWABLE ENERGY SYSTEMS

Contact Hours:	**Credit Hours:**
Theory =48	Theory = **3.0**
Practical = 48	Practical = **1.0**
Total = 96	Total = **4.0**

SUGGESTED COURSE LEARNING OUTCOMES:

Upon successful completion of the course, the student will be able to:

S. No.	CLOs	Domain	Taxonomy level	PLO
1.	**ANALYZE** the characteristics of a photovoltaic system, and **APPLY** the maximum power point tracking algorithm.	Cognitive	4	2
2.	**IDENTIFY** various components of a wind power generation systems and **ANALYZE** the output power characteristics.	Cognitive	2	4

3.	**EXPLAIN** the working principles of tidal, wave, fuel cell and energy storage system.	Cognitive	2	1

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):

The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☐	9	Individual and Team Work:	☐
4	Investigation:	☑	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

COURSE OUTLINE:

Overview

- Present day fuel use,
- Energy Problems of modern societies,
- Renewable Energy Sources as a solution

Solar Thermal Energy:

- Nature and availability of solar radiation,
- Low temperature solar energy applications,
- Active Solar Heating, Daylighting,
- Solar thermal engines and electricity generation,
- Economics Potential and environmental impact.

Solar Photovoltaic:

- Historical Background, PV in Silicon, Reducing the cost of crystalline PV cells,
- Thin film PV, Other innovative PV technologies,
- Electrical characteristics of Silicon PV cells and modules,
- PV systems for remote power,
- Grid-connected PV systems, Economics of PV Energy Systems,
- Environmental Impact and Safely,
- Integration of PV into future energy systems.

Fuel Cells :

- Thermodynamic principles,
- efficiency of fuel cell factors limiting the performance,
- design, new development in fuel cells,
- possibility of future use in Electric vehicles.

Bio Mass:

- Introduction,
- Past and present, Bio Mass as a fuel,
- Extracting the energy, Agricultural residues,

- Energy crops, Environmental benefits and impacts, Economics,
- New Technologies, Future Prospects.

Wind Energy:

- Introduction, wind turbine types and terms,
- Aerodynamics of wind turbines, Mechanical power,
- wind turbine generators, power and energy from wind turbines,
- wind speed characteristics of a site,
- economics of wind turbine,
- Commercial development and wind energy potential.

Tidal Power:

- Tidal energy harnessing schemes,
- tidal barrages

Geothermal Energy:

- Scope, advantages and issues

Energy storage:

- Thermal, potential,
- chemical and mechanical energy storage systems.

Integration:

- Renewable supply availability, changing patterns of energy use,
- balancing economic options,
- Promoting renewables,
- Long term global renewable energy scenario,
- grid interconnection issues.

Advanced Energy Systems:

- Zero energy systems and buildings,
- free energy generation technologies,
- perpetual energy machines.

RECOMMENDED BOOKS:

1. Godfrey Boyle, Renewable Energy and Power for a sustainable future, OUP
2. John Twidell, Tony Weir, "Renewable Energy Resources", Second Edition, 2006, Taylor and Francis, New York and London
3. Aldo V. da Rosa, "Fundamentals of Renewable Energy Processes", Second Edition, 2005, Academic Press.

INDUSTRIAL DRIVES

Contact Hours:
Theory = 48
Practical = 48
Total = 112

Credit Hours:
Theory =**3.0**
Practical = **1.0**
Total = **3.0**

PREREQUISITE
Power Electronics

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	**UNDERSTAND** basic requirements placed by mechanical systems on electric drives	Cognitive	2	1
2.	**DESIGN** torque, speed and position controller of motor drives	Cognitive	4	2
3.	**APPLY** the knowledge of derives to **DESIGN** in lab environment working individually and as a group	Psychomotor	3	5

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☐	8	Ethics:	☐
3	Design/Development of Solutions:	☑	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☑	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

COURSE OUTLINE

1. **D.C. Motor Drives**
   - Introduction to DC motors and their torque characteristics (overview)
   - Thyristor based D.C. Drives
   - Four-quadrant operation and inversion
   - Single-converter reversing drives
   - Current/Torque and Speed control
   - Chopper-Fed D.C. Motor Drives
   - D.C. Servo Drives
   - Servo motors position control
   - Digitally Controlled Drives

2. **Inverter-Fed Induction Motor Drives**
   - Torque–Speed Characteristics – Constant V/f Operation
   - Control Arrangements for Inverter-Fed Drives (Open-loop speed control and Closed-loop speed control)
   - Vector (Field-Oriented) Control
   - Transient torque control and cycloconverter drives

3. **Switched Reluctance derives**
   - Construction & operation
   - Inductance profile
   - Torque profile
   - Co-Energy and convertors

4. **Motor/Drive Selection**
   - To Understand Power Range for Motors and Drives
   - Maximum speed and speed range
   - Load Requirements – Torque–Speed Characteristics
   - Constant-torque load, Inertia matching (gearbox)
   - Fan and pump loads
   - General Application Considerations
     - Regenerative operation and braking
     - Duty cycle and rating
     - Enclosures and cooling
     - Dimensional standards
     - Supply interaction and harmonics

RECOMMENDED BOOKS:

1. Electric Motors and Drives (Fundamentals, Types and Applications) by Austin Hughes
2. Electrical Machines, Drives and Power Systems by Theodore Wildi
3. T. J Miller, "Electronic Control of Switched Reluctance Motor", Latest Book.
4. S.K Pillia, "A First Course on Electrical Drives" John Willey & Sons (latest addition)

FACTS AND HVDC

Contact Hours:
Theory =48
Practical = 48
Total = 96

Credit Hours:
Theory = **3.0**
Practical = **1.0**
Total = 4.**0**

PREREQUISITE:
Power Electronics

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	**DESCRIBE** the design of FACTS and HVDC	Cognitive	2	1
2.	**EXPLAIN** and **ANALYZE** the function FACTs and HVDC	Cognitive	2	2
3.	**ANALYZE** the impact of FACTs and HVDC components on power system stability	Cognitive	4	4

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☑	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

COURSE OUTLINE:

1. **FACTS Concept and General System Consideration**
   - System Compensation
   - Bi-direction Ac voltage converter
   - Voltage-Sourced Converters,
   - Self- and Line-Commutated Current-Sourced Converters

2. **Static Shunt and Series Compensators**
   - TCR
   - TSC
   - SVC
   - STATCOM
   - TSSC

- TCSC
- SSSC

3. **Combined Compensators**
   - Unified Power Flow Controller (UPFC)
   - Interline Power Flow Controller (IPFC)

4. **HVDC Transmission**
   - Introduction to HVDC transmission
   - Types of HVDC Transmission
   - Multi-Level Conversion
   - Line-Commutated CSC Transmission
   - VSC Transmission
   - Multi-Level VSC and CSC Transmission
   - Introduction to Multi-terminal HVDC (MTDC) grid

RECOMMENDED BOOKS:

1. Narain G. Hingorani, Laszlo Gyugyi. "Understanding FACTS: concepts and technology of flexible AC transmission systems" (latest Edition), IEEE Press Marketing.
2. J. Arrillaga, Y.H. Liu, N.R. Watson. Flexible power transmission the HVDC options.(latest Edition) John Wiley & Sons

SMART GRID

Contact Hours:	**Credit Hours:**
Theory =48	Theory = **3.0**
Practical = 48	Practical = **1.0**
Total = 96	Total = **4.0**

PREREQUISITE:

Communication system, Power system analysis, Data Communication

SUGGESTED COURSE LEARNING OUTCOMES:

Upon successful completion of the course, the student will be able to:

S. No.	CLO	Domain	Taxonomy level	PLO
1.	To develop a broader understanding of Smart Grid	Cognitive	6	1
2.	To familiarize students regarding the existing smart grid technologies	Psychomotor	4	5
3.	To apprise students of the latest applications of smart	Psychomotor	3	4

	grid			

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):

The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☐	8	Ethics:	☐
3	Design/Development of Solutions:	☐	9	Individual and Team Work:	☐
4	Investigation:	☑	10	Communication:	☐
5	Modern Tool Usage:	☑	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

COURSE OUTLINE

Smart grid basics:

- Overview of existing grid, why do we need smart grid,
- objectives and main features of Smart Grid,
- Current status of smart grid technology
- Future of Smart Grid, advantages and Disadvantages,
- Implementation of smart grid and possible difficulties.

Distributed Generation:

- Overview of Distributed Generation,
- New paradigm of power generation, future power grid,
- impact of Distributed Generation on the main power grid,
- Smart Grid and Distributed Generation:
- Advantages and Disadvantages

Analysis Tools:

- Challenges for load flow studies,
- Load flow analysis in smart grid environment.

Demand side management:

- Introduction, types and tools for demand side management,
- Demand response and its applications,
- Types of loads & their current signatures,
- Smart Meters.

Communication Technology for Smart Grid:

- Basics of Data communication technology,
- Communication protocols.

SCADA (Supervisor Control and Data Acquisition):

- Power System Monitoring and Control,
- Architecture of SCADA,
- Main features and objectives of SCADA,
- Applications of SCADA

Wide Area Monitoring and Control by Synchro-phasor Technology:

- PMUs (Phasor Measurement Units),
- Architecture of WAMCS,
- Applications of WAMCS.

RECOMMENDED BOOKS:

1. Power System Analysis by Hadi Saadat McGraw-Hill International Editions
2. The Smart Grid: Enabling Energy Efficiency and Demand Response by Clark W. Gellings, P.E.
3. Synchronized Phasor Measurement Units and their applications by A.G Phadke, J.S Thorp

Electrical Engineering (Electronic Engineering Stream) Courses Outline

Instrumentation and Measurements

Contact Hours:
Theory =48
Practical = 48
Total = 96

Credit Hours:
Theory = **3.0**
Practical = 1.0
Total = 4.0

Course outcome:

COURSE LEARNING OUTCOMES:

Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	Explain the fundamentals of instrumentation and measurement systems.	Cognitive	2	4
2.	Illustrate signal conditioning principles and apply them in practical scenarios.	Cognitive	3	4
3.	Illustrate the working principles of sensors and transducers and effectively choose a particular sensor/transducer for a particular application.	Cognitive	3	4
4.	Design a complete instrumentation and measurement system including sensor choice, data acquisition, display, archiving and retrieval.	Cognitive	3	4

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):

The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☐	7	Environment and Sustainability:	☐
2	Problem Analysis:	☐	8	Ethics:	☐
3	Design/Development of Solutions:	☐	9	Individual and Team Work:	☐
4	Investigation:	☑	10	Communication:	☐

5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

Precision measurements terminologies principles of different measurement techniques; instruments for measurement of electrical and non-electrical quantities including voltmeters, ammeters, function generators, oscilloscopes; systems for signal processing and signal transmission; modern instrumentation techniques; static and dynamic responses of instrumentation and signal conditioning; data acquisition systems; principles of operation, construction and working of different analog and digital meters, Advanced Testing & Measuring instruments recording instruments, signal generators, Sensors, Input and output transducers; types of bridges for measurement of resistance, inductance, and capacitance; power and energy meters; high-voltage measurements, PLC systems etc.

Teaching Methodology

- Lecturing
- Written Assignments
- Quizzes
- Written exams

Assessment

Sessional

- Assignments
- Quizzes
- Attendance

Mid Term

- Written (Long Questions, Short Questions)

Final Term

- Written (Long Questions, Short Questions)

Text book:

- Modern Electronic Instrumentation and Measurements Techniques by A.D.Helfrick, W.D. Cooper
- Klaas B. Klaassen and Steve Gee, "Electronic Measurement and Instrumentation," 1996, Cambridge University Press, ISBN: 0521477298.T
- H Kevin, JamesH, "PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control," 2000, Newnes, ISBN: 0750646241.

- Alan S. Morris, Reza Langari, "Measurement and Instrumentation, Theory and Application", Elsevier, 2012, ISBN 978-0-12-381960-4
- Electrical Instrumentation and Measurement techniques ,By A.K.Sawhney

Electronic Circuit Design

Contact Hours:
Theory =48
Practical = 48
Total = 96

Credit Hours:
Theory = **3.0**
Practical = 1.0
Total = 4.0

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	**Construct** and **examine** the small signal and power amplifiers.	Cognitive	4	2
2.	**Design** and **analyze** various small-scale electronic circuits based on operational amplifier including active filters, oscillators and data converters.	Cognitive	5	3
3.	**Analyze** the frequency characteristics and stability analysis of different electronic devices including filters, amplifiers and oscillators.	Cognitive	4	2

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☐	7	Environment and Sustainability:	☐
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☑	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

Amplifier analysis:
Transistor as an amplifier, hybrid model of a transistor, small-signal analysis, large-signal analysis, gain calculation of single-stage amplifier, cascading, multistage gain calculations.
Current sources (simple current mirror, Widler and Wilson current source): output stage design; **Differential Amplifiers:**

DC and AC analysis of differential amplifier; design of simple differential amplifier; level translator; **Use of op-amp** as a circuit element, offset and offset compensation, op-amp with negative feedback, frequency response of an op-amp, DC and AC analysis of op-amp ICs;

Classification of amplifiers on the basis of biasing:

Class A amplifier, class B amplifier, class AB amplifier, class C amplifier, push-pull amplifier, and complementary symmetry amplifier.

Feedback:

Feedback concept, feedback amplifiers, voltage feedback amplifier, current feedback amplifier. Effect of feedback on frequency response.

Practical amplifier considerations:

Input and output impedance, amplifier loading, impedance matching.

Teaching Methodology

- Lecturing
- Written Assignments
- Quizzes
- Written exams

Assessment

Sessional

- Assignments
- Quizzes
- Attendance

Mid Term

- Written (Long Questions, Short Questions)

Final Term

- Written (Long Questions, Short Questions)

Recommended Books:

- S. Sedra and K. C. Smith, "Microelectronic Circuits", Oxford University Press, Latest edition.
- Behzad Razavi "Fundamentals of Microelectronics," Wiley, Latest edition.
- Robert L. Boylestad and Louis Nashelsky "Electronic Devices and Circuit Theory", Prentice Hall, Latest edition.
- Thomas L. Floyd "Electronic Devices (Conventional Current Version)", Prentice Hall, Latest edition
- T.F.Bogart, "Electronic devices and circuits"latest edition

Power Electronics

Contact Hours:
Theory =48
Practical = 48
Total = 96

Credit Hours:
Theory = **3.0**
Practical = 1.0
Total = 4.0

Course Outcome:

Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	Student will be able to state basics of power electronics.	Cognitive	1	1
2.	Student will be able to comprehend the use of various switching devices and methods.	Cognitive	1	1
3.	Student will be able to produce Switch Mode and other Power Supplies.	Cognitive	3	2
4.	Student will be able to analyze drive, monitoring and control circuits.	Cognitive	4	3

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☑	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

Principles of power electronics,
Converters and applications, circuit components and their effects, control aspects.
Power Electronic Devices:
Power diode, Power Transistor, Types of thyristor, triggering devices.
Construction, characteristics, operations, losses, ratings, control and protection of thyristors.

Power Converter
Single phase uncontrolled, semi-controlled and full controlled rectifiers. three-phase uncontrolled, semi controlled and full controlled rectifiers. Single-phase inverters, three-phase inverters, single-phase-to-single-phase cyclo-conveters, DC to DC converters, buck converter, boost converter, buck-boost converters, isolated converters, forward converters, flyback converters. AC voltage regulators.

Application of Power Electronics
Switching mode power supplies, and power electronics control of Electrical Machines, Power System utilities

Teaching Methodology

- Lectures
- Written Materials
- Practical Work
- Report Writing

Assessment

Sessional
- Class Participation
- Assignments
- Quizzes

Mid Term
- MCQ's
- Definitions
- Short Questions
- Long Questions

Final Term
- Short Questions
- Long Questions
- Numerical Problems
- Circuit Analysis

Recommended Books:
- Robert W. Erickson and Dragan Maksimovic, "Fundamentals of Power Electronics," Springer, Latest Edition.
- Muhammad H. Rashid "Power Electronics: Circuits, Devices & Applications" Prentice Hall, Latest Edition.
- Ned Mohan, William P. Robbins and Tore M. Undeland, "Power Electronics: Converters, Applications and Design," Media Enhanced, Third Edition, 2003, John Wiley & Sons, Latest Edition.
- Daniel Hart, "Power Electronics," McGraw-Hill, Latest Edition.

BIOMEDICAL INSTRUMENTATION

Contact Hours:
Theory =48
Practical = 48
Total = 96

Credit Hours:
Theory = **3.0**
Practical = **1.0**
Total = **4.0**

Prerequisites: Analog and Digital Electronic Circuits

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

S.No	CLO	Domain	Taxonomy level	PLO
1.	Explain the physiological source and detection of bio-potentials for the analysis in biomedical instruments.	Cognitive	2	1
2.	Identify a range of sensors and select relevant sensor for a particular application	Cognitive	4	1
3	Describe the elements of risk for various instrumentation methods and basic safety measures.	Cognitive	2	2

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☐	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

COURSE OUTLINE:

Introduction:

- Precision, resolution, sensitivity, accuracy, uncertainty.
- Principles and development of biomedical instrumentation.
- Problems encountered in living systems.

Biological Systems:

- Study of various physiological systems, related bio-potentials and physiological parameters.

Diagnostic Equipment:

- Invasive and noninvasive measurement techniques and related equipment.

Cardiovascular Measurements:

- Electrocardiography
- Measurement of blood pressure
- Blood flow
- Cardiac output

Biomedical Sensors & Transducers:

- Principles and design
- Speed and position
- Temperature, light and pressure transducers
- Programmable logic controller
- PLC interfacing
- Memory processor

Patient Monitoring Equipment:

- Patient monitors
- Central monitoring system
- Telemetry system
- Gas exchange and distributions
- Respiratory therapy equipment

Therapic Equipment:

- Ventilator
- Inhaler
- Defibrillator
- Pacemaker
- Heart lung machines

Radiological Equipment:

- Concept of ionization and non-ionization radiation and related equipment
- Medical lasers and applications

Safety in Medical Equipment:

- Electrical/mechanical safety
- Standards of medical devices
- Biohazards and safety regulations

Quality Assurance and Control:

- Calibration, maintenance and reparability of monitoring equipment

Recommended Books:

1. Biomedical Instrumentation System by Shakti Chatterjee, Edition 1st, Cengage, 2010
2. Biomedical Instrumentation: Technology and Applications by R Khandpur, Edition 1st, McGraw Hill Education, 2004
3. Medical Instrumentation: Application and Design by J G Webster, Edition 4th, Wiley India Private Limited, 2009.

MEDICAL ROBOTICS

Contact Hours:
Theory =48
Practical = 48
Total = 96

Credit Hours:
Theory = **3.0**
Practical = **1.0**
Total = **4.0**

PREREQUISITES
Linear Control Systems

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

S. No.	CLO	Domain	Taxonomy level	PLO
1.	Identify and describe various types of robots for medical applications	Cognitive	1	1
2.	Explain the fundamentals of robot dynamics and simulation	Cognitive	2	1
3	Design and implement robotic assistance for tracking and surgical applications	Psychomotor	6	3

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☐	8	Ethics:	☐
3	Design/Development of Solutions:	☑	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

COURSE OUTLINE

Introduction:
- Fundamentals of medical robotics

- kinematics of medical robots
- Teleportation and cooperative manipulation

Robot dynamics and simulation:
- Trajectory generation
- Surgeon's perspective
- Medical imaging and image-guided interventions

Tracking and surgical navigation:
- Motion planning, prediction, correlation, replication and learning
- Basic methods behind robots like DaVinci system, the cyberknife, motorized C-arms and operating microscopes as well as strategic frames

Broad spectrum of medical and healthcare robotics:
- Robots for neuroscience

RECOMMENDED BOOKS:
- Medical Robotics by Achim Schweikard and Floris Ernst, Edition 1st, Springer, 2015
- Medical Robotics by Jocelyne Troccaz, Edition 1st, Wiley-ISTE, 2012

MICROELECTRONICS TECHNOLOGY

Contact Hours:
Theory =48
Practical = 48
Total = 96

Credit Hours:
Theory =**3.0**
Practical = **1.0**
Total = **4.0**

PREREQUISITE
Applied Physics, Electronic Devices & Circuits

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	To understand, identify and define the scaling requirements in Integrated Chip (IC) manufacturing technology and various processes involved therein	Cognitive	1	1
2.	To demonstrate the connection of various fabrication processes with the physical electronic attributes of the devices	Cognitive	3	1
3.	To design and classify processes to prepare the starting wafer and subsequently a final device structure	Psychomotor	4	3

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☐	8	Ethics:	☐
3	Design/Development of Solutions:	☑	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

COURSE OUTLINE:
Introduction to scaling, Moore's law and International Technology Roadmap of Semiconductors (ITRS); Integrated Chip (IC) Wafers & Substrate (Crystal Growth & Wafer Processing), Oxidation and Thermal Processing, Thin Film Technology (Physical and Chemical Vapour Deposition, Epitaxy, Silicon-on-insulator), Doping (Dopant Diffusion, Ion Implantation), Pattern Making (Lithography, Etching), Contact Metallization & Interconnects, Re-capping/Process Integration of BJT and MOSFET/CMOS fabrication

RECOMMENDED BOOKS:

- Peter Van Zant, "Microchip Fabrication", McGraw.Hill, 6th Ed., 2014.
- Richard C. Jaeger, "Introduction to Microelectronic Fabrication", Prentice Hall; 2nd Ed., 2001
- Stephen A. Campbell, "The Science and Engineering of Microelectronic Fabrication", Oxford University Press, New York, 2nd Ed., 2006.
- C. Y. Chang & S. M. Sze, "ULSI Technology", McGraw-Hill International Ed., 1996.

Integrated Electronics

Contact Hours:
Theory =48
Practical = 48
Total = 96

Credit Hours:
Theory = **3.0**
Practical = **1.0**
Total = **4.0**

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	**Design** pulse and switching circuits	Cognitive	3	3
2.	**Classify** various types of amplifiers based on	Cognitive	3	2

	coupling			
3.	**Analyze** the impact of parameters of Oscillators	Cognitive	3	3

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☐	7	Environment and Sustainability:	☐
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☑	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

Detailed design of pulse and switching circuits; mono-stable, a-stable and bi-stable circuits; Schmitt trigger; logic families (DTL, TTL, ECL, I2L, CMOS);
Introduction to the fabrication of digital microelectronic pMOS, nMOS, CMOS, and BiCMOS circuits; epitaxy, ion implantation and oxidation; amplifier; linear and non-linear applications. analogue and digital circuit interface with applications;
Classification of amplifiers on the basis of coupling:
RC-coupled amplifier, transformer-coupled amplifier, direct-coupled amplifier.
Classification of amplifiers on the basis of frequency:
Audio-frequency amplifier, radio-frequency amplifier, tuned amplifiers.
Oscillators:
Basic theory, tank circuit, damped and undamped oscillations, phase-shift oscillator, Colpitt oscillator, Hartley oscillator, Wein Bridge oscillator, Clapp oscillator.

Teaching Methodology

- Lecturing
- Written Assignments
- Report Writing

Assessment

Mid Term

- Written (Long Questions, Short Questions, MCQs)
- Presentation 20%

- Assignments 20%
- Report Writing 10%

Final Term

- Written (Long Questions, Short Questions, MCQs)
- Presentation 20%
- Assignments 20%
- Report Writing 10%

Recommended books:

- A. S. Sedra and K. C. Smith, "Microelectronic Circuits", Oxford University Press, Latest edition.
- Behzad Razavi "Fundamentals of Microelectronics," Wiley, Latest edition.
- Robert L. Boylestad and Louis Nashelsky "Electronic Devices and Circuit Theory", Prentice Hall, Latest edition.
- Thomas L. Floyd "Electronic Devices (Conventional Current Version)", Prentice Hall, Latest edition

Optoelectronics

Contact Hours:
Theory =48
Practical = 48
Total = 96

Credit Hours:
Theory = **3.0**
Practical = **1.0**
Total = **4.0**

SUGGESTED COURSE LEARNING OUTCOMES:

Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	**Understand** the basic concepts related to optoelectronics mechanisms.	Cognitive	1	1
2.	**Classify** various types of lasers and other optoelectronic devices	Cognitive	1	2
3.	**Analyze** the impact of parameters of modulation related to optoelectronics	Cognitive	3	3

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):

The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☑	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐

5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

Optics Review: Snell's Law, Numerical Aperture, Total internal reflection, Fresnel Equations, Dispersion, Pulse broadening and distortion, Resonant cavities. Dielectric slab optical waveguide, optical fiber waveguide. Laser principles, population inversion and threshold conditions, laser modes.
Light emitting diodes and laser diodes: operating characteristics and typical structures, Types of laser diodes (monomode/tunable) such as DBR and DFB. Light Detectors: Principles of photo-detection, types of semiconductor photodiodes.
Analog / Digital Modulation and corresponding opto-electronic circuits. Noise: Thermal and Shot noise, and signal to noise ratio in electro-optical systems.
Optoelectronics in energy and telecommunications such as photo-voltaic devices and wavelength division multiplexing.

Teaching Methodology

- Lecturing
- Written Assignments
- Report Writing

Assessment

Mid Term (40%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Report Writing 10%

Final Term (60%)

- Written (Long Questions, Short Questions, MCQs) 50%
- Presentation 20%
- Assignments 20%
- Report Writing 10%

Recommended books:

1. Harold Kolimbiris, "Fibre Optics Communications," First Edition, 2004, Prentice Hall, latest edition.
2. John M. Senior, "Optical Fiber Communications: Principles and Practice", Prentice Hall,

latest edition.
3. Henry Zanger, Cynthia Zanger, "Fiber Optics: Communications and other Applications", Maxwell MacMillan International.

VLSI DESIGN

Contact Hours:
Theory =48
Practical = 48
Total = 96

Credit Hours:
Theory =**3.0**
Practical = **1.0**
Total = **4.0**

PREREQUISITE
Electronic Devices & Circuits

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	**ANALYSE** mathematical methods and circuit analysis models in **analysis** of CMOS digital electronics circuits, including logic components and their interconnects	Cognitive	3	1
2.	**APPLY** CMOS technology-specific layout rules in the placement and routing of transistors and interconnects, and to verify the functionality, timing, power, and parasitic effects.	Cognitive	3	2
3.	**DESIGN AND DEPLOY** all the key steps involved in device/circuit designing starting from scratch to the final design files in acceptable format.	Psychomotor	4	3

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☑	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

COURSE OUTLINE:

Fundamental Concepts of VLSI Design

- Introduction
- Conductors, insulators, semiconductors, intrinsic material, extrinsic material
- Integrating circuits manufacturing technology economics
- CMOS Technology
- Power consumption, design and testability

Integrated Circuit Design Techniques

- Design Abstraction
- Translation and layout fabrication steps
- Structure of a transistor
- Transistor modeling parasitic, tubties and latch up
- Leakage and sub threshold currents
- Wires and Vias , skin Effect

SCMOS based Design Rules

- Stick diagrams, physical layout, fabrication Errors
- Static complementary gates
- Switch logic
- Delay through Resistive interconnects
- Low power gates
- Delay through Inductive interconnect

Standard Cell Based Layout

- Fan-out path delay Cross Talk, Buffer insertion
- Latches and flip flop
- Clocking Disciplines
- Sequential system design
- Floor planning methods
- Design validation
- Off chip Connections

General Guideline for the VLSI Lab:

Implementation of VLSI design techniques using VHDL/Verilog HDL/Mentor Graphics modules.

RECOMMENDED BOOKS:

1. Wayne Wolf, "Modern VLSI Design", Prentice Hall, 2002

2. Neil Weste & David Harris "CMOS VLSI Design, A Circuit and System Perspective", Addison Wesley, 3rd Ed., 2004

Industrial Electronics

Contact Hours:
Theory =48
Practical = 48
Total = 96

Credit Hours:
Theory = **3.0**
Practical = **1.0**
Total = **4.0**

PREREQUISITE
Power Electronics

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	**Design** using building blocks of industrial heating system	Cognitive	3	3
2.	**Analyze** various control mechanisms related to industrial drives	Cognitive	3	2
3.	**Analyze** the impact of data acquisition on performance of industrial system.	Cognitive	3	3

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☐	7	Environment and Sustainability:	☑
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☑	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

Electric heating: Principles and applications; induction and dielectric heating; high-frequency welding. Spot welding control. Industrial drives: Speed control of DC, AC, and servo motors. Process control Systems, Measurement of nonelectrical quantities: Temperature, displacement, pressure, time, frequency; digital industrial measuring systems. Ultrasonic generation and applications. Photo-electric devices. Industrial control using PLCs. Data acquisition for industrial processes. Distributed control system in process industries. Basic concepts of SCADA.

Teaching Methodology

- Lecturing
- Written Assignments
- Report Writing

Assessment

Mid Term

- Written (Long Questions, Short Questions, MCQs)
- Presentation 20%
- Assignments 20%
- Report Writing 10%

Final Term

- Written (Long Questions, Short Questions, MCQs)
- Presentation 20%
- Assignments 20%
- Report Writing 10%

Recommended books:

- Frank D. Petruzella, "Programmable Logic Controllers," Latest Edition Frank D. Petruzella, "Industrial Electronics," Latest Edition
- Terry L.M. Bartelt, "Industrial Control Electronics," Cengage Learning, Latest Edition
- Kelvin T. Erickson, "Programmable Logic Controllers: An Emphasis on Design and Application," Dogwood Valley Press LLC, Latest Edition

Solid State Devices

Contact Hours:	**Credit Hours:**
Theory =48	Theory = **3.0**
Practical = 48	Practical = **1.0**
Total = 96	Total = **4.0**

PREREQUISITE

Electronic Devices and Circuits

SUGGESTED COURSE LEARNING OUTCOMES:

Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	**Design** using building blocks of semiconductor units	Cognitive	3	3
2.	**Analyze** various control mechanisms fabrication mechanisms.	Cognitive	3	2
3.	**Analyze** the impact of properties of matter in fabrication process.	Cognitive	3	3

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):

The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☐	7	Environment and Sustainability:	☑
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☑	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

Introduction to semiconductor materials, basic structure and properties, carrier concentration, energy band gap, carrier transport in semiconductor, pn junction, metal-semiconductor contacts, metal oxide semiconductor FET, bipolar transistors, photonic devices, solar cell, semiconductor devices growth and fabrication techniques.

Teaching Methodology

- Lecturing
- Written Assignments
- Report Writing

Assessment

Mid Term

- Written (Long Questions, Short Questions, MCQs)
- Presentation 20%
- Assignments 20%
- Report Writing 10%

Final Term

- Written (Long Questions, Short Questions, MCQs)
- Presentation 20%
- Assignments 20%
- Report Writing 10%

Recommended books:

- Ben Streetman, Sanjay Banerjee "Solid State Electronic Devices", Prentice Hall, Latest Edition.
- Donald A. Neamen "Semiconductor Physics And Devices: Basic Principles", McGraw-Hill, Latest Edition
- Robert F. Pierret, Semiconductor Device Fundamentals, Pearson Education, Latest Edition
- Jasprit Singh, Semiconductor Device Physics and Design, Wiley, Latest Edition
- S. M. Sze, Semiconductor Devices: Physics and Technology, Wiley, Latest Edition

Introduction to Nanotechnology

Contact Hours:
Theory =48
Practical = 48
Total = 96

Credit Hours:
Theory = **3.0**
Practical = **1.0**
Total = **4.0**

PREREQUISITE
Applied Physics

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	**Understand** basic concepts of nano technology	Cognitive	3	1
2.	**Analyze** various control mechanisms for surface probing	Cognitive	3	2
3.	**Analyze** the impact of various parameters on applications.	Cognitive	3	2

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☑
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☐	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

Introduction, nano-scale phenomena, nanoparticles, carbon nanostructures, nano-wires, nano-structured, materials, self assembly, surface probe microscopy, other nano-scale characterization, nanolithography, nano-scale devices and systems, applications of nanotechnology.

Teaching Methodology

- Lecturing
- Written Assignments
- Report Writing

Assessment

Mid Term

- Written (Long Questions, Short Questions, MCQs)
- Presentation 20%
- Assignments 20%
- Report Writing 10%

Final Term

- Written (Long Questions, Short Questions, MCQs)
- Presentation 20%
- Assignments 20%
- Report Writing 10%

Recommended books:

- Charles P. Poole Jr. and Frank J. Owens, "Introduction to Nanotechnology," 2003, John Wiley & Sons, ISBN: 0471079359.
- Massimiliano Di Ventra, Stephane Evoy and James R. Heflin Jr. (Editors), "Introduction to Nanoscale Science and Technology," 2004, Kluwer Academic Publishers, ISBN: 1402077203.
- Mark A. Reed and Takhee Lee (Editors), "Molecular Nanoelectronics," 2003, American Scientific Publishers, ISBN: 1588830063.

RF and Microwave Engineering

Contact Hours:
Theory =48
Practical = 48
Total = 96

Credit Hours:
Theory = **3.0**
Practical = **1.0**
Total = **4.0**

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	**Understand** basic concepts of RF Models	Cognitive	3	1
2.	**Analyze** various single and multiport networks	Cognitive	3	2
3.	**Analyze** the impact of various parameters on filter designs.	Cognitive	3	2

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☑
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☐	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

RF behavior of Passive Components and RF models, Chip components, Distributed Circuit elements, Strip Lines, Microstrip Lines, Coupled Striplines/Coupled microstriplines, Smith Chart, Impedance and Admittance Transformation, Parallel and series Connection, Impedance Matching Networks, Analysis of Single and Multiport Networks using Network Parameters, Microwave Filter Design, Microwave Amplifier design, Mixers and Detectors, Oscillators, Power dividers, Directional Couplers, Circulators, Microwave Systems.

Teaching Methodology

- Lecturing
- Written Assignments
- Report Writing

Assessment

Mid Term

- Written (Long Questions, Short Questions, MCQs)
- Presentation 20%
- Assignments 20%
- Report Writing 10%

Final Term

- Written (Long Questions, Short Questions, MCQs)
- Presentation 20%
- Assignments 20%
- Report Writing 10%

Recommended book:

David M. Pozar, "Microwave Engineering", Wiley, 2009.

Digital Control Systems

Contact Hours:
Theory =48
Practical = 48
Total = 96

Credit Hours:
Theory = **3.0**
Practical = **1.0**
Total = **4.0**

PREREQUISITE
Linear Control Systems

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	**Understand** basic concepts of Digital Control Systems	Cognitive	3	1
2.	**Analyze** various open-loop and close-loop systems.	Cognitive	3	2
3.	**Analyze** the impact of various parameters related to stability of the systems.	Cognitive	3	2

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☑
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☐	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

Introduction to digital control systems • Discrete time systems- Transform methods- Flow graphs - State variables - Transfer functions • Solutions of the state-equation. • Sample/Hold unit with zero-order hold • Sampled-data control systems - Ideal Sampler - Properties & Evaluation of E*(s) • Data Re-construction - A/D - D/A • E(Z) & E*(Z) - Pulse TF - Open Loop Systems with digital filter-Modified Z-Transform • Systems with time delays-Nonsynchronous sampling-Discrete state equation • Closed-loop systems: concepts, derivation procedure-State variable models • Time response -

Characteristics Equation -Mapping S&Z Planes, Steady state accuracy • Stability - Bilinear transformation - Routh-Hurwitz Criterion - Jury test • Root-Locus, Nyquist Criterion, Bode diagram, Frequency Response • Integration and Differentiation filters, PID Controller Design

Lab outline:

- Control system identification; controller design, experimentation, computer simulation, and analysis of control systems.
- All experiments are conducted with real-time process interface cards of PC for experimental data display and storage.
- Stored files are analyzed further using MATLAB. Lab assignments include computer-based control system simulation and design using MATLAB.

Teaching Methodology

- Lecturing
- Written Assignments
- Report Writing

Assessment

Mid Term

- Written (Long Questions, Short Questions, MCQs)
- Presentation 20%
- Assignments 20%
- Report Writing 10%

Final Term

- Written (Long Questions, Short Questions, MCQs)
- Presentation 20%
- Assignments 20%
- Report Writing 10%

Recommended book:

- Digital Control System Analysis and Design. (3rd Edition) Charles L. Phillips & H. Troy Nagle
- Charles L. Phillips and H. Troy Nagle, "Digital Control System Analysis and Design," \Third Edition, 1995, Prentice Hall, Latest Edition ISBN: 013309832X.
- H Benjamin C. Kuo H, "Digital Control Systems," Second Edition, 1995, Oxford University Press, Latest EditionISBN: 0195120647.

- Mohammed S. Santina H, Allen R. Stubberud and Gene H. Hostetter, “Digital Control System Design,” Second Edition, 1995, Oxford University , Latest Edition Press, ISBN: 0030760127.
- Katsuhiko Ogata, “Discrete-Time Control Systems,” Second Edition, 1995, Prentice Hall, Latest Edition, ISBN: 0130342815.

Electrical Engineering (Telecommunication/Communication Engineering Stream) Courses Outline

COMPUTER COMMUNICATION NETWORKS

Contact Hours:
Theory =48
Practical = 48
Total = 96

Credit Hours:
Theory = 3.0
Practical = 1.0
Total = 4.0

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	Example CLO	Domain	Taxonomy level	PLO
1.	To understand and analyze the issues with host naming, addressing, and routing packets in networks of networks (internetworks)	Cognitive	2	1
2.	To reproduce a simple network simulator to analyze the TCP protocol performance under limited network resources.	Psychomotor	3	3
3.	To analyze the issues in providing quality of service for networked multimedia applications, such as internet telephony.	Cognitive	4	2

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☑	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

- Network Models and Topologies
- Network Layering Concepts and Protocols
- Internet Protocol (IP) and Associated Control Protocols. End-To-End Protocols, With TCP and UDP as Examples

- Addressing schemes at link layer, network layer and transport layer
- Transmission Media and characteristics
- Switching Techniques
- Channel Access Techniques
- MAC
- Routing Protocols and Multicast
- Overview of Application Layer Protocols (HTTP, FTP, SMTP etc.)
- Multimedia Protocols (RTP, RTSP, RTCP)
- Security Mechanisms and Services
- Concepts of Symmetric and Asymmetric Cryptography, Digital Signature
- Convergence of communication networks

Teaching Methodology

- Lecturing
- Discussion
- Exercises

Assessment

Sessional & Mid term

- Written (Long Questions, Short Questions, MCQs)
- Quizzes
- Presentation
- Assignments
- Report Writing

Final Term

- Written (Long Questions, Short Questions, MCQs)
- Presentation
- Report Writing

Text and Reference Books:

- James F. Kurose and K. W. Ross, "Computer Networking: A top down approach".
- Bruce S. Davie, "Computer Networks: A Systems Approach", Morgan Kaufmann Publishers, Latest edition
- S. Tanenbaum, "Computer Networks", Prentice Hall, Latest Edition

SATELLITE COMMUNICATION

Contact Hours:
Theory =48
Practical = 0
Total = 48

Credit Hours:
Theory = 3.0
Practical = 0.0
Total = 3.0

Prerequisite Course:
Communication Systems

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

S#	Example CLO	Domain	Taxonomy level	PLO
1.	LEARN about different generations of satellites and develop and understanding of satellite subsystems	Cognitive	1	1
2.	SOLVE and ANALYZE the problems related to satellite communication links design.	Cognitive	4	2
3.	DESIGN an end to end communications link for given data rate, bandwidth and SNR requirements	Cognitive	5	3

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☑	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☑
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

- Introduction to Satellite Communication, Space-segment and ground segment
- Orbital Mechanics, Geostationary and Non geostationary Orbits, Launching and Spacecraft subsystems, Look angle determination, Orbital perturbations, Orbital effects in communication system performance space craft and its subsystem
- Satellite Link Design, Propagation Characteristics of Satellite Links, Channel Modeling, Access Control Schemes, Modulation Schemes, Multiple Access Schemes, Coding.
- System Performance Analysis, System Design, Space standards, Earth Station Technology.
- Satellite Applications such as earth observation, weather, and communication, VSATs and Network Architectures, GPS, Future trends

Teaching Methodology

- Lecturing
- Course projects
- Presentations
- Filed Trips

Text and Reference books:

- Tom Logsden, "Mobile Communication Satellites: Theory and Applications", McGraw-Hill, (Latest edition).
- Gerald M., Michel Bousquet, "Satellite Communication Systems: Systems, Techniques and Technologies", John Willey, (Latest Edition).
- Leon W. Couch, "Digital & Analog Communication Systems", Latest Edition, Prentice Hall, ISBN: 0131424920.
- Timothy Pratt, Charles W. Bostian and Jeremy E. Allnutt, "Satellite Communications," Latest Edition, 2003, John Wiley & Sons, ISBN: 0471429120.
- Dennis Roddy, "Satellite Communications", Latest Edition

OPTICAL COMMUNICATION

Contact Hours:
Theory =48
Practical = 48
Total = 96

Credit Hours:
Theory = 3.0
Practical = 1.0
Total = 4.0

Prerequisite Courses:

Communication Systems, Electromagnetic Field Theory

SUGGESTED COURSE LEARNING OUTCOMES:

Upon successful completion of the course, the student will be able to:

S#	Example CLO	Domain	Taxonomy level	PLO
1.	DESIGN and EVALUATE the performance of the optical systems	Cognitive	5	4
2.	ASSEMBLE different optical components to make a basic optical system	Psychomotor	3	5

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☐	7	Environment and Sustainability:	☐
2	Problem Analysis:	☐	8	Ethics:	☐
3	Design/Development of Solutions:	☑	9	Individual and Team Work:	☐
4	Investigation:	☑	10	Communication:	☐
5	Modern Tool Usage:	☑	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

- Comparison between optical and electrical mediums, basic optical communication system, Snell's law, refractive index, phase velocity and group velocity, optical and electrical bandwidth.
- Step index and graded index fibers, Ray Propagation through Optical Fibers, acceptance angle and acceptance cone, Numerical aperture
- Modes in planar wave guides, wave guiding condition, evanescent waves, modes in cylindrical fibers, Single mode fibers
- Attenuation due to: (i) absorption, (ii) scattering (iii) bending losses, Dispersion, Reflectance and optical return losses, special types of fibers.
- Optical sources and detectors, modulators and modulating schemes, demodulator and demodulation methods, couplers, connectors, switches, splicing, optical amplifiers and repeaters, Optical time division multiplexing, wavelength division multiplexing, link budgeting w.r.t time and power.
- LAN system, FDDI, SONETS and SDH, Wavelength routing based optical networks, Optical burst switching.

Teaching Methodology

- Lecturing
- Course / Lab projects
- Lab Demonstrations

Assessment

Sessional + Mid Term

- Written (Long Questions, Short Questions, MCQs)
- Assignments
- Projects

Final Term

- Written (Long Questions, Short Questions, MCQs)

- Project Report
- Lab Manuals
- Viva

Text and Reference books:

- John M. Senior, "Optical Fibre Communications: Principles and Practice", Latest Edition, Prentice Hall, ISBN: 0136354262.
- Gerd Keiser, "Optical Fibre Communications," Latest Edition, McGraw-Hill, ISBN: 0072360763.
- Harold Kolimbiris, "Fiber Optics Communications," Latest Edition, Prentice Hall, ISBN: 0130158836.
- Djafar Mynbaev and Lowell Scheiner, "Fibre-Optic Communications Technology," Latest Edition, Prentice Hall, ISBN: 0139620699.

Data Communication

Contact Hours:
Theory =48
Practical = 48
Total = 96

Credit Hours:
Theory = **3.0**
Practical = 1.0
Total = 4.0

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	Describe the fundamental concepts of data communications	Cognitive	2	1
2.	Explain elements of a protocol, and the concept of seven layers of OSI Model	Cognitive	2	1
3.	Discuss signals, signal encoding methods, analog to digital and digital to analog conversion and multiplexing at physical layer	Cognitive	2	1
4.	Understand and Demonstrate the data link layer services including error detection and correction, flow control and multiple access.	Cognitive	3	2

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☐	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

Principles underlying communication network design, including physical layer. Internet structure, Internet protocol models. Physical layer description including modulation, data transmission, line

encoding schemes, pulse code modulation (PCM), digital to analog conversion and multiplexing. Data link layer services including error correction and detection, flow control including stop and wait, Go Back N, Selective repeat, error control and High level data link layer control (HDLC). MAC layer description including ALOHA, CSMA/CD, CSMA/CA, controlled access and channelization.

Teaching Methodology

- Lecturing
- Written Assignments

Assessment

Sessional (25%)

- Quizzes 60%
- Assignments 40%

Mid Term (25%)

- Written (Long Questions, Short Questions, MCQs) 100%

Final Term (50%)

- Written (Long Questions, Short Questions, MCQs) 100%

Text book:

Data and Computer Communications by William Stallings

TRANSMISSION AND SWITCHING SYSTEMS

Contact Hours:	**Credit Hours:**
Theory =48	Theory = 3.0
Practical = 0	Practical = 0.0
Total = 48	Total = 3.0

SUGGESTED COURSE LEARNING OUTCOMES:

Upon successful completion of the course, the student will be able to:

Ser	Example CLO	Domain	Taxonomy level	PLO
1.	ACQUIRE the basic knowledge of Transmission and switching used in telecommunication network	Cognitive	1	1
2.	UNDERSTAND transmission, switching, access network, MUX standards, switching modes, telecom networks, exchange hierarchy, signaling, telecom management and enterprise networks, SS7 signaling call flow diagram	Cognitive	2	1

3.	SOLVE, ANALYZE and EVALUATE the problems using imagination and calculation while tackling different switching and transmission problems	Cognitive	4	2

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☐	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

- Transmission Systems including PDH and SDH, Synchronization, routing techniques, Line Encoding Techniques (e.g. HDB3, 2B1Q)
- Types of Switching Review of switching technologies Circuit, Message and Packet Switching
- Digital Telephone Network basics including packet based networks ,Telecommunication Network (PSTN, PLMN), Next generation network based protocols
- Exchanges Hierarchy, Basic Functions of a Circuit base and packet base Digital Switching Exchanges, SPC, Software Structure of SPC Digital Switches
- Telecommunications Traffic and models including characterization of PABX and Public exchange traffic, GOS, BHCA, Network Traffic Load and Parameters
- Basic functions of typical digital switching exchanges software structure of SPC digital switches, Line Codes for Fiber Optic Transmission, routing techniques, software life cycle
- Channel SS7 signaling components , intelligent Networks Associated Signaling (CAS) and Common Channel Signaling (CCS)
- SS 7 Signaling call flow problems and troubleshooting

Teaching Methodology

- Lecturing
- Guest Speaker
- Field Visits

Assessment

Sessional + Mid Term

- Written (Long Questions, Short Questions, MCQs)
- Presentation
- Assignments
- Report Writing

Final Term

- Written (Long Questions, Short Questions, MCQs)
- Presentation
- Report Writing

Text and Reference books:

- J. E. Flood, "Telecommunication Switching, Traffic and Networks" First Edition, 1995, Prentice Hall, ISBN-13: 978-0130333094.
- John Bellamy, "Digital Telephony", Third Edition, 2000, Wiley Interscience, ISBN-13: 978-0471345718.
- Roger L. Freeman, "Telecommunications Transmission Handbook", Fourth Edition, 1998, Wiley , ISBN-13: 978-0471672487.
- David R. Smith, "Digital Transmission Systems", Third Edition, 2012, Springer, ISBN-13: 978-1461347262.

ANTENNAS AND WAVE PROPAGATION

Contact Hours:
Theory =48
Practical = 48
Total = 96

Credit Hours:
Theory = 3.0
Practical = 1.0
Total = 4.0

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	Example CLO	Domain	Taxonomy level	PLO
1.	EXPLAIN the fundamental concepts of Antenna Radiation, Review basic performance parameters and Identify the difference between different types of Antennas	Cognitive	2	1
2.	ANALYZE the behavior of waves coming out of the Antenna	Cognitive	4	2
3.	COMPARE the performance of Antenna arrays based upon different arrangement of point sources	Cognitive	4	3
4.	DESIGN an antenna for the given requirements and Evaluate its performance for performance validation	Cognitive	5	3
5.	MEASURE various antenna parameters using test and measuring equipment such as Spectrum analyzer and vector network	Psychomotor	4	5

	analyzer.			

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☑	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☑	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

- Antenna and Radiation, Basic Antenna Types (Two wire antenna + dipole), Isotropic, omni-directional antennas, Practical antenna types
- Antenna pattern, Beam area, beam solid angle, radiation intensity, Gain and Directivity,
- Short dipole, Fields of a short dipole, The thin linear antenna, Radiation patterns of a dipole antenna, Helical antenna, Modes of operation (Helix), Design procedure
- Micro-strip antennas + feeding methods, Transmission line models, Cavity model, Slot antenna + feeding method, Different forms of slot antenna
- Horn Antenna, Phase Center, Rectangular horn design, Reflector antenna, Corner reflector + parabolic dish, Yagi-Uda configuration, Yagi-Uda design
- Point sources, Antenna arrays, Different cases of isotropic sources, Principle of pattern multiplication, Pattern synthesis
- Linear array of N isotropic sources, Evaluation of total field, Broadside and End-fire arrays, Beam scanning and Null pointing, Phase shifters, Beam switching feed network
- Antennas for different applications, Mobile phones and antennas, Satellite antennas, Active antennas, multiband / broadband antennas
- Reflection Coefficient, Vector Network Analyzer, anechoic chamber, Antenna gain measurement
- Maxwell's equations, Transmission Lines, Wave Equation, Plane waves, Phase velocity, Lossy media, Propagation mechanisms, Geometrical optics, Diffraction, Single knife edge, Fresnel zones, Propagation Models, Path loss, Noise modeling, Free space loss, Plane earth loss, Link Budget

Teaching Methodology

- Lecturing
- Guest Speaker
- Field Visits
- Lab demonstration

Assessment

Sessional + Mid Term

- Written (Long Questions, Short Questions, MCQs)
- Presentation
- Assignments
- Report Writing

Final Term

- Written (Long Questions, Short Questions, MCQs)
- Presentation
- Report Writing
- Viva

Text and Reference books:

- Antenna Theory: Analysis and Design, 4th Edition by Constantine A. Balanis SBN: 978-1-118-64206-1
- Antennas for all applications (2nd Ed.) by J. D. Krauss
- Antennas and propagation for wireless communication systems (2nd Ed.) by Simon R. Saunders

WIRELESS AND MOBILE COMMUNICATION

Contact Hours:
Theory =48
Practical = 48
Total = 96

Credit Hours:
Theory = 3.0
Practical = 1.0
Total = 4.0

Prerequisites:
Communication Systems

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	Example CLO	Domain	Taxonomy level	PLO
1.	UNDERSTAND the basics concepts of wireless communication and networks.	Cognitive	1	1
2.	UNDERSTAND and ANALYSE the different wireless multiple access techniques, paths loss models, wireless sensors networks and cooperative diversity networks	Cognitive	2	2
3.	DEMONSTRATE the wireless networks using different simulation tools.	Psychomotor	3	5

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☐	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☑	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course Outline:

- Cellular Concepts, Frequency reuse, Channel Interference
- Path loss models (Empirical, Probabilistic, Deterministic), shadowing, Multipath Models, multipath fading, wideband models,
- Capacity of wireless channels, digital modulation, Performance in wireless fading channels,
- Time Diversity, Frequency Diversity, Space Diversity, Cooperative Diversity
- Introduction to Cooperative Diversity Networks, Introduction to Wireless Sensors Networks

- Orthogonal Frequency Division Multiplexing (OFDM), Orthogonal Frequency Division Multiple Access (OFDMA), Time Division Multiple Access (TDMA), Code Division Multiple Access (CDMA)

Teaching Methodology

- Lectures
- Laboratory work
- Projects

Assessment

Sessional + Mid Term

- Written (Long Questions, Short Questions, MCQs)
- Presentation
- Assignments
- Report Writing

Final Term

- Written (Long Questions, Short Questions, MCQs)
- Presentation
- Report Writing

Text and Reference Books:

- Theodore S. Rappaport, "Wireless Communications", Latest Edition
- William Stallings, "Wireless Communication & Networks" Latest Edition

- William Lee, "Wireless & Cellular Communication", McGraw-Hill, Latest Edition
- Andrea Goldsmith, " Wireless Communication", Latest Edition
- Morvin K. Simon & Slim Alouini, " Digital Communication over Fading Channels" Latest Edition

DIGITAL SIGNAL PROCESSING

Contact Hours:
Theory = 48
Practical = 48
Total = 96

Credit Hours:
Theory = 3.0
Practical = 1.0
Total = 4.0

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	Example CLO	Domain	Taxonomy level	PLO
1.	ANALYSE and evaluate the properties of LTI systems in terms of its z-transforms.	Cognitive	4	1
2.	UNDERSTAND the sampling theorem and perform sampling on continuous-time signals.	Cognitive	2	2
3.	APPLY the concepts of all-pass and minimum-phase systems to analyze the LTI system and address complex design problems.	Cognitive	3	5
4.	EVALUATE design problems related to frequency selective processing and design FIR/IIR filters.	Cognitive	3	3
5.	CONSTRUCT systems for spectral estimation of real signals.	Psychomotor	3	2

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☑	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☑	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

- Review of Signals & Systems: Discrete LTI systems, Convolution, Difference Equations.
- z-transforms
- Sampling of Continuous Time Signals: Basic principles, Changing sampling rate, Pre-filtering to avoid aliasing, Quantization errors.
- Transform Analysis of LTI Systems

- Frequency response of LTI systems, All pass systems, Minimum phase systems.
- IIR & FIR Filters and Filter Design Techniques
- Discrete Time Fourier Transform (DFT) and FFT Algorithms
- Fourier Analysis of Real Signals with DFT

Practical:

- Implementation of FIR and IIR filter
- Signal detection
- Equalizer implementation
- Channel Estimation

Teaching Methodology

- Lectures
- Laboratory work
- Projects

Assessment

Sessional + Mid Term

- Written (Long Questions, Short Questions, MCQs)
- Presentation
- Assignments
- Report Writing

Final Term

- Written (Long Questions, Short Questions, MCQs)
- Presentation
- Report Writing

Text and Reference books:

- A.V. Oppenheim, R.W. Schafer and J.R. Buck, Discrete-Time Signal Processing, 3rd Edition, Pearson Education, 2009.
- S.K. Mitra, Digital Signal Processing: A Computer Based Approach, McGraw-Hill, 2011.
- J.G. Proakis and D. Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, Prentice-Hall, 2007.
- Li Tan, Digital Signal Processing Fundamentals and Applications, Academic Press, Elsevier, ISBN: 978-0-12-374090-8

TELECOM POLICIES AND STANDARDS

Contact Hours:
Theory =48
Practical = 0
Total = 48

Credit Hours:
Theory = 3.0
Practical = 0.0
Total = 3.0

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	Example CLO	Domain	Taxonomy level	PLO
1.	UNDERSTAND the basic concepts of telecom polices and standards	Cognitive	2	1
2.	FOLLOW the dynamics of telecom sector and emerging technologies and importance of effective regulation for the benefit of society.	Affective	3	6
3.	RECOGNIZE the importance optimization of scares resources like spectrum and quality of service of telecom services	Cognitive	4	12
4.	APPLY the knowledge of regulation for protecting the rights of stakeholders of telecom sector	Cognitive	3	8

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☑
2	Problem Analysis:	☐	8	Ethics:	☑
3	Design/Development of Solutions:	☐	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☑	12	Lifelong Learning:	☑

Course outline:

- Introduction to ICT, Basic Concepts and Selected Regulatory Terminologies, Introduction to the Real World Environment of Policy, Introduction to Telecom sector of Pakistan, Introduction to Telecom Standards and Protocols
- Standards Setting Process. Types of regulators, Telecom Deregulation and Liberalization, Regulation for Effective Competition, Introduction to International/ Regional Telecom regulatory organizations / Bodies

- Licensing Procedures, Interconnection regulation, Universal service, Spectrum Management, IMR regulation, Number portability regulation
- Functioning of Telecom Regulatory Stakeholders in Pakistan, Process of legislation in Pakistan, Telecom Policies, Act, Rules and Regulations, Regulation of electronic media, PEMRA ordinance 2002, PEMRA rules

Teaching Methodology

- Lecturing
- Guest Speaker
- Report Writing

Assessment

Sessional + Mid Term

- Written (Long Questions, Short Questions, MCQs)
- Presentation
- Assignments
- Report Writing

Final Term

- Written (Long Questions, Short Questions, MCQs)
- Presentation
- Report Writing

Text and Reference books:

- An Introduction to International Telecommunication Law, by C H Kenndy& MV Paster
- Telecommunication Regulation Handbook, Colin Blackman and Lara Srivastava, International Telecommunication Union, 2011
- Telecommunication Regulation Handbook, Hank Intven and McCarthy Tetraut, InfoDev World Bank, 2000.
- Digital Crossroads, Jonathan E. Nuechterlein and Philip J. Weiser, The MIT Press Cambridge, Massachusetts London, England
- Pakistan Telecommunication Authority Documents of Act, Rules and Regulations.
- Telecom Reform, Principles, policies and regulatory practices, William H. Melody 1997

EMERGING WIRELESS TECHNOLOGIES AND RF PLANNING

Contact Hours:
Theory =48
Practical = 0
Total = 48

Credit Hours:
Theory = 3.0
Practical = 0.0
Total = 3.0

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	Example CLO	Domain	Taxonomy level	PLO
1.	UNDERSTAND the basic knowledge of wireless standards and RF planning.	Cognitive	2	1
2.	ANALYZE the impact of optimization on network performance	Cognitive	4	5
3.	ANALYZE the effects of technological innovation in the field of wireless communication and planning of network	Cognitive	4	4

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☐	8	Ethics:	☐
3	Design/Development of Solutions:	☐	9	Individual and Team Work:	☐
4	Investigation:	☑	10	Communication:	☐
5	Modern Tool Usage:	☑	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

- Introduction to wireless technologies, Broadband Wireless alternatives, xDSL alternatives packet cable, WiMAX and Mobile WiMAX, LTE (Long Term Evolution), Mobile TV Platforms, Multimedia Broadcast/ Multicast Services (MBMS)
- RF Planning: Introduction to RF environment and propagation model, Wireless network planning process, Antenna and feeder system, Site survey, Link budget, Capacity theory
- RF Optimization: Network optimization process, Access optimization, signaling trace, Handoff optimization, Power control optimization, Drop call optimization
- Advanced tools for network planning: Simulation and optimization, Drive test

Teaching Methodology

- Lecturing
- Guest Speaker
- Field Visits
- Report Writing

Assessment

Sessional + Mid Term

- Written (Long Questions, Short Questions, MCQs)
- Presentation
- Assignments
- Report Writing

Final Term

- Written (Long Questions, Short Questions, MCQs)
- Presentation
- Report Writing

Text and Reference books:

- Ghosh, J. Zhang, J. G. Andrews and R. Muhammad, "Fundamentals of LTE", First Edition, 2010, Prentice Hall, ISBN:978-0137033119.
- Y. Xiao and Y. Pan, "Emerging Wireless LANs, Wireless PANs, and Wireless MANS: IEEE 802.11, IEEE 802.15, 802.16 Wireless Standard Family", First Edition, 2009, Wiley, ISBN: 978-0471720690.
- D. M. Dobkin, "RF Engineering for Wireless Networks", First Edition, 2004, Newnes, ISBN: 978-0750678735.
- H. Hammuda, "Cellular Mobile Radio Systems: Designing Systems for Capacity Optimization", First Edition, 1998, Wiley, ISBN: 978-0471956419.
- J. Wheat, R.Hiser, J. Tucker, A. Neely and A. McCullough, "Designing a Wireless Network: Understanding How Wireless Communication Works", First Edition, 2001, Syngress, ISBN: 978-1928994459.

DIGITAL COMMUNICATION

Contact Hours:
Theory =48
Practical = 48
Total = 96

Credit Hours:
Theory = 3.0
Practical = 1.0
Total = 4.0

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	Example CLO	Domain	Taxonomy level	PLO
1.	DESCRIBE random variables and random processes in terms of their mean, variance, and correlation functions and characterize important random variables and processes.	Cognitive	1	1
2.	IDENTIFY and ANALYSE methods of digital modulation and COMPARE their performance using signal-space analysis.	Cognitive	4	2
3.	EXPLAIN receiver techniques for detection of a signal in AWGN channels.	Cognitive	2	1
4.	IMPLEMENT error-control coding techniques using software / hardware platforms	Psychomotor	4	5

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☐	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☑	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

- Probability distributions, Random variables, Random processes, Statistical averages, Correlation.
- Digital Modulation Techniques: Signal space analysis, Binary Phase-shift Keying (BPSK), Quadrature Phase Shift Keying (QPSK), Quadrature Amplitude Modulation (QAM).
- Digital Demodulation & Detection Techniques: Correlator-demodulator, Maximum likelihood detection (MLD) in additive white Gaussian noise (AWGN), Bit Error Rate (BER) performance.
- Channel Encoder/Decoder: Linear block codes, Cyclic codes, Convolutional codes, Viterbi algorithm.
- Information Theory: Source Entropy, Huffman Coding, Channel Capacity

Teaching Methodology

- Lectures
- Exercises
- Lab Demonstrations
- Report Writing

Assessment

Sessional + Mid Term

- Written (Long Questions, Short Questions, MCQs)
- Presentation
- Assignments
- Report Writing

Final Term

- Written (Long Questions, Short Questions, MCQs)
- Presentation
- Report Writing

Text and Reference books:

- S. Haykin, Communication Systems, 4th edition, John Wiley, 2001.
- J.G. Proakis, Digital Communications, 4th ed, McGraw Hill, 2001
- B. Sklar, Digital Communications: Fundamentals and Applications, 2nd edition, Prentice Hall.
- Proakis, J.G. & Salehi, M., Communications Systems Engineering, 2nd edition, Pearson/Prentice Hall, 2002.

NAVIGATION AND RADAR SYSTEMS

Contact Hours:	**Credit Hours:**
Theory =48	Theory = 3.0
Practical = 0	Practical = 0.0
Total = 48	Total = 3.0

Prerequisite Course:

Communication Systems

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

S#	Example CLO	Domain	Taxonomy level	PLO
1.	UNDERSTANDING of radar range equation and other important parameters	Cognitive	1	1
2.	INVESTIGATE different types of radars for determination of its appropriateness for a given scenario	Cognitive	4	2
3.	DESIGN of a radar system for given requirements	Cognitive	6	3

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☑	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

- Radar Basics, Radar frequencies, Application of the Radar, Origin of the Radar.
- Radar Equations: Detection of signals in noise, receiver noise and signal to noise ratio, Probability of detection and false alarm, Integration of the Radar pulses, Radar cross section of targets, Transmitter power pulse repetition frequency.
- MTI and Doppler Radar: Delay line cancellers, Staggered pulse repetition frequencies, Limitation to MTI performance.
- Tracking Radar: Tracking with Radar, Monopulse tracking, Conical scan and sequential lobing.
- Radar Transmitters and Receivers: Linear beam power tubes, Solid state RF power sources, Magnetron, Cross field amplifiers, Other RF power sources, The receiver noise figure, Super Heterodyne receiver, Duplexers and receiver protectors, Radar displays.
- Propagation of the Radar Waves: Forward Scattering from a flat earth, Scattering from the round earth surface, Atmospheric Refraction, Standard and non-standard propagation, Diffraction, Attenuation by atmospheric gases, External environmental noise, Other propagation effects.
- Navigational aids: Terminology used in navigational Systems, Global and reginal navigational systems, Direction finding, GPS, Laser Gyro, Decca, Loran, Beacon system.
- Introduction to GNSS: Conventional navigation, Comparison of GNSS with other navigation systems, GNSS Transmitter and Receiver, GNSS Applications

Teaching Methodology

- Lecturing

- Course projects
- Filed Trips

Assessment

Sessional + Mid Term
- Written (Long Questions, Short Questions, MCQs)
- Assignments
- Projects

Final Term
- Written (Long Questions, Short Questions, MCQs)
- Project Report

Text and Reference books:
- Merrill I. Skolnik, "Introduction to Radar Systems", Latest edition.
- Gerry L Eaves & Edward K Reedy, "Principles of Modern Radar", Latest Edition.
- Teunissen, Montenbruck, “Springer handbook of Global Navigation Satellite Systems” 2017.

DIGITAL IMAGE PROCESSING

Contact Hours:	**Credit Hours:**
Theory =48	Theory = 3.0
Practical = 0	Practical = 0.0
Total = 48	Total = 3.0

Prerequisites:

Programming Fundamentals , Signals and Systems

SUGGESTED COURSE LEARNING OUTCOMES:

Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	ACQUIRE the basic knowledge of Digital Image Processing. UNDERSTAND the concepts of digital image acquisition	Cognitive	2	1
2.	ANALYZE and EVALUATE the digital image acquisition, perception and processing in order to use them in computer vision, image enhancement and compression	Cognitive	4	3

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):

The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☐	8	Ethics:	☐
3	Design/Development of Solutions:	☑	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

- Concept of digital image, Types of images
- Visual Perception, Light & Electromagnetic Perception
- Image sensing & acquisition
- Spatial and luminance resolution parameters, Image Sampling and quantization, Imaging defects, Noise, Histogram Processing
- Spatial Filtering, Convolution & Correlation, Smoothing & Sharpening
- Fourier Transform, Discrete Fourier Transform
- Frequency based filtering, Contrast enhancement & adjustment
- Noise elimination: smoothing, Histogram manipulation (equalization, compression & Stretching, Image Restoration & Reconstruction
- Edge detection, Image segmentation, Segmentation, Feature extraction
- Image Coding & Compression,
- Applications

Assessment

Sessional + Mid Term

- Written (Long Questions, Short Questions, MCQs)
- Presentation
- Assignments
- Report Writing

Final Term

- Written (Long Questions, Short Questions, MCQs)
- Report Writing

Text and Reference books:

- R. C. Gonzalez and R. E. Woods, "Digital Image Processing".
- R. C. Gonzalez and R. E. Woods, "Digital Image Processing using Matlab" Third Edition

RF AND MICROWAVE ENGINEERING

Contact Hours:
Theory =48
Practical = 48
Total = 96

Credit Hours:
Theory = 3.0
Practical = 1.0
Total = 4.0

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	Example CLO	Domain	Taxonomy level	PLO
1.	Evaluate the performance of a microwave device by looking at its s-parameters	Cognitive	2	1
2.	Synthesize a passive microwave device from given specifications	Cognitive	4	2
3.	Measure the behavior of passive microwave devices using EM simulation Tools	Psychomotor	4	5

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☐	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☑	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

- Basics of RF Circuits and Microwave Devices, Planar and 3D Transmission Lines
- Performance Parameters: Reflection Coefficient, VSWR, s-parameters
- RF / Microwave Device Analysis: Two port / Multi port Network Analysis using Scattering Parameters, Stability Circles, Noise performance, Smith Charts
  Waveguides, Couplers, Power Dividers / Combiners / Isolators / Duplexers, Microwave Switches
- Microwave Filters: Types, Responses, Performance Parameters, Complete Filter Design including impedance matching and other design constraints, Different types of filters
- Solid State Devices Introduction, Energy band Diagram, RFICs and MMICs
- Microwave Active Devices: BJT, HBT, HEMT, MOS Capacitor, FETs, MOSFET
- Microwave Amplifier Design: Introduction, Power Gain Equations, Stability Constraints, Noise Figure
- Applications of RF / Microwaves: Microwave Oscillators, Microwave Power Amplifiers, Travelling Wave Tubes, Microwave detectors and micers

Assessment

Sessional + Mid Term

- Written (Long Questions, Short Questions, MCQs)
- Presentation
- Assignments
- Report Writing

Final Term

- Written (Long Questions, Short Questions, MCQs)
- Report Writing

Text and Reference books

- Microwave Engineering: David Pozar
- Antennas for all applications (2nd Ed.) by J. D. Krauss
- Antennas and propagation for wireless communication systems (2nd Ed.) by Simon R. Saunders

ELECTRICAL ENGINEERING (COMPUTING STREAM) Courses Outline

OPERATING SYSTEMS

PREREQUISITE:
Introduction to Embedded Systems.

Contact Hours:
Theory =48
Practical = 48
Total = 96

Credit Hours:
Theory = 3.0
Practical = 1.0
Total = 4.0

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	**Understand** basic concepts of Operating Systems	Cognitive	3	1
2.	**Analyze using** various types of programming components	Cognitive	3	2
3.	**Design** using impact of various parameters related to deadlock and optimization	Cognitive	3	3

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☑
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☑	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

The concepts covered are; Definition of a process; process states and state transitions; process control block; operations on processes; interrupt processing; parallel processing; resource allocation; shared and unshared allocation; critical sections; semaphores; deadlock; deadlock

prevention, avoidance, detection, and recovery; memory management; memory allocation schemes; virtual memory; paging and segmentation; page replacement strategies; working sets; demand paging; job and processor scheduling; scheduling levels, objectives, and criteria; various scheduling algorithms; multi-processor considerations; file system functions; file organization; tree structured file systems; space allocation; file catalogs; file access control mechanisms; operating systems security, device drivers.

Text and Reference Books:

- Silberschatz, Galvin & Gagne, "Operating System Concepts", Wiley, Latest Edition
- A. S. Tanenbaum, "Modern Operating Systems", Prentice Hall, Latest Edition

COMPUTER VISION

Contact Hours:
Theory =48
Practical = 48
Total = 96

Credit Hours:
Theory = 3.0
Practical = 1.0
Total = 4.0

Prerequisites:

Linear Algebra, Signals and Systems

SUGGESTED COURSE LEARNING OUTCOMES:

Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	**Understand** basic concepts of Computer Vision	Cognitive	3	1
2.	**Analyze** various types of 2D and 3D Primitives and Model images.	Cognitive	3	2
3.	**Design** using impact of various parameters related to Linear Classification	Cognitive	3	3

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):

The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☑
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☑	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐

5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

- **Geometric Primitives and Transformations in 2D**:
  Digital Images, 2D Points, P^2space, Ideal points, Lines in 2D, Point on a line, intersection of 2 lines, line joining 2 points, Parallel lines, Line at infinity, 2D Transformations, Image Registration, Basic 2D Linear Transformations, Concatenation of transforms, Inverse Transformations, Hierarchical Transformation groups, Degrees of Freedom, Invariants, Factorizing transformations, SVD, Least squared error solution for recovering a linear transform, Pseudo inverse, warping.
- **3D Primitives, Transformations and Camera Model Types of images:**
  Transformation of lines in 2D, Points and planes in 3D, 3D Transformations, Translation, Scaling, Rotation about principal axis, properties of rotation matrices, Rotation about arbitrary axis, Rodriguez formula, Camera Model, Pinhole camera model, Pinhole camera model for non-canonical view, surveillance camera example, airplane example, Special Cases of Homography: Camera looking at a plane, Camera undergoing rotation, Camera Calibration, Camera Anatomy, Action of camera on points, lines, planes, Back-projection, Vanishing points and vanishing lines, Orthographic Camera.
- **Feature Detection and Matching:**
  Image Gradients, Line Detection, Image Features, Corner Detection, KLT, Making Panorama, SIFT, Global Features, HOG, PCA
- **Learning Algorithms:**
  Eigenfaces, Image Classification, Learning algorithms, classification basics, Nearest Neighbor, K-NN, Unsupervised Learning, K-Means, MeanShift Segmentation, Kernel Density Estimation, Bag of Words for Scene Categorization
- **Linear Classifiers:**
  Generative vs Discriminative Learning, Curse of Dimensionality, Error Types, Linear Discriminant Functions (Discriminative Approach), Linear Machine, Kernel Trick, Gradient Descent, Stochastic Gradient Descent, Perceptron, Linear Machines applied on Image Categorization, Hinge Loss, Softmax, Regularization

- **Deep Learning:**
  Artificial Neural Networks, Back-Propagation Algorithm, Convolutional Neural Networks, Examples of CNN Architectures, Deep learning applications.

Text and Reference books:

- Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer 2010.
- Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press 2016.
- Richard Hartley and Andrew Zisserman, "Multiple View Geometry in Computer Vision", 2nd Ed, Cambridge University Press, 2004.

Digital System Design

Contact Hours:
Theory =48
Practical = 48
Total = 96

Credit Hours:
Theory = **3.0**
Practical = **1.0**
Total = **4.0**

PREREQUISITE
Introduction to Embedded Systems

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	**Understand** basic concepts of VHDL Systems	Cognitive	3	1
2.	**Analyze** various types of architectures	Cognitive	3	2
3.	**Design** using impact of various parameters related to Optimization	Cognitive	3	3

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☑
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☑	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

Basic VHDL Elements and Semantics, Industry standard EDA tools for logic description, simulation and synthesis, VHDL Design Styles, Sequential and Concurrent Code, Programmable Logic architecture (i.e., PLD, FPGA and CPLD and particularly how these structures affect the outcomes of the synthesize process), Digital Design and FPGAs; FPGA Based System Design; FPGA Fabrics (SRAM-Based FPGAs, Permanently Programmed FPGAs, Chip I/O, Circuit Design of FPGA Fabric); Embedded Blocks, Multipliers, Adders, Carry Chains, Embedded Processors, and interfaces, Advanced VHDL Coding Topics (Procedure, Functions and etc), FPGA Design Flow based on VHDL (Place and Route, Synthesize & Fitting),State Machine Design, Optimization and principles Using VHDL, Arithmetic Circuits (Addition, Subtraction, and Division), Architectures for

Basic Building Blocks, Adder, Compression Trees, and Multipliers, Barrel Shifter, Abstract hardware models; compilation and optimization techniques

Teaching Methodology

- Lecturing
- Written Assignments
- Report Writing

Assessment

Mid Term

- Written (Long Questions, Short Questions, MCQs)
- Presentation 20%
- Assignments 20%
- Report Writing 10%

Final Term

- Written (Long Questions, Short Questions, MCQs)
- Presentation 20%
- Assignments 20%
- Report Writing 10%

Recommended book:

- Wayne Wolf, "FPGA Based System Design", PRENTICE HALL, 2004, ISBN: 0-13-142461-0.
- Volei A. Pedroni "Circuit Design and Simulation with VHDL", MIT Press, 2nd Edition, 2010, ISBN: 978-81-203-4301-6.
- Charles H. Roth, Jr. "Digital System Design Using VHDL", Cengage Learning, 2nd edition, 2008, ISBN: 978-0534384623.
- Kenneth L. Short "VHDL For Engineers", Prentice Hall, 2008, ISBN: 978-0131424784.

Network Security

Contact Hours:	**Credit Hours:**
Theory =48	Theory = 3.0
Practical = 0	Practical = 0.0
Total = 48	Total =3.0

Prerequisite:

Computer Communication Networks.

SUGGESTED COURSE LEARNING OUTCOMES:

Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	**Understand** the fundamentals of cryptography.	Cognitive	3	1
2.	**Analyze** the tradeoffs of balancing key security properties (Confidentiality, Integrity, Availability).	Cognitive	3	2
3.	Analyze, implement and maintain security requirements and mechanisms in various computer systems and networks	Cognitive	3	3

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):

The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☑
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☑	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course Outline:

Ability to achieve security in a multiuser environment and ensuring basic security mechanism. The main topics includes: Introduction to cryptography and Network Security, Security architecture, Security attacks, services and mechanisms, Security Models, Classical encryption techniques, Modern encryption techniques (DES, AES), Modes of operation , Stream Ciphers , Public Key Encryption and RSA , Hash and MAC Functions, Digital Signatures, Key Management, Network Security Application(Security mechanisms on different layers), PKI, Email Security (PGP and S/MIME), IPSec, SSL and TLS , HTTPS, System Security(IDS, Firewalls , Malicious software's /Trojans/spywares/adwares/viruses/worms), Implementation of security application , providing the network authentication, integrity and confidentiality , Packet and application level firewalls and intrusion detection systems, design of Line encryptors using multicore architecture, Security Requirements for cryptographic modules(FIPS PUB 140-2), Development of penetration testing toolkits and implementation of attack detection methodologies.

Recommended Books:

- Information security: Principles and practice. Mark Stamp
- Foundations of security: what every programmer needs to know. Neil Daswani
- Applied Cryptography. Bruce Schneier
- Security Engineering: a guide to building Dependable Distributed systems. Ross Anderson (First edition)

- Introduction to Network security. Matt Bishop
- Cryptography and network Security 5th edition: by William stalling

Network and Systems Programming

Contact Hours:
Theory =48
Practical = 0
Total = 48

Credit Hours:
Theory = 3.0
Practical = 0.0
Total =3.0

Prerequisite:
Programming Fundamentals, Computer Communication Networks,

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	**Understand** basic concepts of Sockets based programming	Cognitive	3	1
2.	**Analyze** various types of multicasting and broadcasting applications.	Cognitive	3	2
3.	**Implementation of** Network Management Schemes	Cognitive	3	3

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☑
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☑	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course Outline:

The main topics includes: Review of Transport layer protocols (TCP , UDP and SCTP) , Introduction to Linux operating system and .Net based Socket Programming , Sockets (TCP.UDP and RAW), Advanced Name and Address Conversions, Handling SIGNALS I/Os, I/O Multiplexing using select and poll , Non-blocking I/O, Multithreading, Daemon Processes, IPC mechanisms (Pipes , Shared memory ,Semaphores , Remote procedure calls, Messaging Queues), Broadcasting/ Multicasting, Data-link Access using SOCK_PACKET and libpcap, libpcap architecture with examples

of transmitters and receivers, Implementation of Network management applications with SNMP, Development of multithreading and multi-core applications,(e.g. Web proxy and URL filtering).

Recommended Book:

- W. Richard Stevens, Bill Fenner and Andrew Rudolph, Unix Network Programming, Volume I, 2004.

Embedded Systems

Contact Hours:
Theory =48
Practical = 0
Total = 48

Credit Hours:
Theory = 3.0
Practical = 0.0
Total =3.0

Prerequisite:
Introduction to Embedded Systems, Programming Fundamentals

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	Explain design challenges, hardware software co-design issues and different hardware platforms available in embedded systems	Cognitive	3	1
2.	Analyze serial and parallel communication protocols and demonstrate use of peripheral devices like interrupts, timers, sensors, actuators and converters	Cognitive	4	2
3	Examine role of software components like codec libraries, device drivers and real time operating systems (RTOS) in embedded system design	Cognitive	4	3
4	Propose solutions for inter-process communication, process synchronization in embedded software through semaphores and conditional variables	Cognitive	5	5
5	Develop schedules for concurrent process execution using preemptive and non-preemptive scheduling algorithms	Cognitive	5	3

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of	☑	9	Individual and Team Work:	☐

	Solutions:				
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☑	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course Outline:

Introduction to Embedded systems, Evolution, Issues and Challenges, Embedded Design Constraints
Embedded Microprocessor Architecture and Types , Von Neumann vs Harvard Architecture
Superscalr vs. VLIW Processor Architectures, Embedded Controllers vs. DSP Processors
ASIC's & FPGA's System on Chip (SOC)
I/O devices and Communication in Embedded Systems
Timers & Interrupts, Sensors & Actuators, Bus Arbitration, Memory Hierarchy & Cache structure
Virtual Memories and MMU, Serial & Parallel Communication Protocols, RS232, I2C, CAN, ISA, PCI, Bluetooth, 802.11b WLAN
Embedded Software Design
Hardware/software trade-offs, Hardware/firmware partitioning, Programming Languages for Embedded Software, Embedded Software Optimization, Processes, tasks, threads, context switching
Thread states , running, blocked, finished Process Synchronization
Semaphores & Mutexes, Inter- Process communication (IPC), shared memory, mailboxes
Process Scheduling, Time driven vs. Priority driven scheduling, Preemptive and non-preemptive systems
Scheduling algorithms, First come first serve (FCFS), Round Robin (RR), SJF, Rate-monotonic algorithm and EDF scheduling, Real-Time Operating Systems, Introduction to Real Time Operating Systems
Real Time kernel, Kernel space vs. user space, Scheduling in real time operating systems
Survey of different RTOS's Programming for con-current Processes
Mutexs and condition variables, Reader writer problem, Producer consumer problem

Recommended Book(s)

Embedded System Design A Unified Hardware Software Introduction By Frank Vahid, Tony D. Givargis, John Wiley And Sons
Real Time Systems by Jane W. S. Liu, Pearson Education

Reference Book(s)

An Embedded Software Primer, David E. Simon
Embedded Systems Architecture, Programming And Design By Raj Kamal
Embedded Systems Building Blocks By Jean J. Larbosse

Parallel Processing

Contact Hours:
Theory =48
Practical = 48
Total = 96

Credit Hours:
Theory = 3.0
Practical = 1.0
Total = 4.0

Prerequisite:
Computer Architecture, Programming Fundamentals

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	**Understand** basic concepts of Parallel Processing	Cognitive	3	1
2.	**Analyze** various types of processors	Cognitive	3	2
3.	**Design** using impact of various parameters related to topologies	Cognitive	3	3

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☑
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☑	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course Outline:

Parallel Processing Motivation, Scope & Applications, Implicit Parallel Arch: ILP, Pipelining, Superscalar & VLIW, Parallel Memory Arch: Physical/Logical, Shared/Dist. , parallel system Arch: SIMD/MIMD, Multicore SMP, UMA/NUMA, Vector/array processor, Cluster Multicomputer, LAN/SAN, Parallel Program Models: SM vs Message Passing, MPMD/ SPMD, Problems: SMP parallelism limit & Message Passing Protocol, IN : array/ mesh/ hypercube topologies & Evaluation, Dynamic IN : crossbar & multistage-IN configs & Evaluation, Routing Algorithms for Static & Dynamic Interconn-Networks, GPU vs CPU arch, CUDA Memory & Threads hierarchy, cudaC host/device Memory allocation & data transfer APIs, cudaC threads-exec-config Mapping to 1-D Arrays & 2-D Images, cudaC Kernel code/Launch: Vector-Add & Image-Multiply, cudaC Image Processing: brightness, contrast, resolution, histogram, cudaC SignalProcessing: FIR Filter, 1D/2D Convolution, MatrixOps, GPU: Warp/scheduling, scalability, contDiversion, PinnedMem, DMA, Program Message

Passing platforms: Pseudo-code based, Program Message Passing platforms: MPI-code based, Partitioned Processing 1D/2D Image & Matrix-Operations, Program Joint MPI-cudaC: 1D/2D partitioned Image & Matrix Ops, Joint MPI-CUDA Projects Solution methodology, Multiprocessor Cache Coherence issues & design choices, Bus-based MESI & Directory-based Normal/ Efficient CC-Protocol, PRAM-models & Parallel Performance Evaluation Program multicore platforms: multi-Thread fork-join-mutex based Program Multicore platforms: open MP based Embedding Static Topologies (array/mesh /hypercube),Group Communication Operations, one-to-all & all-to-all Broadcast/Reduction, Scatter/Gather,Cost (Compute+Comm) 1D/2D Parallel Partitioned Tasks.

Recommended Books:

- Introduction to Parallel Computing (2nd Ed) by Grama
- Parallel Computers: Architecture & Programming by V. Rajaraman
- Programming Massively Parallel Processors (2nd Ed) by D.B.Kirk

GENERAL ELECTRICAL ENGINEERING DEGREE PROGRAM

SPECIALIZED COURSES OUTLINE

Analog and Digital Communication

Contact Hours:
Theory =48
Practical = 48
Total = 96

Credit Hours:
Theory = **3.0**
Practical = **1.0**
Total = **4.0**

SUGGESTED COURSE LEARNING OUTCOMES:

Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	Analyze signals and systems for continuous wave and digital modulation and demodulation techniques.	Cognitive	4	2
2.	compare and analyze the performance of various analog communication systems in the presence of noise	Cognitive	4	2
3.	Design AM and FM transmitters and receivers.	Cognitive	5	3

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☐	7	Environment and Sustainability:	☐
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☑	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☐	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

Introduction to Communication Systems- Elements and Limitations of Communication Systems, Modulation and Coding. Signals, Spectra and Filtering, Linear CW Modulation, Angle CW Modulation, Sampling and Pulse Modulation, Receivers for CW Modulations, Probability and Random Processes, Analog Communication in Noise, Baseband digital Transmission, Bandpass digital transmission

SUGGESTED LAB COURSE LEARNING OUTCOMES:

Ser	CLO	Domain	Taxonomy level	PLO
1.	To observe different data formats (Line codes).	Psychomotor	1	1
2.	Practice different modulation techniques.	Psychomotor	3	1
3.	Demonstrate AM and FM transmitters and Receivers.	Psychomotor	4	1

Teaching Methodology

- Lecturing
- Written Assignments
- Report Writing

Text book:

- Communication Systems, by Bruce Carlson

Reference book:

- Modern Digital and Analog Communication Systems, by B.P Lathi
- Analog and Digital Communication, by Simon Haykin.

Control Systems

Contact Hours:
Theory =48
Practical = 48
Total = 96

Credit Hours:
Theory = **3.0**
Practical = **1.0**
Total = **4.0**

SUGGESTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

Ser	CLO	Domain	Taxonomy level	PLO
1.	Acquire sufficient knowledge to mathematically **Model** the behavior of different physical systems	Cognitive	3	1
2.	**Analyze** the behavior of system using mathematical techniques	Cognitive	4	2
3.	**Design** controllers to meet the specified control design objectives such as faster transient response and smaller steady state errors while ensuring system stability.	Cognitive	5	3
4.	Use **Modern Tools** for system modeling, analysis, design validation and performance comparison of different types of controllers.	Cognitive	6	5

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):
The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☑	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☑	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course outline:

Systems and their models, dynamic response

Modeling examples, differential equations, impulse response, transfer functions, poles and zeros, feedback.

Root locus design

Evans' root locus method, dynamic compensation.

Frequency response design

Bode plots, Nyquist stability criterion.

State space design

Introduction to modern control, linear pole placement, estimator design, LQR.

Grading Policy

Mid Term (25%)

- Written (Long Questions, Short Questions) 100%

Final Term (50%)

- Written (Long Questions, Short Questions) 100%

Sessional (25%)

- Assignments 20%
- Quizzes 80%

Text/Reference book:

1. Norman S. Nise, "Control Systems Engineering", seventh edition.
2. Franklin, Powell and Emami-Naeini, "Feedback Control of Dynamic Systems", seventh edition.
3. Steffani, Savant, Shahian and Hostetter, "Design of Feedback Control Systems" 4th Edition, Saunders College Publications.
4. Katsushiko, Ogata, "Modern Control Engineering," McGraw-Hill, `5th Edition
5. R. C. Dorf and R. H. Bishop, "Modern Control Systems," 12th Edition
6. B. C. Kuo, "Automatic Control Systems" 7th Edition

POWER SYSTEM ANALYSIS AND PROTECTION

Contact Hours:
Theory =48
Practical = 48
Total = 96

Credit Hours:
Theory = **3.0**
Practical = **1.0**
Total = **4.0**

PREREQUISITE
Electrical Network Analysis

SUGGEDTED COURSE LEARNING OUTCOMES:
Upon successful completion of the course, the student will be able to:

S. No.	CLO	Domain	Taxonomy level	PLO
1.	To carry out, plan and propose the power flow in electric networks using different methods and understand the concepts of basic power system stability	Cognitive	6	4
2.	To solve, analyze and discuss the problems in power system in normal as well as faulted state	Cognitive	4	2

3.	To solve and analyze the problems in power system protection	Cognitive	3	2
4.	To demonstrate and construct individually the one line diagrams and Matrices of complex power systems	Psychomotor	3	3
5.	To conduct experiments on Trainers, MATLAB and ETAP to observe and verify the experimental results	Psychomotor	4	5

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):

The course is designed so that students will achieve the following PLOs:

1	Engineering Knowledge:	☑	7	Environment and Sustainability:	☐
2	Problem Analysis:	☑	8	Ethics:	☐
3	Design/Development of Solutions:	☑	9	Individual and Team Work:	☐
4	Investigation:	☑	10	Communication:	☐
5	Modern Tool Usage:	☑	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

COURSE OUTLINE

Introduction:

- Structure & Growth of Electrical Power Systems, Per unit system of calculations, One Line Diagram, Impedance & Reactance Diagram, Bus Impedance and Admittance Matrices---Formation, Modifications and Importance.

Load Flow Solution:

- Load Flow Problem Formulation & Solution Methodologies, Gauss Siedel, Newton Raphson and Fast Decoupled Method and Load Flow Control.

Fault Analysis:

- Faults and their Types, Symmetrical Fault Analysis (SFA), Unsymmetrical Fault Analysis (UFA), Symmetrical Components, Sequence Impedances, Sequence Networks of Loaded Generator, Line-to-Ground (L-G) fault, Line-to-Line (L-L) Fault and Line-to-Line-Ground (L-L-G) Fault analysis of unloaded generator and Power system.

Power System Stability

- Stability Problem, Steady State & Transient Stability, Solution of Swing Equation, Factors Effecting Stability.

Power System Protection

- Protective Relays, Instrument Transformers, Overcurrent Protection, Differential Protection, Earth Leakage Protection, Protection of Transformers, Generators and Transmission Lines, Circuit Breakers and Switchgears, Fuses, Circuit interruption, Circuit Breaker-Types.

RECOMMENDED BOOKS:

1. Hadi Saadat, “Power System Analysis”, McGraw-Hill International Editions.
2. Glover and Sarma “Power System Analysis”
3. William D. Stevensons Jr, "Elements of Power System Analysis", McGraw Hill, Latest Ed.
4. B. M. Weedy ,B. J. Cory, N. Jenkins, Janaka B. Ekanayake, Goran Strbac “Electric Power Systems”, John Wiley.
5. Fundamentals of Power System Protection by Y.G. Paithankar and S.R. Bhide.
6. Protective Relaying; Principles and Applications, by J. Lewis Blackburn, Thomas J. Domin.

Power Generation, Transmission & Distribution

Contact Hours:
Theory =48
Practical = 48
Total = 96

Credit Hours:
Theory = **3.0**
Practical = **1.0**
Total = **4.0**

Prerequisite:

Electrical Network Analysis

Course outcome:

SUGGESTED COURSE LEARNING OUTCOMES:

Upon successful completion of the course, the student will be able to:

S. No.	CLO	Domain	Taxonomy level	PLO
1.	To understand basic operation of different types of power plants	Cognitive	1	1
2.	Selection of power plants based on the site, cost and performance	Cognitive	2	1
3.	To understand power Transmission and selection of voltages.	Cognitive	3	1
4.	To understand power distribution and types of distribution systems.	Cognitive	4	1
5.	To conduct experiments on Trainers, MATLAB and ETAP to observe and verify the experimental results	Psychomotor	4	5

RELEVANT PROGRAM LEARNING OUTCOMES (PLOs):

The course is designed so that students will achieve the following PLOs:

1 Engineering Knowledge: ☑ 7 Environment and Sustainability: ☐

2	Problem Analysis:	☐	8	Ethics:	☐
3	Design/Development of Solutions:	☐	9	Individual and Team Work:	☐
4	Investigation:	☐	10	Communication:	☐
5	Modern Tool Usage:	☑	11	Project Management:	☐
6	The Engineer and Society:	☐	12	Lifelong Learning:	☐

Course Outline:

Power Generation

Types of power Station, Cost of Electrical Energy, Hydro Electric generation, Costs of Hydro Electric Stations, Steam Power, Gas Turbines, Diesel Electric generation, Nuclear Power Stations and renewable energy generation.

Power Transmission

One-line diagram, choice of voltage and choice of AC/DC systems, introduction to HV, EHV and UHV systems. Conductor Types, skin effect, Ferranti effect. Short, medium and long transmission lines, voltage regulation and line surges. Line Supports, Sag and tension calculation, effect of wind pressure and ice loading, conductor vibration and use of dampers. Insulators and Insulator material, string efficiency, corona effect. Introduction to HVDC transmission.

Power Distribution

Distribution systems. Primary, secondary and tertiary voltages. Radial and ring main systems, distribution transformers, Power Factor, Disadvantages and causes of low power factor, methods for improvement, application of shunt capacitors in distribution network.

Recommended Books:

1. M. V. Deshpande, “Elements of Electrical Power Station Design”, 2010, PHI Publishers
2. M. M. El Wakil, “Power Plant Technology”, McGraw Hill International Editions, Electrical and Mechanical Engineering Series.
3. Arche W. Culp “Principles of Energy Conversion”, Latest Edition. TuranGonen, “Electrical Power Distribution System”, CRC Press.
4. M. L. Anand, “A Text Book of Electrical Power”, Latest Edition
5. Arche W. Culp “Principles of Energy Conversion”, Latest Edition.
6. Turan Gonen, “Electrical Power Transmission System Engineering --- Analysis & Design”, John Wiely& Sons.

7. Electrical Transmission and Distribution Reference Book by Central Station Engineers, Westinghouse

M.Sc./MS/ME IN ELECTRICAL ENGINEERING

The proposed list of subjects for MEng/MSc/ME programmes in Electrical Engineering in different specializations is given below. This list is not exhaustive. Individual universities/ institutions may design specializations and subjects keeping in view the demand and availability of faculty and facilities. The curriculum/ syllabus shall be approved by the individual university/ institution as per procedures listed in their charters.

List of Courses (MSc Electrical Engineering with Specialization in Power System Engineering)

- Advanced Power System Analysis
- Advanced High Voltage Engineering
- Power System Stability and Control
- Computational methods in power system analysis
- Flexible AC Transmission System
- High voltage DC Transmission System
- Distribution System Modeling and Analysis
- Advanced Power System Operation and Control
- Power Generation Economics
- Power System Restructuring
- Advanced Power System Transmission
- Power System Reliability
- Advanced Smart Grid
- Power System Transients
- Power Quality
- Modeling and Simulation of Power System Components
- Artificial Intelligence Techniques in Power System
- Advanced Power System Protection
- Digital Signal Processing in Power System
- Insulation Coordination in Power Systems
- Power Generation Economics
- Power System Restructuring
- Energy Management
- Energy Audit
- Advanced Renewable Energy Systems
- Distributed Generation
- Condition Monitoring Techniques

- Advanced Electrical Machines and Drives
- Advanced Power Electronics
- Modeling and Simulation of Electrical Machines
- Special Purpose Electrical Machines
- Advanced Electrical Machine Design
- Maintenance and Troubleshooting of Electrical Machines
- Advanced Control Systems
- Photovoltaic Systems
- Power System Planning
- Integration of Green Energy sources with power system
- Optimization techniques in power systems
- Advanced topics in power system
- Power Electronic Converters

List of Courses (MSc Electrical Engineering with Specialization in Control Systems)

- Linear Systems Theory
- Nonlinear System Analysis
- Nonlinear Control Systems
- Multivariable Feedback Control
- Robust Control Systems
- Advanced Control Systems
- Distributed Control Systems
- Guidance Navigation and Control
- Optimal Control Systems
- Control of Electric Machine Drives
- Control of Power Electronic Converters
- Digital Control Systems
- Adaptive Control Systems
- Stochastic Control Systems

List of Courses (MSc Electrical Engineering with Specialization in Electronics, Communications and Computing)

- Simulation Modeling and Analysis
- Stochastic Processes
- Optimization Theory
- Advanced Computer Architecture
- Advanced Computer Networks
- Machine Learning
- Data Mining Concepts and Algorithms
- Embedded Systems Design
- Operating Systems Design
- Image and Video Processing
- Design and Analysis of Algorithms
- Network Security
- Wireless and Mobile Communication
- Information and Coding Theory
- Statistical Signal Processing
- Adaptive Filter Theory
- Optical Communications
- Advanced Electromagnetic Theory
- Analysis and Design of Microwave Linear Circuits
- Advanced VLSI System Design
- Antenna Theory and Design
- Power Electronic Converters
- Control of Electric Machine Drives
- Advanced Power Electronics
- Array Signal processing
- Adaptive Array Processing
- Artificial Intelligence
- Pattern Recognition
- Distributed Systems
- Nonlinear Microwave and RF Circuits

List of Courses (MSc Electrical Engineering with Specialization in Electronics, and Embedded Systems)

- Simulation Modeling and Analysis
- Stochastic Processes
- Electronic Design Automation

- Advanced Microsystems Technology
- MEMS and Micromachining
- Nanotechnology
- Advanced VLSI Design
- Digital Signal Processing Using FPGA
- Computer Vision
- Embedded Operating System
- Advanced Electromagnetic Field Theory
- Microwave Devices and Circuits
- Radiating Systems & Antennas
- Advanced Digital Signal Processing
- Advanced FPGA-Based Design
- Advanced Control System
- Advanced Microcomputer System
- Linear System Theory
- Control System with Embedded Implementation
- Multimedia Systems
- Filter Designing Techniques
- Switched Mode Power Converters
- HDL and High Level Synthesize

List of Courses (MSc Electrical Engineering with Specialization in Communication/Telecommunication / Network Engineering)

- Cellular and mobile communications
- RF circuits design
- Optimization theory
- Mobile and sensor networks
- Advanced communication systems
- Principles of digital communications
- Advanced digital communications
- Information theory and coding
- Advanced communication networks
- Advanced microwave engineering
- Radar signal processing
- Advanced concepts in radar systems
- Global positioning and navigation systems
- Advanced digital signal processing
- Advanced mobile communication
- Signal detection and estimation

- Advanced optical communication
- Advanced satellite communications
- Advanced wireless communications
- Broadband communication
- Electromagnetic field analysis
- Advanced EMF theory
- Multimedia communication
- Cryptography and network security
- Cyber security
- Cognitive radio networks
- Software defined radios
- Signal processing applications in reconfigurable architecture
- Stochastic processes
- Modeling and simulation
- Telecommunication network operations
- Digital image processing
- Antenna theory and design
- Mobile and pervasive computing
- Scientific writing and research methodology
- Microwave networks & passive components
- Adaptive filter theory
- Computational electromagnetic
- Microwave and RFIC design
- Filtering & tracking
- Computer vision
- Pattern recognition
- Machine learning
- Medical image processing
- Hardware security
- Next generation networks
- Smart grid
- Quantum communication
- Quantum cryptography
- Cloud computing
- Advanced digital system design
- Quality of service in telecom networks
- Network planning and optimization
- Data communication and security
- Data mining
- Big data
- Computer sensing

- Telecom policies and standards
- RF electronics
- SS7 and intelligent networks
- Internet of things
- Human computer interaction
- Telecommunication networks management
- Multimedia systems
- Speech communication
- Wireless sensor networks
- Data security
- Telecommunication economics
- Electromagnetic compatibility
- Visible light communications
- Free space optical communications
- Digital broadcasting
- Array signal processing
- Smart antennas